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Mother-daughter communication about breast cancer risk: interpersonal and biological stress processes

Kate L. Berlin · Charissa Andreotti · Fiona Yull · Ana M. Grau · Bruce E. Compas

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Abstract Women with a personal or maternal history of breast cancer experience psychological stress in relation to breast cancer risk, and adolescent and young adult daughters are particularly at risk for experiencing stress related to their mothers' history of breast cancer. The current study examined interpersonal and biological stress responses during a laboratory-based communication task about breast cancer risk in 32 mother-daughter dyads and explores whether certain communication styles between mothers and daughters are associated with increased stress reactivity during the task. Five saliva samples were collected from each participant to determine cortisol baseline levels, reactivity to, and recovery from the task. Negative maternal communication was associated with higher cortisol levels in daughters. In addition, maternal sadness was correlated with lower levels of daughters' cortisol at all time points with the exception of baseline measures. Implications for understanding the psychobiology of stress in women at risk for breast cancer are highlighted.

Keywords Mother · Daughter · Breast cancer · Communication · Stress · Cortisol

Introduction

Breast cancer is the second leading cause of cancer death in American women (American Cancer Society, 2011). It is well documented that a maternal history of the disease significantly increases a women's risk for developing breast cancer and living with the threat of breast cancer is a source of significant chronic stress (e.g., Cohen et al., 2002; Kim et al., 2003). Two features of the chronic stress of breast cancer risk are salient. First, the stress of breast cancer risk affects and is affected by the relationship between mothers and daughters. And second, this chronic stress triggers psychological and biological responses that may have important health implications for mothers and daughters. The current study examined interpersonal and biological aspects of stress during conversations about breast cancer between mothers and their adolescent and young adult daughters.

Women with a maternal or broader family history of breast cancer, but no personal cancer history, often experience psychological stress in relation to breast cancer risk (e.g., Cohen et al., 2002; Kim et al., 2003). Adolescent and young adult daughters are particularly at risk for experiencing psychological stress around their mother's cancer diagnosis (Compas et al., 1994), and chronic stress has been shown to take both a psychological (Keller et al., 2007) as well as a biological toll (Juster et al., 2010). Further, the relationship between mothers and daughters represents an important interpersonal dyad within broader relationships in the family. Research on families coping with stress indicates that adolescent girls and young adult women are likely to turn to their families, and most significantly their mothers, for emotional support and assistance in problem-solving and decision making when faced with increased risk for breast cancer (e.g., Chalmers et al., 1996; Spira & Kenemore, 2000). Mother-daughter relationships are thus likely to be especially challenged by the stress of increased breast cancer risk (e.g., Grant & Compas, 1995).

K. L. Berlin · C. Andreotti · F. Yull · A. M. Grau · B. E. Compas (✉)
Department of Psychology and Human Development, Vanderbilt University, Peabody 552, 230 Appleton Place, Nashville, TN 37203, USA
e-mail: bruce.compas@vanderbilt.edu

For example, in a retrospective study of adult women whose mothers had been diagnosed with breast cancer, Wellisch et al. (1992) found adult women (age 18-64 years-old) who were adolescents when their mothers were diagnosed with breast cancer reported the greatest amount of stress at the time of their mother's diagnosis and displayed the poorest long-term adjustment to their mother's disease. Brown et al. (2007) found that daughters of breast cancer survivors (age 8–19 years-old) were more likely to experience depressive symptoms in relation to their mother's cancer than sons. Lichtman et al. (1987) found that the relationships between mothers with breast cancer and their adolescent daughters were especially strained by the mothers' diagnosis. Among the reasons cited for the increased strains were daughters' fears about inheriting the disease and the high level of support that mothers expected from their daughters. Given the significance of the mother-daughter relationship for adolescent and young adult women, conflict and hostility in this relationship may be a significant source of stress. This may be even greater in mothers and daughters who experience chronic stress as a result of being at increased risk for breast cancer. Further, the significance of the mother-daughter relationship may be greater for adolescent as compared with young adult women.

In addition to psychological stress, several of studies have examined biological responses to stress in women with a maternal or broader family history of breast cancer. A series of studies by Bovbjerg et al. showed that when compared to women at normal risk, women with a familial risk of breast cancer had increased heart rate, serum cortisol and epinephrine levels, and natural killer cell activity in response to a version of the Trier Social Stress Test (Kirschbaum et al., 1993; Valdimarsdottir et al., 2002; Gold et al., 2003). These researchers also examined catecholamine responses to everyday work stress and found that women with a familial history experienced a heightened biological reactivity to stressors in their daily lives (James et al., 2004). Together, these studies imply that women at increased risk for breast cancer may suffer from chronic stress due to their risk status, and that this chronic stress increases reactivity to acute stressors, both in the laboratory and in their daily lives (Gold et al., 2003; James et al., 2004). The chronic activation of the HPA axis is important to understand in women at risk for breast cancer because it may contribute to health-related risk through compromised or suppressed immune function (see Irwin, 2008 for a review).

Only one study has examined the biological aspects of the chronic stress of breast cancer risk in the context of the relationship between mothers and daughters. Cohen and Pollack (2005) examined the relationship between breast cancer-related stress, as measured by questionnaires as well as stress hormones and immune factors in women with breast cancer and their adult daughters, and found that self-reports of psychological distress were correlated between mothers and daughters. In addition, daughters experiencing more breast cancer-related stress had lower natural killer cell activity and decreased secretion of cytokines that increase immunity. These authors also reported that natural killer cell activity and Th1 cytokine secretion were inversely correlated with distress and stress hormones in daughters of breast cancer patients, signifying that increased distress and stress hormones were associated with decreased immunity (Cohen et al., 2002). However, relationship quality and style have not been studied between mothers and daughters in families with a history of breast cancer, and it remains to be seen whether relationship variables such as communication could affect this association.

Research examining other interpersonal relationships has shown there are both intrapersonal and interpersonal correlates of psychological and biological stress processes. Further, several studies have supported the accuracy of biological stress measures taken during laboratory interaction tasks. For example, Kiecolt-Glaser et al. (1997) and Levenson et al. (1994) collected physiological and hormonal data while married couples performed structured interaction tasks in which they were asked to discuss stressful topics relevant to their relationship. Findings indicate that negative interaction styles (i.e., hostility) were significantly related to physiological arousal and decreased immune functioning. In another example, Robles et al. (2006) examined wives' cortisol declines during a conflict interaction task. Results from this study indicate that the quality of discussion, even if focused on a stressful topic, may support more adaptive biological responses to interpersonal conflict. Even during stressful interactions, the presence of support led to a steeper decline (faster recovery) in cortisol levels whereas high levels of negativity were linked to flatter cortisol declines (slower recovery). Such studies have been conducted mainly in married couples. However, a more recent study by Weichold et al. (2008) examined salivary alpha-amylase as marker of biological stress reactivity in young adolescent females during a conflict discussion task with their mothers, indicating that such measures are feasible and may be successfully evoked and measured in mother-daughter dyads. Further, Papp et al. (2009) found significant covariation in the diurnal cortisol patterns of a community sample of mothers and adolescent daughters. To our knowledge, the current study is the first study to examine biological stress responses in mother-daughter dyads during an interaction task focused on cancer risk.

The current study empirically examined biological stress reactions in mothers and their adolescent and young adult

daughters during a breast-cancer related stress task. Because previous studies have included daughters ranging from adolescence through adulthood (e.g., Brown et al., 2007; Wellisch et al., 1992), the current student enrolled daughters from 11 to 30 years-old to examine possible age and developmental differences. Further, the current study built on the only previous study of stress biology in this population by enrolling mothers with and without a history of breast cancer and their daughters (Cohen & Pollack, 2005). Specifically, mother-daughter dyads engaged in an emotion eliciting discussion about their risk for breast cancer and the experience of the disease in their families. Mothers' and daughters' behaviors and emotions during the discussions were coded for several behavioral and affective characteristics and then examined in relationship to biological stress reactivity. The specific hypotheses were as follows: (1) Mothers' behaviors and emotions will be associated their own biologic reactivity (i.e., negative maternal communication will be associated with increased stress hormone levels and longer time to recovery). (2) Mothers' behaviors and emotions will be associated with biologic reactivity in daughters (i.e., negative maternal communication will be associated with increased stress hormone levels and longer time to recover in daughters, and positive maternal communication will not be associated with a change in stress hormones in daughters). (3) Daughters' communication styles will be associated with their own biologic reactivity (i.e., negative communication will be associated with increased stress hormone levels and longer time to recovery). (4) Daughters' behaviors and emotions will be associated with their mothers' biologic reactivity (i.e., negative communication will be associated with increased stress hormone levels and longer time to recovery). Exploratory analyses examined possible differences as a function of mothers' personal history of breast cancer and daughters' age.

Method

Participants

The sample included 32 mothers with 32 daughters, for a total of 32 mother-daughter dyads. Mothers' mean age was 47.1 years (SD = 6.47); mean level of education was 15.89 years (SD = 2.27), or equivalent to high school plus some college; and 82 % of mothers were currently employed. Breast cancer risk was calculated as a categorical variable for each dyad and split into two categories: dyads where the mother had a personal history of breast cancer, and dyads where the mother did not have a personal history of the disease. Sixteen (50 %) of the mothers had a personal history of breast cancer and sixteen (50 %) did not. Mothers with and without a personal history of breast cancer did not differ on any demographic variables. Daughters' mean age was 18.16 years (SD = 5.28, range 11–30) and 60 % reported that they currently live with their mothers. The sample was 53 % Caucasian, 28 % African American, 3 % Asian American, and 3 % mixed ethnicity, and the remaining 13 % chose not to report their ethnicity.

Recruitment

Eligible women were recruited from a university medical hospital breast diagnostic center and a breast health center at a public hospital serving primarily a low-income urban community. The study was presented to all English-speaking women receiving services at these centers who had at least one daughter between the ages of 11 and 30-years-old. No women who had a daughter in this age range and who expressed interest in the study were excluded from the study. Demographic factors did not differ between the two recruitment sites except for mothers' age, $F(1,56) = 11.97$, $p < .01$, mean of 49 years at the university-based center, 42 years at the public hospital) and race, $\chi^2 = 18.1$, $p < .01$, primarily Caucasian at the university setting and primarily African American at the public hospital.

Measures

The current study utilized a multi-method, multi-informant process of data collection including direct observations of behavior, self-reports of mothers and daughters in interviews and in response to questionnaires, and biological measures of stress reactivity. The measures used in analyses are explained in detail below.

Biological measures

Salivary cortisol

Saliva samples were collected before the interaction task, directly after, and at three 15-min follow-up intervals after the task for use in analyses of salivary cortisol. The five data points allowed for analyses of both reactivity to stress (as reflected in increases from pre- to post-stress) and recovery from stress (as reflected in the rate of decrease in cortisol after the interaction). To control for diurnal fluctuations in cortisol, the researchers attempted to schedule all of the breast cancer discussions for the afternoon (2–5 pm) whenever possible. This time restriction controlled for diurnal patterns and it also accommodated work

and school schedules of the participants. Participants were instructed to refrain from eating, alcohol use, smoking, exercise, or prescription drugs for at least 1 h prior to participation.

Following a standardized method used in previous research, five saliva samples were collected from each participant for determination of cortisol baseline levels and reactivity to the task. Samples were taken approximately every 15 min, and corresponded to baseline, immediately post-task, and three additional recovery samples (15, 30, and 45 min post-task; see Kiecolt-Glaser et al., 1997, for an example of the collection of multiple samples before, during, and after a laboratory stress task for the assessment of stress hormones). Saliva collection was chosen for determination of cortisol levels because it is simple, non-invasive, non-aversive to the subject, and could be collected repeatedly throughout the study.

Salivary cortisol concentrations were independent of flow rate, and reflect unbound "free" levels in plasma. Saliva samples were obtained with the Salivette sampling device (Sarstedt, Rommelsdorf, Germany). Participants were instructed to place a small cotton swab in their mouths and chew on it for 1 min. The swabs were immediately frozen and stored at −80 °C for 1–3 months prior to analysis. Samples were assayed by Salimetrics (Penn State University). Analyses of cortisol (μg/dL) were conducted in duplicate and the mean level of the two tests was used in all analyses.

Procedure

A laboratory visit was scheduled for each mother-daughter pair. Mother/daughter dyads came to the behavioral laboratory at a university to participate in a breast cancer-specific stress task (mother-daughter interaction). Participants arrived at the laboratory and signed informed consent forms.

An observation room equipped with videotaping equipment was used at each site for this aspect of the project. Upon arrival at the laboratory, the experimenter provided an overview of the procedures for that session to the participants. A saliva sample was taken by having each participant keep a Salivette in her mouth for 1 min. Participants then completed the stress task and a second saliva sample was obtained from each participant upon completion of the task. Mothers and daughters were then seated in separate rooms where they viewed a neutral video (a documentary about national parks) for a 45-min recovery period. Saliva samples were collected at 15-min intervals throughout the recovery period. Mothers and daughters then met together with the experimenter for debriefing. Participants were thanked and compensated $25 for their participation.

Breast cancer-specific stress: behavioral observation of mother-daughter interactions

Based on extensive research on observational methods of assessing dyadic interactions, a procedure was used to assess the quality of several aspects of the relationship between daughters and their mothers. The observation procedure was based on methods developed by Conger et al. in studies of families coping with stress (Reuter & Conger, 1995a, b).

Mothers and daughters were instructed to spend 15 min discussing their feelings and concerns about breast cancer, as well as their thoughts on the best way to monitor for the disease. Specifically, mothers and daughters were asked to respond to the following questions: (1) What kinds of feelings do we each have about breast cancer and the chance that we might get breast cancer? (2) How often do we talk about our feelings about breast cancer? If we don't talk about it, then why not? What prevents us from talking about it? (3) What is it about breast cancer that has most affected our lives? (4) What has been the most emotional or difficult time in our family regarding breast cancer? (5) Do we feel that we have any control over the chance of getting breast cancer? (6) *Mother*: Do you worry about your daughter and her risk of breast cancer? *Daughter*: Do you worry about your mom and her risk of breast cancer?

In addition to this breast cancer-specific discussion, mother-daughter pairs engaged in a 15-min discussion about a topic on which they experienced disagreement, conflict, or stress. This topic was selected based on a questionnaire filled out by mothers and daughters and included issues such as finances, religion, and daughter's choice of a romantic partner. The rationale for including this discussion topic was originally to provide a "warm-up" for mothers and daughters to begin discussing an emotional topic prior to participating in the discussion of breast cancer risk. However, in order to counteract an order effect of always having this alternate discussion first, discussion order (breast cancer task, issue task) was counterbalanced across mother-daughter pairs. Therefore, approximately half of the pairs discussed the issue task first, and half of the pairs discussed breast cancer risk first. The hypotheses for the current research did not directly evaluate communication during the stressful issue task, and therefore data from this task was not considered in this manuscript.

All mother-daughter interactions were videotaped and independently coded for communication and emotions. The Iowa Family Interaction Rating Scales (IFIRS; Melby & Conger, 1993, 2001) was used as the manual for coding emotion, communication, and behavior in the mother-daughter interactions. The IFIRS has well-established reliability and validity for use in coding of observations of behaviors and emotions of adults (parents), adolescents, and children (Melby & Conger, 2001). Trained observers

who were naïve to mothers' breast cancer history rated several dimensions of the mother-daughter interaction and individual member characteristics using scales ranging from 1 (the behavior is not at all characteristic of the person during the interaction) to 9 (the behavior is very characteristic of the family member during the interaction). These ratings were used to derive scores for each mother-daughter pair on several dimensions, including hostile interaction style, warm interaction style, prosocial behavior, and antisocial behavior.

Coding of behavioral interactions

Trained research assistants conducted coding of the videotapes of the mother-daughter discussions of breast cancer risk using the Iowa Family Interaction Rating Scales (IFIRS; Melby & Conger, 2001). All videotapes from the project were coded by two raters, and any disagreements (i.e., ratings that differed by more than 1-point) were resolved through consensual coding.

All videotaped interactions were double-coded by two research assistants. Mean reliability between coders was 75.3 % (Sd = 14.8) overall, 74.7 % (SD = 16.4) for mothers, and 75.9 % (SD = 13.3) for daughters. This signifies that across 14 codes with possible scores ranging from 1 to 9 for each subject, coders were within one point on the rating scales approximately 75 % of the time. This average exceeds the 60 % reliability suggested by the IFIRS coding system for the double-coding of interactions (Melby & Conger, 1993). Seventeen codes describing specific aspects of communication were utilized for this project. However, only 13 of the codes were used for analyses. For example, regarding negative communication styles, denial, as outlined in the IFIRS manual, included the participant's tendency to deny the existence of a problem or to take responsibility for a problem. The mothers in this study typically exhibited denial as a refusal to address their daughters' questions and worries about breast cancer. Externalized negative, defined by hostility toward things or people outside the interaction, was often typified by a similar negativity on mothers' part toward a doctor, another family member, or references to people other than the daughter. Antisocial behavior was defined as immature, self-centered, or obnoxious actions, and is also a composite code consisting of denial, externalize negative, and several other negative codes. All three of these codes exemplify behavior that it is critical, uncaring, and unresponsive to daughter's feelings.

Data analyses

The primary analyses involved a series of Pearson correlations examining the relations among mothers' and daughters' observed behaviors and emotions and measures of cortisol extracted from saliva samples. This approach is standard for examining associations of maternal and child characteristics of this type (e.g., Cohen & Pollack, 2005). Statistical power analyses were conducted using G-power (Faul et al., 2007). With a sample size of 32 mothers and daughters, alpha set at .05 and beta at .80, we were able to detect correlations of $\geq$.29 as statistically significant.

Results

Descriptive analyses

Means and standard deviations for each IFIRS code are reported in Table 1. The coders rated mothers with a personal history of breast cancer as exhibiting significantly more sadness, whining/complaining, positive mood, better communication, and more prosocial behavior, but less avoidance than mothers without a history of breast cancer (all significant t tests, $p < .05$). There were no differences in ratings made by the coders for mothers on the basis of recruitment site.

Coders rated daughters of dyads where mother had a personal breast cancer history as demonstrating more sadness and positive mood than in dyads with no personal breast cancer history (all significant t tests, $p < .05$). None of the codes for daughters differed as a function of recruitment site.

Descriptive statistics for salivary cortisol measurements are reported in Table 2. Changes in hormonal levels across time were analyzed by using repeated measures ANOVA with time as the within-subjects factor. Cortisol levels did not vary across time significantly for mothers. However, in daughters, cortisol did vary significantly across time. Cortisol changed across time ($F(1,27) = 5.82$, $p < .01$) linearly such that levels began high at baseline and fell across time.

Repeated measures ANOVAs were then calculated with time as the within-subjects factor and mother's breast cancer history (either positive or negative) as the between-subjects variable. Cortisol levels in daughters were not affected by mothers' breast cancer history. The same was found for cortisol levels in mothers. Mothers' hormone levels did not vary as a function of recruitment site and neither did daughters' cortisol. Correlational analyses showed that there were no associations at any time points between mothers' cortisol levels and daughters' cortisol.

Positive mood, hostility, warmth, externalized negative, and avoidance were significantly positively correlated between mothers and daughters, such that *both* members of the dyad tended to display the behavior (r's ranged from .32 to .63, all $p < .05$). Further, several separate individual

Table 1 Descriptive statistics for mothers and daughters on measures of communication

		N	Mean	SD
Mothers				
	Percent reliability: 74.73 ± 16.36	32		
Sadness	–	32	5.06	1.72
Anxiety	–	32	5.44	1.29
Hostility	–	32	2.59	2.00
Denial	–	32	2.31	1.62
Externalized negative	–	32	2.88	1.43
Avoidance	–	32	2.59	1.48
Whine/complain	–	32	2.03	1.51
Antisocial	–	32	2.87	1.41
Positive mood	–	32	5.34	1.64
Warmth/ supportiveness	–	32	4.53	1.70
Listener responsiveness	–	32	6.13	1.56
Communication	–	32	6.38	1.26
Prosocial	–	32	5.97	1.33
Daughters				
	Percent reliability: 75.86 ± 13.28	32		
Sadness	–	32	3.59	1.74
Anxiety	–	32	5.31	1.49
Hostility	–	32	3.53	2.48
Denial	–	32	3.16	1.95
Externalized negative	–	32	2.81	1.45
Avoidance	–	32	3.81	2.13
Whine/complain	–	32	2.75	1.44
Antisocial	–	32	3.84	1.74
Positive mood	–	32	4.66	1.72
Warmth/ supportiveness	–	32	3.78	1.91
Listener responsiveness	–	32	5.50	1.74
Communication	–	32	5.50	1.69
Prosocial	–	32	5.22	1.72

codes were correlated between mothers and daughters. For example, mothers' sadness was positively correlated daughters' warmth and listener responsiveness, and negatively correlated with daughters' avoidance and antisocial responses (see Table 3). Mothers' hostility was positively correlated with daughters' hostility, whine/complain, and antisocial responses, and negatively correlated with daughters' listener responsiveness, communication, and prosocial responses (see Table 3). Daughters' age was significantly positively correlated with only mothers' sadness and whine/complain behaviors; no significant correlations were found between daughters' age and their emotions and behaviors as coded on the IFIRS.

Table 2 Descriptive statistics for mothers and daughters on measures of biological stress

Measure	N	Mean	SD
Mothers			
Salivary cortisol (μg/dL)			
1. Baseline	32	0.25	0.46
2. Post-discussion	32	0.17	0.25
3. 15 min post-discussion	31	0.16	0.35
4. 30 min post-discussion	31	0.17	0.33
5. 45 min post-discussion	31	0.24	0.76
Daughters			
Salivary cortisol (μg/dL)			
1. Baseline	33	0.28	0.68
2. Post-discussion	32	0.27	0.82
3. 15 min post-discussion	31	0.16	0.23
4. 30 min post-discussion	31	0.10	0.08
5. 45 min post-discussion	32	0.15	0.34

μg/dL micrograms per deciliter

Correlations of mothers' and daughters' behaviors, emotions, and cortisol

To address the first hypothesis, correlations were calculated between mothers' communication style and their own hormone levels. As seen in Table 4, there was a strong correlation between mothers' whine/complain and higher levels of mothers' cortisol, and a moderate negative relationship between maternal positive mood and cortisol levels.

The second hypothesis proposed that mothers' communication style would be associated with daughters' biological reactivity, such that negative maternal communication would correlate with increased stress reactivity, and positive communication would not be related to daughters' biological reactivity (see Table 5). As hypothesized, there was a significant relationship between negative maternal communication and daughters' stress response. However, positive maternal communication did not correlate with daughters' stress hormone levels. Negative maternal communication, more specifically denial, externalized negative, and antisocial, was significantly correlated with higher cortisol levels in daughters (see Table 5). Although several of these correlations did not remain significant after Bonferroni correction, there was a clear pattern of an association between higher levels of these negative maternal behaviors and higher levels of

Table 3 Correlations of IFIRS communication codes between mothers and daughters

Daughters' codes	Mothers' codes													
Code	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.
1. Sadness (sd)	.22	.14	−.07	.06	−.35**	.29*	−.07	.05	.11	−.07	−.02	.09	−.07	.01
2. Anxiety (ax)	−.02	.15	.02	.22	−.02	.14	.12	.05	.06	.02	.07	.04	.03	−.11
3. Positive Mood (pm)	.18	.19	.63***	−.17	−.11	.31*	.01	.35**	.23	−.25	−.06	.36**	−.13	.01
4. Hostility (hs)	−.15	−.03	−.25	.44***	.10	.07	.25	.12	.07	−.03	.28*	.04	.08	−.13
5. Denial (de)	.01	−.22	.01	.06	.24	−.09	.08	−.04	.05	.04	.21	0	.04	.11
6. Warmth (wm)	.31*	.37**	.38**	.09	−.18	.41***	.09	.23	.08	−.08	.07	.23	.03	.09
7. Externalize negative (ex)	−.20	−.05	−.18	.13	.02	−.14	.39**	.07	−.01	.07	.01	−.02	.07	.09
8. Listener responsiveness (lr)	.33*	.28*	.42***	−.27*	−.11	.19	−.05	.21	.13	−.29*	−.16	.25	−.27*	.05
9. Communication (co)	.25	.32*	.31*	−.30*	−.21	.23	0	.25	.13	−.20	−.11	.22	−.18	.07
10. Avoidance (av)	−.29*	−.20	−.39**	.22	.05	−.12	.03	−.30*	−.18	.32*	.17	−.33*	.33*	−.17
11. Whine/complain (wc)	−.10	−.12	−.18	.43***	−.01	.06	.26+	.07	.10	−.02	.11	.03	.09	−.12
12. Prosocial (pr)	.21	.35**	.37**	−.29*	−.23	.23	−.02	.21	.07	−.13	−.17	.20	−.16	.10
13. Antisocial (an)	−.28*	−.16	−.27*	.27*	.14	−.16	.12	−.04	−.03	.18	.16	−.18	.24	−.04
14. Daughter's Age	.33*	.24	.06	.06	.03	−.07	.04	−.11	−.08	.14	.29*	−.04	.12	–

+ $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$ (remains significant after Bonferroni correction)

Table 4 Correlations among mothers' IFIRS communication codes and cortisol levels

Mothers' codes	Mothers' cortisol levels				
Code	Salivary cortisol (μg/dL)				
	Baseline	Post-discussion	15 min post	30 min post	45 min post
1. Sadness (sd)	.27	.25	.28	.22	.27
2. Anxiety (ax)	.18	.08	.04	.07	.08
3. Positive mood (pm)	−.49**	−.47**	−.42*	−.40*	−.39*
4. Hostility (hs)	.18	.19	.25	.18	.19
5. Denial (de)	−.07	−.02	−.06	−.13	−.16
6. Warmth (wm)	.13	.08	0	.15	.11
7. Externalized negative (ex)	−.29	−.24	−.16	−.24	−.26
8. Listener responsiveness (lr)	−.26	−.28	−.32	−.26	−.25
9. Communication (co)	−.15	−.19	−.25	−.21	−.21
10. Avoidance (av)	.16	.15	.19	.16	.17
11. Whine/complain (wc)	.65***	.68***	.75***	.67***	.70***
12. Prosocial (pr)	−.27	−.30	−.34	−.26	−.27
13. Antisocial (an)	.11	.14	.19	.14	.14

+ $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$ (remains significant after Bonferroni correction)

daughters' cortisol across multiple time points of hormonal measurement. Unexpectedly, maternal sadness was correlated with lower levels of daughters' cortisol at all time points with the exception of baseline (see Table 5). This may be indicative that maternal sadness induced an empathic, caretaking response in daughters, especially since mothers with a history of breast cancer were coded as exhibiting more sadness. Additionally, it could represent healthy emotional expression as opposed to emotional suppression.

To address the third hypotheses, correlations were also computed between daughters' communication and daugh-

Table 5 Correlations between mothers' IFIRS communication codes and daughters' cortisol levels

Mothers' codes	Daughters' cortisol levels				
Code	Salivary cortisol (μg/dL)				
	Baseline	Post-discussion	15 min post	30 min post	45 min post
1. Sadness (sd)	−.35	−.36*	−.45*	−.41*	−.38*
2. Anxiety (ax)	−.25	−.23	−.20	−.15	−.22
3. Positive mood (pm)	−.07	−.04	−.11	−.17	−.08
4. Hostility (hs)	.00	−.06	−.04	.22	−.06
5. Denial (de)	.52**	.52**	.41*	.09	.55***
6. Warmth (wm)	−.31	−.30	−.17	−.17	−.31
7. Externalized negative (ex)	.33^{+}	.30	.27	.37*	.35^{+}
8. Listener responsiveness (lr)	−.26	−.23	−.16	−.05	−.23
9. Communication (co)	−.21	−.20	−.15	−.12	−.20
10. Avoidance (av)	.18	.17	.12	.09	.18
11. Whine/complain (wc)	.11	.09	.01	−.05	.11
12. Prosocial (pr)	−.28	−.27	−.20	−.10	−.28
13. Antisocial (an)	.40*	.40*	.30	.09	.39*

$^{+}$ $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$ (remains significant after Bonferroni correction)

Table 6 Correlations among daughters' IFIRS communication codes and cortisol levels

Daughters' codes	Daughters' cortisol levels				
Code	Salivary cortisol (μg/dL)				
	Baseline	Post-discussion	15 min post	30 min post	45 min post
1. Sadness (sd)	−.32^{+}	−.30	−.29	−.19	−.33^{+}
2. Anxiety (ax)	−.12	−.17	−.20	.13	−.13
3. Positive mood (pm)	−.13	−.10	−.10	−.27	−.11
4. Hostility (hs)	−.02	−.07	−.05	.37*	−.05
5. Denial (de)	.10	.06	−.01	.03	.09
6. Warmth (wm)	−.22	−.21	−.25	−.25	−.24
7. Externalized negative (ex)	.36*	.32^{+}	.32^{+}	.42*	.35*
8. Listener responsiveness (lr)	−.27	−.26	−.22	−.10	−.29
9. Communication (co)	−.42*	−.39*	−.33^{+}	−.25	−.41*
10. Avoidance (av)	.21	.21	.11	.17	.24
11. Whine/complain (wc)	.18	.09	.20	.63***	.11
12. Prosocial (pr)	−.37*	−.35^{+}	−.30	−.16	−.36*
13. Antisocial (an)	.26	.25	.20	.24	.27
14. Daughter's age	.08	.05	.07	.07	.08

$^{+}$ $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$ (remains significant after Bonferroni correction)

ters' hormone levels (see Table 6). As seen in Table 6, patterns emerged indicating that higher levels of daughters' cortisol were associated with higher levels of their own externalized negative and whine/complain behaviors, and daughters' cortisol levels were negatively correlated with their own sadness, communication and prosocial behavior.

With regard to the fourth hypothesis, there were no significant correlations between mothers' cortisol levels and daughters' behaviors and emotions based on the IFIRS codes (see Table 7). Only the correlations for daughters' hostility and avoidance approached significance in their association with higher levels of mothers' cortisol.

Daughters' age was not related to their own cortisol levels at any of the time points and was positively correlated with mothers' cortisol ($r = .38$, $p < .05$) but only at the baseline cortisol assessment.

Table 7 Correlations between daughters' IFIRS communication codes and mothers' cortisol levels

Daughters' codes	Mothers' cortisol levels				
Code	Salivary cortisol (μg/dL)				
	Baseline	Post-discussion	15 min post	30 min post	45 min post
1. Sadness (sd)	−.15	−.16	−.19	−.17	−.17
2. Anxiety (ax)	−.11	−.18	−.14	−.23	−.21
3. Positive mood (pm)	−.22	−.21	−.23	−.16	−.17
4. Hostility (hs)	.25	.29	.35^{+}	.27	.30
5. Denial (de)	.17	.12	.18	.10	.13
6. Warmth (wm)	−.17	−.17	−.12	−.11	−.09
7. Externalized negative (ex)	.06	.06	.09	.001	.01
8. Listener responsiveness (lr)	−.21	−.19	−.19	−.17	−.16
9. Communication (co)	−.22	−.22	−.23	−.15	−.15
10. Avoidance (av)	.34^{+}	.28	.32^{+}	.22	.25
11. Whine/complain (wc)	.02	.02	.09	.01	.01
12. Prosocial (pr)	−.27	−.29	−.29	−.24	−.24
13. Antisocial (an)	.23	.22	.25	.17	.20
14. Daughter's age	.38*	.28	.31	.25	.28

$^{+}$ $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$ (remains significant after Bonferroni correction)

Discussion

Previous research has shown that being at risk for breast cancer is a source of psychological stress in women, including women without a known familial history of the disease (e.g., Cohen et al., 2002; Kim et al., 2003). Additionally, correlational research has demonstrated that being at higher risk for breast cancer by virtue of maternal or broader family history is associated with increased biological stress reactivity in response to laboratory stress that is not related to breast cancer (e.g., Gold et al., 2003; Kirschbaum et al., 1993; Valdimarsdottir et al., 2002). However, previous research has focused on adult women and has not examined the psychological and biological correlates of breast cancer risk in younger women or adolescent girls or in the context of family relationships. In light of these findings, the current study examined mother-daughter communication about breast cancer risk during a structured, stressful interaction, and measured associated patterns of stress reactivity. The current study utilized a correlational design to examine whether a specific set of behaviors observed during interactions between mothers and their daughters were associated with indicators of biological stress processes in mothers and adolescent and young adult daughters.

Daughters' salivary cortisol levels were not related to maternal breast cancer history. As expected, daughters' cortisol levels declined across time from baseline to 45 min after the interaction. This pattern follows the expected change in cortisol due to diurnal rhythms in an average person; levels are typically highest just after waking and then decrease slowly throughout the day. The current findings suggest that the daughters' biological stress responses, at least as measured by salivary cortisol, did not change in response to the discussion with their mothers about breast cancer. That is, their cortisol levels did not increase from baseline to after the stressful discussions with their mothers. Although this was unexpected, it is understandable in the context of a recent meta-analysis examining studies of laboratory stressors and changes in cortisol levels (Dickerson & Kemeny, 2004). These authors found that motivated performance tasks with the elements of uncontrollability and social evaluative threat had the largest and most consistent effects on cortisol levels. A prototypic example of this type of task is the Trier Social Stress Test (Kirschbaum et al., 1993), in which participants are asked to prepare a speech (active, motivated performance task) for an audience of confederates (social evaluative threat) and then are told to conduct a serial subtraction task out loud while being harassed by confederates (uncontrollability). The mother-daughter interaction task used in the current study, in contrast, may not have contained these elements. The task was an open-ended discussion format in which the participants were informed of what would occur and were left alone in the room during the discussion. The presence of the video camera could have been considered a source of social evaluative threat, but anecdotal observations suggest that most of the dyads appeared to ignore or habituate to its presence during the interactions, as confirmed by the coders while viewing the tapes. Thus, our interaction task most likely did not possess all of the qualities that were expected to elicit strong cortisol responses.

Despite the lack of changes in cortisol levels over the course of the observed mother-daughter interaction, there were several significant associations between maternal behaviors and emotions and daughters' cortisol levels, including baseline levels of cortisol. This suggests an association between mothers' and daughters' interpersonal interactions and daughters' levels of cortisol in anticipation of the laboratory interaction task; that is, daughters' levels of this important stress hormone may be related to their mothers' emotions and behaviors, rather than changing in response to this particular interaction. Four maternal emotional and behavioral codes were found to relate to salivary cortisol levels in daughters. Specifically, mothers' denial, externalize negative, and antisocial behavior were positively correlated with daughters' cortisol, whereas maternal sadness was negatively associated with daughters' cortisol. Although this was the first study to our knowledge to measure cortisol in relation to mother-daughter communication about breast cancer, these findings parallel related research on communication and stress physiology. For instance, studies of marital conflict demonstrated that hostile communications during a laboratory interaction (much like the task used in the current study) were associated with partners' increases in cortisol (Kiecolt-Glaser et al., 1997) and autonomic arousal (Levenson et al., 1994).

Denial, externalize negative, and antisocial, the three negative maternal codes that related to daughters' cortisol, are all aspects of negative communication. Daughters whose mothers consistently communicate in this manner may be exposed to this source of stress on an ongoing basis, including prior to the interaction. These daughters may have felt during the interaction that their feelings and beliefs about breast cancer were being evaluated negatively by their mothers. Therefore, it is possible that a chronic social evaluative stressor, in the form of negative maternal communication, was responsible for the meaningful variations in cortisol found in these daughters.

Another interesting finding was that an affective code, maternal sadness, related in the opposite direction as negative maternal behavioral codes to daughters' cortisol levels. That is, maternal sadness was negatively correlated with daughters' cortisol at all time points with the exception of baseline, such that higher levels of mothers' sadness were related to lower levels of daughters' cortisol during the interaction task. One possible reason for this finding is that mothers with a history of breast cancer displayed significantly higher levels of sadness than unaffected mothers. It is possible that discussing mothers' experiences and struggles with the disease elicited an empathic response from daughters. This effect was observed on the videotapes, as many of the daughters with affected mothers attempted to comfort them when sadness was displayed during the interaction.

According to gender-based theories of stress, the type of interaction task used in the current could elicit the production of oxytocin and not cortisol in daughters in response to their mothers' sadness (Taylor, 2006). Oxytocin, often considered the "mothering" hormone due to its release during breast-feeding, has been shown to be released in women at times when social support is elicited (Taylor, 2006). According to this theory, our social interaction stress paradigm would not have activated the HPA axis (and therefore cortisol levels) but instead the hormone oxytocin and other, more gender-specific stress responses. Oxytocin levels were not measured in this study, but these data suggest that it may be important to measure hormonal correlates of empathic responses in mothers and daughters communicating about breast cancer. Oxytocin would be an excellent candidate for this correlate, given prior findings of its release during "tend and befriend" behaviors in women (Taylor, 2005).

Further, it is possible that maternal sadness was a form of emotional expression. In the literature on emotion suppression, emotional expression can function as an adaptive form of coping, while active efforts to suppress emotion have detrimental effects on psychological outcome (e.g., Richards & Gross, 1999; Gortner et al., 2006). It is important to note that sadness may not be a psychological symptom or reflection of stress as in clinical depression, but instead a healthy expression of a significant emotion. Since these mothers were not clinically depressed, it is possible that mothers' sadness was positively perceived by daughters as a sign of emotional connectedness by daughters both psychologically and biologically.

Yet another consideration in interpreting daughters' biological stress reactions is daughters' own communication behaviors. Daughters' behavior codes for externalize negative and whine/complain were correlated with higher levels of their own cortisol, and the codes communication and prosocial were correlated with lower cortisol. These patterns are consistent with an overall pattern in which positive behaviors were associated with decreased cortisol and negative behaviors with increased cortisol. It is most likely the case that several factors were associated with daughters' cortisol levels, including both maternal communication and daughters' own communication patterns.

Finally, positive maternal communication was not related to daughters' cortisol levels. This finding suggests that positive communication would not elicit a biological stress response in daughters, and therefore would not be associated with any changes in stress hormone levels. Our data indicate, however, that future studies should examine the relationship between positive maternal communication and oxytocin levels in both mothers themselves and in their daughters in order to capture a biological picture of empathic responses.

It is noteworthy that none of the correlations between daughters' behaviors and mothers' cortisol levels were statistically significant. This suggests that daughters may be more stress reactive to the emotions and behaviors of their mothers than the converse. This one-directional pattern warrants attention in future research.

It is also striking that few of the observed behaviors as coded on the IFIRS or the measures of mothers' or daughters' cortisol levels were correlated with daughters' age. This suggests that the pattern levels of emotional and biological responses of daughters and their mothers in the current study were robust across a wide age range of adolescent and young adult daughters.

Several limitations of the current study need to be addressed in future research. First, the sample size in the current study was relatively small and this resulted in a limit in our statistical power. We may have been unable to detect some associations between mothers' and daughters' behaviors, emotions, and stress biology that were relatively small in magnitude. Second, measures of cortisol reactivity in mothers' and daughters' at risk for breast cancer could be augmented by diurnal measures of cortisol to examine possible covariation between mothers' and daughters' diurnal patterns (see Papp et al., 2009). And third, measures of other important stress linked hormones, including oxytocin, will be important to include in future studies.

In conclusion, the results from this study indicate that certain types of maternal communication about breast cancer have an association with daughters' emotions and behaviors and with daughters' biological reactions to stress during a discussion about breast cancer. Mothers' sadness and hostility appear to be closely linked to their daughters' emotions and behaviors. Further, three primarily negative maternal communication styles (denial, externalize negative, and antisocial) were found to relate to increased levels of cortisol in adolescent and young adult daughters. Additionally, maternal sadness was found to be associated with decreased levels of daughters' cortisol. These findings provide further evidence for the potential emotional and biological significance of the quality and characteristics of the mother-daughter relationship in families at risk for breast cancer. The findings also suggest that, based on work with breast cancer patients and survivors, interventions to enhance effective communication between mothers and daughters may have both psychological and biological consequences (e.g., Antoni et al., 2009; Thorton et al., 2009).

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