THESIS

PARTNER COMMUNICATION BEHAVIORS AND DIURNAL CORTISOL PATTERNS

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ABSTRACT

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Previous research suggests that diurnal cortisol patterns are associated with marital communication behaviors reported in naturalistic settings (e.g., Stawski, Cichy, Piazza, & Almeida, 2013), and observed communication behaviors are associated with acute cortisol responses to marital conflict laboratory tasks (e.g., Feinberg et al., 2013). However, it is unclear how observed marital communication behaviors are linked to individuals' typical diurnal cortisol patterns. The goal of this study was to investigate whether partners' ratios of observed positive to negative communication behaviors, self-reported marital conflict, and/or self-reported resolution predict diurnal cortisol patterns. Participants were heterosexual couples (n=124) who engaged in a conflict discussion which was videotaped and coded for negative and positive communication behaviors and reported marital conflict. Cortisol samples were taken across two days for each individual.

Results of structural equation model analyses suggested that men's greater observed communication quality predicted women's higher cortisol intercepts and men's steeper slopes, men's greater self-reported marital conflict predicted women's lower intercepts, and, in some models, women's greater reported resolution predicted women's lower intercepts and men's steeper slopes. Overall, these findings suggest that less positive and more negative marital conflict is a stressor that contributes to dysfunctional functioning of the stress system. Implications of this research for couples' therapy practice are discussed.

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Literature Review

Extensive research has suggested a strong link between marriage and health, with marital status, marital satisfaction, and marital interaction predicting health outcomes (for full review, see Burman & Margolin, 1992). Married individuals are at lower risk for chronic diseases as well as for mortality, and declines in marital satisfaction are related to increases in health problems (Burman & Margolin, 1992). In addition, higher marital quality (operationalized as higher marital satisfaction, higher levels of positive interaction behaviors, and lower levels of negative interaction behaviors) is associated with lower mortality risk for both genders (for full review, see Robles, Slatcher, Trombello, & McGinn, 2014). Clearly, multiple marital variables are related to health outcomes.

More specifically, marital *interaction* patterns are associated with health outcomes (for review, see Kiecolt-Glaser & Newton, 2001). Negative marital communication is associated with poorer perceived health, more chronic health problems, more symptoms of illness, greater likelihood of physical disability (Bookwala, 2005), lower satisfaction with physical health (Novak, Sandberg, & Harper, 2014), and less-healthy patterns of immune functioning (Gouin et al., 2009; Kiecolt-Glaser, Malarkey, Cacioppo, & Glaser, 1993). In addition, a specific and particularly negative pattern of marital interaction -- withdrawal during conflict -- has been associated with a 400% increase in mortality in women (Eaker, Sullivan, Kelly-Hayes, D'Agostino Sr, & Benjamin, 2007), and reports of high marital conflict are associated with husbands' fair or poor health (Iveniuk, Waite, Laumann, McClintock, & Tiedt, 2014). In contrast, positive communication is associated with faster wound healing (Gouin et al., 2010) and healthier patterns of immune response (Gouin et al., 2009; Graham et al., 2009).

Stress physiology may be an important mechanism linking marital interaction patterns to health (e.g., Taylor, Repetti & Seeman, 1997). Couples who are exposed to the chronic stress of negative interaction may suffer the effects of chronic over-activity of physiological stress systems. This chronic activation may result in wear and tear on the body, or allostatic load, which is related to negative health outcomes (McEwen, 1998). One important indicator of physiological stress functioning is an individual's pattern of diurnal cortisol secretion.

Cortisol is a regulatory hormone released by the hypothalamic-pituitary-adrenal (HPA) axis, one of the primary branches of the human stress response. A normative diurnal cortisol rhythm involves a relatively high waking cortisol level (i.e., intercept), an increase in levels shortly after awakening (cortisol awakening response, CAR), a rapid decline for the next several hours, and a slower decline (i.e., slope) throughout the remaining hours of the day. A less healthy pattern of diurnal cortisol secretion may involve a lower waking level, a weaker CAR, a flattened slope (whereby cortisol declines less throughout the day), and/or a too much or too little total cortisol secretion (e.g., Fries, Hesse, Hellhammer, & Hellhammer, 2005; Lucas-Thompson & Hostinar, 2013). These patterns of cortisol secretion allude to a dysregulation of the physiological stress system and are associated with myriad negative health outcomes, including hippocampal atrophy, diabetes, inflammation, suppressed immune functioning, lung disease, cardiovascular disease, and mortality (for a review, see Edwards, Heyman, & Swidan, 2011; for a review, see Slatcher, 2014).

Given that communication behaviors and diurnal cortisol patterns are both related to health outcomes, diurnal cortisol patterns may reflect an underlying pathway by which communication behaviors are related to health. Certain communication behaviors may lead to increased allostatic load, and thus dysregulated cortisol patterns that are linked to health outcomes. However, research has yet to investigate the relationship between observed communication behaviors and diurnal cortisol patterns over a typical day. The purpose of this study is to explore the association between diurnal cortisol patterns and observed couple communication behaviors.

Observed Couple Communication Behaviors and Cortisol Reactivity

Although there is little evidence linking couple communication behaviors and diurnal cortisol patterns, researchers have investigated the associations between couple interaction behaviors during laboratory tasks and their cortisol reactivity to that task. Couple "problem-solving" or "conflict" discussion tasks are frequently utilized in this research, whereby couples are prompted to discuss the most frequent and/or intense area(s) of conflict in their relationship (for review, see Heyman, 2001). These discussions are coded for the frequency and/or intensity of different communication behaviors by objective observers, allowing positive and negative communication behaviors to be directly observed during couple conflict. Such observation of behaviors eliminates the self-report and retrospective bias present in questionnaire research (Hahlweg, Kaiser, Christensen, Fehm-Wolfsdorf, & Groth, 2000). Given that couples' communication behaviors in conflict discussion tasks tend to be relatively consistent across time (Gottman & Levenson, 1999), behaviors in such marital interaction tasks are typically interpreted as trait-like patterns of interaction between couples.

Research suggests that observations of greater overall positive communication behaviors are related to lessened cortisol reactivity and steeper post-discussion cortisol recovery (Feinberg, Jones, Granger, & Bontempo, 2013, for men with high levels of anxiety). In addition, husbands' greater overall positive interaction behaviors are related to steeper cortisol slopes in wives from pre- to post-discussion, and wives' lower levels of overall positive behavior are related to their flatter slopes (Robles, Shaffer, Malarkey, & Kiecolt-Glaser, 2006). Further, supportive behavior is related to less cortisol reactivity as well as steeper declines in cortisol levels from pre- to post-discussion for husbands (Laurent et al., 2013) and wives (Robles et al., 2006). The association between supportiveness and cortisol reactivity is reflected in studies using self-report measures as well: individuals who report greater satisfaction with their partners' support behaviors show less cortisol reactivity during problem-solving discussions (Heffner, Kiecolt-Glaser, Loving, Glaser, & Malarkey, 2004). In addition, cortisol reactivity during conflict is reduced following couple relationship education (Ditzen, Hahlweg, Fehm-Wolfsdorf, & Baucom, 2011) and marriage enrichment interventions (Worthington et al., 2015), which aim to enhance positive communication behaviors and reduce negative communication behaviors between partners. Taken together, these findings suggest that overall positive communication behaviors, and specifically support behaviors, may lessen stress reactivity to marital conflict as well as improve recovery to such stressors.

In contrast, observed negative conflict behaviors are related to greater cortisol reactivity and attenuated cortisol recovery. Overall intensity of negative interaction behaviors is associated with greater cortisol reactivity (Aloia & Solomon, 2015b; Feinberg et al., 2013, only for men; Miller, Dopp, Myers, Stevens & Fahey, 1999, only for men), flatter slopes in women's cortisol from pre- to post- discussion (Robles et al., 2006), and attenuated cortisol recovery (Feinberg et al., 2013, in men with high anxiety and a history of frequent marital conflict). Moreover, negative behavior reciprocity between partners has been found to account for 21.3% of the variance in wives' cortisol slopes throughout conflict discussions (Kiecolt-Glaser et al., 1997), and has also been associated with wives' attenuated cortisol recovery following conflict discussions (Laurent et al., 2013).

In addition, observed wife demand/husband withdraw communication patterns are related to wives' greater cortisol reactivity and attenuated post-discussion recovery (Heffner et al., 2006; Kiecolt-Glaser et al., 1996). Criticism, intensity of displays of disagreement, as well as loudness of speech during conflict interactions are also related to greater cortisol reactivity for both partners (Aloia & Solomon, 2015a; Rodriguez & Margolin, 2013). The results of these studies suggest that negative communication behaviors heighten physiological stress reactivity to, and impair recovery from, marital conflict.

However, there are some inconsistent results about the nature of the associations between observed communication behaviors and cortisol reactivity and recovery. For instance, higher levels of negative interaction characteristics have been linked with lower cortisol reactivity (Fehm-Wolfsdorf, Groth, Kaiser, & Hahlweg, 1999; Laurent et al., 2013), as well as wives' steeper cortisol slopes from pre- to post- discussion (Robles et al., 2006). One study demonstrated links between negative interaction characteristics and healthier cortisol recovery, although particularly for pregnant women with high levels of anxiety and self-reported high frequency of marital conflict (Feinberg et al., 2013). In addition, more positive interaction behaviors have been linked with both greater cortisol reactivity (Fehm-Wolfsdorf et al., 1999; Feinberg et al., 2013, for pregnant women with high anxiety) and also lower cortisol recovery (Feinberg et al., 2013, for pregnant women).

Still others have found no relation between certain conflict behaviors and cortisol reactivity/ recovery, though it is important to note that these studies have had limited power in general. For example, two studies found no association between cortisol reactivity and negative interaction behaviors (Kiecolt-Glaser et al., 1997, for men; Feinberg et al., 2013, for women). Another study found no associations between wives' levels of positive or negative communication behaviors and cortisol reactivity or recovery (Miller et al., 1999). These results suggest that the associations among communication behaviors and acute cortisol reactivity are not always as predicted, and further research is needed to clarify the nature of such findings.

The association between communication behaviors and cortisol responses that is often found in these studies highlights physiological stress functioning as a potential mechanism whereby marital interaction variables affect health outcomes for partners in long-term relationships. Although there are many studies linking observed marital interaction behaviors to acute cortisol reactivity, there is less research investigating how observed behaviors during marital conflict predict patterns of cortisol produced throughout the day. Such research is important, as diurnal patterns of cortisol may reflect an individual's allostatic load over and above acute cortisol stress reactivity. Allostatic load may increase over time from engagement in more negative and less positive marital interactions. Given that observed problem-solving behaviors may represent persistent patterns of couple interaction (e.g., Gottman & Levenson, 1999), positive or negative interaction behaviors observed in the lab may be related to an individual's allostatic load. As such wear and tear on the body is linked to health outcomes over time, further research is needed to investigate how observed couple communication behaviors are related to healthy and unhealthy diurnal cortisol patterns.

Relationship between Acute Cortisol Responding and Diurnal Cortisol Patterns

Measures of both acute cortisol responding and diurnal cortisol rhythms reflect functioning of the HPA axis. Cortisol reactivity and patterns of cortisol produced throughout the day are distinct processes that are both important to understand, and these processes are separate but also linked. Research has produced mixed results for the direction of the relationship between cortisol reactivity to and recovery from stress and diurnal cortisol patterns. Some researchers have found no association between some measures of cortisol reactivity and diurnal cortisol patterns (e.g. Kidd et al., 2014). Other studies suggest that greater cortisol reactivity is related to greater total diurnal cortisol output, as those who are more reactive respond to daily stressors by releasing higher levels of cortisol throughout the day (Kidd, Carvalho, & Steptoe, 2014). However, others argue that down-regulation of the HPA-axis can result in physiological dampening that spans across both acute cortisol responding and diurnal cortisol patterns. For example, less cortisol reactivity to an acute stressor is related to flattened cortisol slopes throughout the day during adolescence (Lucas-Thompson, Henry, & McKernan, under review), as well as both lower morning cortisol and flatter cortisol slopes for younger children (Koss, Mliner, Donzella, & Gunnar, 2016) and adults (for a review, see Edwards, Heyman, & Swidan, 2011). Attenuated HPA axis functioning may be indicative of greater allostatic load (Fries, Hesse, Hellhammer, & Hellhammer, 2005), and has been related to problems with physical and mental health (for a review, see Edwards, Heyman, & Swidan, 2011). Just as under-functioning of the stress system is associated with negative health outcomes, so is over-functioning; for example, excessive secretion of cortisol (i.e., hypercortisolism) is associated with myriad negative health outcomes (Chrousos, 2009).

Although the relationship between acute cortisol responses and diurnal cortisol patterns is complex, it appears that these distinct processes are associated. Given the robust association between observed communication behaviors and acute cortisol responding as reviewed above, this lends support to the argument that observed communication behaviors may be related to diurnal cortisol patterns, though this question has yet to be tested empirically. It is important that this research be conducted, as diurnal cortisol patterns reflect every-day functioning of the stress system, and thus measures may capture typical functioning of the HPA axis as it occurs all the time rather than just in response to acute stressors. In this way, diurnal cortisol patterns may reflect an individual's physiological allostatic load above acute cortisol stress reactivity.

Within-Person Associations between Self-reported Couple Communication Behaviors and Diurnal Cortisol Patterns

Although there are no studies linking observed interaction behaviors and diurnal cortisol, studies utilizing within-subjects designs and self-report measures have suggested that marital communication behaviors are related to diurnal cortisol patterns. The frequency of a partners' engagement in physically affectionate behaviors on a given day is associated with lower total cortisol production on that day (Ditzen, Hoppmann, & Klumb, 2008) and, for women, days with higher frequencies of husbands' support behavior are associated with steeper diurnal cortisol slopes (Crockett & Neff, 2013). Taken together, these findings suggest that spousal support and affection behaviors are associated with individuals' day-to-day variation in stress physiology.

Furthermore, negative relationship experiences are associated with dysregulated diurnal cortisol patterns. For instance, within person, interpersonal and home-related stressors are related to increases in total cortisol output across days, with greater effects than work and other social stressors (Stawski, Cichy, Piazza, & Almeida, 2013). Specific negative conflict behaviors, like avoidance of argument, are also related to higher cortisol levels on the following day (Birditt, Nevitt, & Almeida, 2015). More broadly, greater couple conflict is associated with flatter cortisol slopes on the day of conflict (Keneski, Neff, & Loving, 2017) and a lower CAR the following morning for anxiously attached women (Hicks & Diamond, 2011). Relationship-specific stressors and negative communication behaviors may be causes or results of relationship distress that are associated with dysregulated diurnal cortisol rhythms.

Between-Group Associations between Self-reported Couple Communication Behaviors and Diurnal Cortisol Patterns

Researchers have also utilized between-subjects designs to investigate the link between communication behaviors and diurnal cortisol patterns. Such studies have found that individuals who report higher levels of positive behaviors in their relationships (e.g., verbal affection, physical affection, quality of received support) show healthier patterns of diurnal cortisol (e.g., greater CARS, steeper cortisol slopes, lower total cortisol secretion; Floyd, 2006; Floyd & Riforgiate, 2008; Turner-Cobb, Sephton, Koopman, Blake-Mortimer, & Spiegel, 2000). In addition, CARs are more consistent across days in couples who report higher levels of spousal support, suggesting that receiving support from a partner may protect individuals from the physiological effects of unpredictable day-to-day stressors (Liu, Rovine, Cousino-Klein, & Almeida, 2013). The effects of positive relationship characteristics on diurnal cortisol patterns may have long-lasting impacts, as individuals who felt understood and appreciated by their spouses at an initial evaluation were shown to have greater CARs and steeper cortisol slopes at a ten-year follow-up (Slatcher, Selcuk, & Ong, 2015).

Thus, individuals who report more positive relationship behaviors may show better-regulated patterns of stress physiology. The opposite is true of those who report regularly practicing more negative communication behaviors and/or report more marital concerns. Spouses who report a greater number of problems regarding their marriages have flatter diurnal cortisol slopes and weakened CARs (Barnett, Steptoe, & Gareis, 2005). In addition, female-reported partner aggression is related to flatter diurnal cortisol slopes for both partners (Kim et al., 2015; Saxbe et al., 2015) as well as higher total cortisol levels for women (Kim et al., 2015).

A benefit of studies that measure between-group differences in diurnal cortisol patterns is that they help to illuminate why differences in health outcomes are evident among groups of individuals. However, such studies have exclusively looked at relations among self-reported behaviors and diurnal cortisol patterns. No research to my knowledge has studied how observed communication behaviors are related to diurnal cortisol patterns. The findings of the current study will add to the literature in investigating whether dysregulation of physiological stress systems may be a pathway underlying differences in health between groups of individuals who demonstrate more positive or less negative communication behaviors during marital conflict.

The Current Study

In sum, the literature suggests that marital communication behaviors reported in daily diary and self-report studies are related to diurnal cortisol patterns in naturalistic environments, and that communication behaviors in laboratory tasks are related to acute cortisol responses to those tasks. However, no research to my knowledge has investigated how observed couple communication behaviors are related to individuals' typical diurnal cortisol patterns. In this study, I investigate the extent to which (1) the ratio of observed positive communication behaviors (support, physical affection, calm discussion, problem solving, and humor) to observed negative communication behaviors (nonverbal and verbal anger, defensiveness, physical distress, physical aggression, threat, pursuit, insult, and withdrawal) predicts diurnal cortisol patterns for men and women in committed relationships. I hypothesize that greater positive to negative (P/N) behavior ratios predict healthier diurnal cortisol patterns (i.e., higher waking levels and/or steeper cortisol slopes across the day). I also explore whether (2) self-reports of the frequency/intensity and (3) resolution of marital conflict predict healthy or unhealthy patterns of diurnal cortisol. I hypothesize that reports of less frequent/intense marital conflict and greater resolution predict healthier diurnal cortisol patterns.

The findings of the proposed study will fill a significant gap in the literature by being the first to explore whether observed couple communication behaviors, rather than self-reported communication behaviors, are related to diurnal cortisol patterns. Through objective observation of couple communication behaviors, I eliminate self-report bias and capture conflict behaviors in an unprecedented manner in diurnal cortisol research. I focus on diurnal cortisol patterns rather than reactive cortisol responses because every-day patterns of cortisol secretion have a unique ability to contribute to and reflect allostatic load and thus influence health outcomes. A between-subjects design is employed so that our study may add to the literature that has found differences in health among groups of people who demonstrate differing marital interaction qualities. The findings of the current study further knowledge on the possible pathways between marital processes and health, with implications for couples' interventions.

Method

Participants

Participants were couples (n=124) who were recruited through advertisements in local parenting magazines, local newspaper classifieds, and church bulletins. Participants were recruited for a larger study on family relationships and adolescent stress responding (Lucas-Thompson & Granger, 2014). Couples were heterosexual and had been married or cohabitating for at least 2 years prior to the study (length of relationship M = 16.03 years, SD = 5.81 years). In addition, all couples had at least one child in the home that was between the ages of 10 and 17. Participants were middle-aged on average (Men's M = 44.40 years, SD = 6.23 years, Women's M = 43.36 years, SD = 11.05 years).

Household income had a large range across the sample, from $3,375 to $450,000 (*Median* = $85,936.86, *SD* = $68,531.04). On average, both members of couples had completed an Associate's Degree or vocational training beyond high school. Among the women in the sample, 2% had completed less than a high school degree, 7% completed high school or a GED, 15% completed some college but no degree, 20% completed an Associate's degree or vocational training, 25% completed a B.A., 8% completed some graduate work, 17% had a M.A., 2% had a J.D., and 5% had more than one M.A. Among the men in the sample, 3% had completed less than a high school degree, 12% completed high school or a GED, 12% completed some college but no degree, 20% completed an Associate's degree or vocational training, 23% completed a B.A., 8% completed some graduate work, 10% had a M.A., 2% had a J.D., 3% had more than an M.A., and 7% had a doctoral degree. In terms of race/ethnicity, women were 72% Caucasian, 13% Black, 8% Asian, and 7% endorsed 'other' or multiple races/ethnicities, whereas men were 66% Caucasian, 18% Black, 7% Asian, and 10% endorsed 'other' or multiple races/ethnicities.

Procedures

Participants presented to a university laboratory to complete laboratory procedures. First, participants gave informed consent. Participants then completed a marital conflict discussion task and several questionnaires. Following study procedures, participants were debriefed and paid $20 for their participation, as well as $10 for transportation costs. Couples were then invited to provide diurnal cortisol samples and were given $10 of further compensation for participation.

Marital conflict discussion task. A widely-used procedure was used to generate and observe conflictual interactions between partners (e.g., for a review, see Gottman & Notarius, 2000; Lucas-Thompson, George, & Quinn-Sparks, 2016). Couples were asked to conduct independent ratings of common areas of conflict to identify the largest area of conflict in the couple relationship. A research assistant then reviewed those topics and selected the 3-4 topics that were rated as the most conflict producing. Couples were videotaped for 15 minutes as they discussed and tried to work towards a resolution of the topics. To prompt couples to behave as naturally as possible during the discussion, a research assistant asked participants to talk as they normally do during disagreements, to avoid talking to the camera, and to avoid explaining details such as names or events to the camera.

Collection of diurnal cortisol. Participants were asked to provide saliva samples using Salivettes® to assess diurnal cortisol patterns for two back-to-back days that were similar in schedule, which were always school or work days and were not the same day as the lab visit. A research assistant explained how to use the Salivettes® to take a saliva sample, and then participants practiced by taking a saliva sample in the laboratory. Participants were asked to take a saliva sample immediately after waking up in the morning, 30 minutes after waking, at 4 PM, and before brushing their teeth for bed. Participants were sent reminders from research assistants through email or text message to collect the samples at the correct times. Participants were instructed to freeze each saliva sample until the end of collection, and then to mail Salivettes® in a pre-addressed, postage-paid envelope back to the laboratory. In addition, participants were instructed to fill out a daily diary questionnaire each day to record the exact time of all collections as well as report any behaviors that may affect cortisol levels (e.g., ingestion of certain medications, exercise). Of the individuals who provided daily diary information, 78% provided their samples on the same day as their partner for both days and 11% provided samples on one of the same days as their partner. However, only 18 partners (32%) woke up at the same time; on average, partners were different in wake time by 91.11 minutes (*SD* = 148.18 minutes), suggesting that cortisol samples were usually not taken by partners at the same times even if they were taken on the same day.

Measures

Audio Computer Assisted Self Interview (ACASI) Software was utilized in this study to collect self-report information. This software allows participants the option of either reading questionnaire items to themselves or having the items and answers read aloud to them, to allow data collection from individuals of all reading levels. Participants reported on demographic information including family income, relationship duration, as well as individuals' age, ethnicity, education, and depressive symptoms.

Self-reported conflict. The Conflict subscale from the Braiker-Kelly Partnership Questionnaire (Braiker & Kelly, 1979) was utilized to measure intensity and frequency of marital conflict. This subscale includes five questions (e.g., "How often do you and your partner argue with one another," "When you and your partner argue, how serious are the problems or arguments", "To what extent do you communicate negative feelings toward your partner") rated on a 9-point scale from "not at all" to "very much." The means of each participant's scores were calculated to create a marital conflict score for each person. Higher scores represent higher levels of conflict (Cronbach's α, Women = .79; Men = .76).

The 13-item Resolution subscale from the Kerig Conflicts and Problem-Solving Scales (Kerig, 1996) was used to measure the self-reported degree of resolution of conflict for each participant. Participants rated the extent ("Never," "Rarely," "Sometimes," or "Usually") to which each statement (e.g. "We feel that we've resolved it, or come to an understanding", "We feel worse about one another than before the fight", "We don't speak to one another for a while") typically reflects the outcomes of their disagreements. A weighted score was calculated for each participant, such that higher scores reflected a greater degree of resolution of conflict. To calculate weighted scores, highly positive resolution scores were multiplied by 2, highly negative resolution scores were multiplied by -2, and these aggregate scores were summed with the answers to two questions ("We don't resolve the issue but 'agree to disagree'," and "We each give in a little bit to the other") that represent mixed positive/negative resolution outcomes. Cronbach's α were .64 and .53 for women and men, respectively.

Observed partner communication behavior. All videos of the marital conflict discussions were coded for positive as well as negative partner communication behaviors following the Marital Conflict Coding Manual (Cummings et al., 2007). Members of couples were coded separately by different observers. Participants were scored for the degree of each conflict behavior demonstrated on a scale from 0 to 1 (0 = absence of behavior, 1 = subtle display, and 2 = very strong display). Negative communication behaviors included nonverbal and verbal anger, defensiveness, withdrawal, physical distress, physical aggression (toward partner or objects), threat, pursuit, and insult. Positive communication behaviors included support, physical affection, calm discussion, problem solving, and humor. Coders were first trained using training videotapes which were not part of the study. Intraclass correlation coefficients (ICCs) showed that coders achieved at least 70% reliability on coding individual behaviors in training. Ratings that were discrepant between coders were consensus coded. Prior to consensus coding, adequate reliability was achieved (ICCs > .82). Positive relative to negative (P/N) communication behavior ratios for each partner were calculated by dividing the frequency of positive communication behaviors by the frequency of negative plus positive communication behaviors (i.e., positive communication behaviors / total communication behaviors). This step was completed in light of evidence that ratios of positive to negative communication behaviors during conflict discussions are especially predictive of divorce and lower marital quality (Gottman, 1994).

Measurement of diurnal cortisol. Saliva samples were assayed for cortisol concentrations at the University of Trier. Saliva samples were first centrifuged at 2,000 g for 10 minutes. A solid phase time-resolved fluorescence immunoassay with flouromeric end point detection (DELFIA) was utilized to analyze salivary cortisol levels for all samples. The intraassay coefficient of variation was between 4.0% and 6.7%. The corresponding interassay coefficients of variation were between 7.1%–9.0%. All samples were assayed in duplicate and averaged.

Analytic Plan

Data preparation. To prepare data for analyses, all variables were tested for normality. Variables that were transformed due to skewness included all individual diurnal cortisol variables, as well as women's and men's self-reported marital conflict and men's self-reported resolution. Potential control variables that were log-transformed due to skewness included: women's and men's depressive symptoms, women's age, family income, women's and men's average number of cigarettes consumed, women's and men's average amount of alcohol consumed, as well as women's and men's average waking time.

Missing data analysis. Results of Little's missing completely as random (MCAR) test were nonsignificant (p = .860), suggesting that data were missing at random. The execution of *t*-tests comparing those who completed and did not complete daily diary measures of health behavior variables revealed that there were some differences between these groups. Both men and women who completed the daily diary reported higher family incomes (women's $t(57)$ = -2.68 , p = .010; men's $t(57)$ = -3.28, p = .002) than those who did not complete the daily diary. In addition, women who completed the daily diary demonstrated higher levels of positive relative to negative (P/N) communication behavior ($t(58)$ = -2.50 , p = .016.), as did their partners ($t(57)$ = -2.69 , p = .009). Women who completed the daily diary had also been married for more years ($t(59)$ = -2.62, p = .011), were significantly less depressed ($t(53)$ = 2.11, p = .039), and had higher cortisol levels 30 minutes after waking ($t(60)$ = -2.19, p = .033). Men who completed the daily diary showed greater P/N communication behavior ($t(57)$ = -1.57, p = .030) and had lower cortisol levels at bed ($t(60)$ = 2.49, p = .015) than those who did not complete the daily diary.

Control variable analyses. To determine what control variables to include in the models, several health behavior variables linked with cortisol production in past studies (i.e., wake time, prescription and non-prescription drug use, hours of sleep the nights before, consumption of fruits, vegetables, or breakfast the days of sample collection) were separately tested as potential predictors of diurnal cortisol intercept and/or slope in MPlus (version 7.11, Muthen & Muthen, 2013). For those predictors that were time-varying, potentially having a different value across different sample times (consumption of dairy, caffeine, and/or chips in the hour before sample collection), paths to individual cortisol values were tested; for predictors that were not time-varying, paths to the latent variables were tested.

Demographic variables were also tested as potential predictors of cortisol latent variables, and included: family income, relationship duration, as well as individuals' age, ethnicity, education, and depressive symptoms. As participants reported their ethnicity by stating whether or not (1 = yes, 0 = no) they were Asian, black, or another race, when examining ethnicity as a predictor in analyses, models included all three dummy-coded variables as predictors. This allowed us to examine the association between outcome variables and each ethnicity as compared to Caucasian race. Given established links between partner depression and couple communication quality (for review, see Rehman, Gollan, & Mortimer, 2008), we also tested *partner* depressive symptoms as a potential control variable. Correlations among communication predictor variables and these demographic variables were also tested, and significant associations were controlled for in further analyses.

Testing the conceptual model. Structural equation modeling and latent growth curve modeling were utilized in this study to assess whether reported or observed marital conflict were associated with diurnal cortisol patterns. First, a dual latent basis growth curve model (GCM) for both men and women was estimated in MPlus to model cortisol intercepts (awakening cortisol level) and slopes (cortisol change throughout the course of the day), and to examine associations among partners' diurnal cortisol intercepts and slopes. Due to challenges with model identification in such complex models and our relatively small sample, two separate latent basis GCMs for men and for women were also estimated. For all growth curve models, the factor loadings for the slope were constrained at 0 and 1 for waking and bedtime samples, and the factor loadings for all samples in between the waking and bedtime samples were freely estimated. This step was completed without covariates, as our sample was relatively small and we hoped to limit the number of predictors as much as possible.

Men's and women's growth curve models were then fit into separate structural equation models to examine associations among cortisol intercepts/slopes and potential communication predictors (i.e., women's and men's self-reported marital conflict, women's and men's self-reported resolution of conflict, as well as women's and men's P/N communication behaviors). Maximum likelihood estimation with robust standard errors was utilized in all analyses. Model fit was examined using criteria suggested by Hu & Bentler (1998): adequate fit is indicated by a nonsignificant chi-square test, a root mean square error of approximation (RMSEA) of .08 or lower, a comparative fit index (CFI) of .95 or greater, and a standardized root mean square residual (SRMR) of .08 or lower. Structural equation models were tested first without control variables. Models were then tested with health behavior control variables as related to cortisol latent variables. Lastly, in order to limit the variable to sample size ratio to avoid problems with model identification, sensitivity analyses were conducted adding demographic control variables to the models one by one. Lastly, SEMs without covariates were tested with the sample restricted to those who had complete data on those control variables whose addition to the model made originally statistically significant results disappear, to examine if changes to the sample when the covariate was added were responsible for such changes.

Results

Descriptive Statistics and Bivariate Correlations

Bivariate correlations as well as means and standard deviations are presented in Table 1. Correlations considered relevant for our purposes are described next.

Correlations among communication predictor variables. All correlations between communication predictor variables were in the expected direction, with observed P/N communication behavior being positively correlated with self-reported resolution and negatively correlated with self-reported conflict. More specifically, women who demonstrated greater P/N communication behavior reported greater resolution, as did their husbands, and also had husbands who demonstrated greater P/N communication behavior and reported less marital conflict. Men who demonstrated greater P/N communication behavior reported greater resolution and less marital conflict, and had wives who reported less marital conflict. Women's and men's self-reported marital conflict also were positively correlated, as were women's and men's self-reported resolution. In addition, women and men who reported greater marital conflict also reported less-positive resolution. No other communication variables were significantly associated. Covariances among all communication predictor variables were modeled in structural equation model analyses.

Correlations among communication predictor variables and demographic variables. Women and men who had been together for longer displayed greater P/N communication behavior, as did their partners. Women and men who reported Black race relative to Caucasian race and those in couples in which the female partner had more depressive symptoms also displayed lower P/N communication behaviors.

Women who had been married for longer, reported fewer depressive symptoms, and were Caucasian relative to Asian/Asian American reported less marital conflict. Furthermore, women's and men's self-reported resolution was greater for those who had been married for longer and reported greater levels of education. Men also reported greater levels of resolution if they were with women who reported fewer depressive symptoms. These significant associations among communication predictor variables and demographic variables were controlled for in the sensitivity analyses described below. No other relevant correlations emerged as significant among communication predictor variables and demographic variables.

Associations of Demographic and Health Behavior Variables with Cortisol Latent Variables

Analyses in Mplus revealed that women's cortisol intercepts were higher for women who were older ($\beta = .37$, $SE = .19$, $p = .050$), had higher family incomes ($\beta = .55$, $SE = .16$, $p = .001$), reported higher levels of education ($\beta = .39$, $SE = .14$, $p = .005$), were Caucasian relative to Black ($\beta = -.59$, $SE = .15$, $p < .001$), and did not report prescription drug use ($\beta = -.74$, $SE = .22$, $p = .001$). Women's diurnal cortisol slopes were flatter (i.e., less negative) for women who were younger ($\beta = -.56$, $SE = .20$, $p = .006$), had been married for fewer years ($\beta = -.05$, $SE = .02$, $p = .020$), reported lower family incomes ($\beta = -.62$, $SE =.15$, $p < .001$), were less educated ($\beta = -.53$, $SE = .14$, $p < .001$), reported more depressive symptoms ($\beta = .46$, $SE = .16$, $p = .003$), were Black relative to Caucasian ($\beta = .61$, $SE = .16$, $p <.001$), had later average wake times ($\beta = .43$, $SE = .18$, $p = .016$), and consumed more cigarettes ($\beta = .52$, $SE = .26$, $p = .048$). Women also had flatter cortisol slopes if their partners reported more depressive symptoms ($\beta = .61$, $SE = .19$, $p = .001$).

Men's cortisol intercepts were higher when they also reported lower levels of depressive symptoms (β = -.38, *SE* = .12, *p* = .001) and greater levels of physical activity (β = .43, *SE* = .13, *p* = .001). Men's slopes were flatter for those who reported lower family incomes (β = -.46 , *SE* = .15, *p* = .002), younger age (β = -.38 , *SE* = .15, *p* = .013), lower levels of education (β = -.53 , *SE* = .13, $p < .001$), greater levels of depressive symptoms (β = .40, *SE* = .16, *p* = .02), Black race relative to Caucasian race (β = .41 , *SE* = .18, *p* = .022), and later average wake times (β = .37 , *SE* = .15, *p* = .02). In addition, for men, consumption of dairy at the time of the third collection on either day predicted greater cortisol values at that time point (β = .37, *SE* = .09, $p < .001$). All significant predictors in these analyses were included as covariates as described below.

Testing the Growth Curve Models

Testing the dual latent basis growth curve model: Are partners' diurnal cortisol patterns associated? A dual latent basis growth curve model was estimated in MPlus using diurnal cortisol intercepts and slopes (see Figure 1). Women's and men's cortisol variables were allowed to covary in the growth curve model. The dual growth model was estimable and fit well [$X^2(14) = 9.87$, *p* = .771; RMSEA = .00; CFI = 1.00; SRMR = .06]. Fixed effect estimates for the diurnal cortisol growth curves indicated that cortisol tended to decline throughout the course of the day; more negative estimates corresponded to steeper slopes throughout the day. There were significant associations among all of women's and men's latent cortisol variables; women's higher intercepts were significantly associated with women's (β = -.70, *SE* = .20, $p < .001$) and men's (β = -.60, *SE* = .15, $p < .001$) steeper cortisol slopes as well as associated with men's higher intercepts (β = .53, *SE* = .09, $p < .001$). Men's higher intercepts were significantly associated with women's (β = -.75, *SE* = .13, $p < .001$) and men's (β = -.72, *SE* = .10, $p < .001$)

steeper slopes. Men's and women's slopes were also significantly and positively associated (β = .86, *SE* = .13, $p < .001$).

Testing the Structural Equation Models: Does Couple Conflict Predict Diurnal Cortisol Patterns?

As noted, we wished to limit the number of parameters in our analyses due to our relatively small sample size. Therefore, the SEM models were tested using separate growth curve models for men and women. When these models were estimated before adding predictors, both growth curve models were estimable and fit relatively well [women's: $X^2(3) = 1.27$, $p = .737$; RMSEA = .00; CFI = 1.00; SRMR =.03; men's: $X^2(3) = 2.12$, $p = .550$; RMSEA = .00; CFI = 1.00; SRMR = .05]. Results between women's intercepts and slopes and men's intercepts and slopes were similar to in the dual GCM; in the women's GCM, women's higher intercepts were associated with women's steeper slopes (β = -.70, *SE* = .20, $p = .001$), and in the men's GCM, men's higher intercepts were associated with men's steeper slopes (β = -.73, *SE* = .10, $p < .001$). Thus, associations among slopes and intercepts were modeled in all growth curve models.

Models without covariates. First, separate structural equation models (SEMs) without covariates for women (see Figure 2) and men (see Figure 3) were tested. The five communication variables (women's and men's P/N behavior, women's and men's self-reported marital conflict, as well as women's and men's self-reported resolution of conflict) were tested as predictors of cortisol intercepts and/or slopes.

The women's SEM fit relatively well [$X^2(15) = 8.71$, $p = .892$; RMSEA =.00; CFI = 1.00; SRMR =.03]. Men's P/N communication behavior significantly predicted women's cortisol intercepts (β = .42, *SE* = .14, $p = .003$), as did men's self-reported marital conflict (β = -.41, *SE* = .20, $p = .035$). On average, women's cortisol intercepts increased as men's positive relative to negative communication behavior increased and as men's self-reported marital conflict decreased. No other communication variables were significant predictors of women's cortisol intercepts or slopes, although women's greater self-reported resolution reached marginal significance as a predictor of women's lower cortisol intercepts ($\beta = -.31$, *SE* = .18, $p = .08$), and men's greater P/N communication behavior also demonstrated marginal significance in predicting women's steeper slopes ($\beta = -.35$, *SE* = .19, $p = .07$).

The men's SEM demonstrated relatively good fit according to chi-square and SRMR [X^2 (15) = 20.88, p =.141; SRMR =.04] but RMSEA and CFI indices were respectively above and below cutoff values for relatively good fit (RMSEA =.08; CFI = .91). In this model, men's P/N communication behavior predicted men's cortisol slopes ($\beta = -.55$, *SE* = .21, $p = .011$): for men who demonstrated more positive relative to negative communication behavior, cortisol slopes were steeper. Men's cortisol intercepts and slopes were not predicted by any other communication variables.

Models with health behavior covariates. Next, SEMs with health behavior covariates were tested. The women's SEM with health behavior covariates demonstrated relatively good fit as indicated by chi-square and RMSEA, [$X^2(42) = 47.23$, $p = .267$; RMSEA = .05] but did not meet criteria for good fit as indicated by CFI and SRMR indices (CFI = .83; SRMR = .11). In these analyses, we controlled for the associations between women's cortisol intercepts and use of prescription drugs as well as between women's cortisol slopes and average wake time and average cigarettes consumed. The pattern of results was identical to the model discussed above; more specifically, women's intercepts were higher in couples in which the men demonstrated greater P/N communication behavior ($\beta = .56$, *SE* = .22, $p = .010$), and in which men reported less marital conflict ($\beta = -.49$, *SE* = .18, $p = .007$). Women's greater self-reported resolution reached marginal significance as a predictor of women's lower intercepts (β = -.43, *SE* = .23, *p* = .061), as did men's greater P/N communication behavior in predicting women's steeper slopes (β = -.43, *SE* = .23, *p* = .06).

In the men's SEM with health behavior covariates, we controlled for the association between average wake time and men's slopes, average amount of exercise and men's intercepts, and consumption of dairy at the time of the third sample on the cortisol value at that time. Model fit was similar to the fit of the model without the covariates, with chi-square and SRMR suggesting relatively good fit [$X^2(24) = 30.82$, $p = .159$; SRMR = .06] but not RMSEA or CFI (RMSEA = .08 CFI = .84). In this model, men's P/N communication behavior no longer significantly predicted men's slopes (β = -0.32, *SE* = 0.31, *p* = 0.317); in addition, as in the model without controls, all other pathways between marital variables and cortisol were non-significant.

Models with demographic covariates. Demographic control variables were added to the SEMs one by one in sensitivity analyses. The women's SEM was tested first. Results continued to suggest that men's greater P/N communication behavior and men's lower self-reported marital conflict predicted women's greater cortisol intercepts (as above) when controlling for: relationship duration, family income, ethnicity, education, women's depressive symptoms, and men's depressive symptoms. However, men's P/N communication behavior no longer predicted women's cortisol intercepts when adding age (β = .31, *SE* = .32, *p* = .323) into the model. In addition, women's self-reported resolution became a significant predictor of women's cortisol intercepts (surpassing marginal significance) when controlling for family income (β = -.34, *SE* = .16, *p* =.034) and education (β = -.34, *SE* = .16, *p* =.04). Results suggested that as women's reported resolution rises, women's intercepts decline. Finally, men's greater self-reported resolution approached marginal significance as a predictor of women's lower intercepts when including women's depressive symptoms ($\beta = -.24$, *SE* = .13, $p = .058$) and education ($\beta = -.24$, *SE* = .15, $p = .10$).

When demographic controls (family income, relationship duration, education, age, ethnicity, men's depressive symptoms, women's depressive symptoms) were added one at a time to the men's SEM, men's P/N communication behavior continued to be a significant predictor of men's cortisol slope, with more positive and/or less negative communication behavior associated with men's steeper cortisol slopes. When family income was added into the men's SEM, women's self-reported resolution demonstrated marginal significance as a predictor of men's cortisol slopes ($\beta = -.05$, *SE* = .03, $p = .076$) with greater levels of reported resolution predicting men's steeper cortisol slopes. When women's depressive symptoms were added into the model, this association surpassed trend levels and became significant ($\beta = -.37$, *SE* = .18, $p = .037$).

Models with samples restricted to participants with complete data on relevant covariates. For those covariates whose addition to the SEMs made originally statistically significant results disappear, structural equation models were tested without covariates with the sample restricted to individuals who had complete data on those covariates. As MPlus employed listwise deletion methods in these analyses, the intention of these analyses was to examine if changes to the sample when adding certain covariates into the model were the cause of such changes in statistical significance, rather than the effect of adding the covariate.

As stated above, in the men's SEM, the addition of health behavior covariates (i.e., average wake time, average hours of physical activity, and consumption of dairy at the third time point) resulted in men's P/N communication behavior no longer significantly predicting men's slopes. When the sample was restricted to those who had complete data on these health behavior variables (n= 51), results revealed that men's P/N communication behavior did not predict men's slopes (β = -.39, *SE* = .29, *p* = .18). These results suggest that the addition of men's health behavior covariates into the model may have an effect on significance through the changes in the sample that result from the addition of these variables.

In the women's SEM, addition of age into the model resulted in men's P/N communication behavior no longer predicting women's cortisol intercepts. When the sample was restricted to those who had complete data on age (n= 42), men's greater P/N communication behavior became a marginal, rather than significant, predictor of women's higher intercepts (β = .45, *SE* = .25, *p* = .068), suggesting that changes in the results may be due to changes in the sample when age is added as a covariate into the model.

Discussion

The goal of this study was to investigate whether partners' ratios of observed positive to negative communication behaviors, self-reported marital conflict, and/or self-reported resolution predicts diurnal cortisol patterns. Though past research has demonstrated that diurnal cortisol patterns are associated with marital communication behaviors reported in naturalistic settings (e.g., Stawski, Cichy, Piazza, & Almeida, 2013), and that observed communication behaviors are linked to acute cortisol responses to marital conflict laboratory tasks (e.g., Feinberg et al., 2013), this is the first study to explore the extent to which observed couple communication behaviors are related to individuals' typical diurnal cortisol patterns.

As hypothesized, I found significant associations among partner communication variables and diurnal cortisol patterns. In regards to observed communication quality (hypothesis one), there was a positive association between men's greater P/N communication behavior and women's higher cortisol intercepts (in all models except for with women's age). Men's greater P/N communication behavior also demonstrated marginal significance in predicting women's steeper slopes. In addition, men who demonstrated greater communication quality also displayed steeper cortisol slopes (in all models except for those with health behavior covariates).

Concerning self-reported marital conflict (hypothesis two), women with husbands who reported greater marital conflict demonstrated lower cortisol intercepts (in all models). Results of analyses investigating self-reported resolution as a predictor (hypothesis three) indicated that women who reported greater resolution tended to demonstrate lower intercepts (in models with women's education and family income; these results were at marginal significance in other models). In addition, when women's depressive symptoms were added into the model, women's greater levels of reported resolution were also associated with men's steeper cortisol slopes, and this association was marginal when family income was added into the men's SEM. Finally, when including women's depressive symptoms and women's education, men's greater self-reported resolution approached marginal significance as a predictor of women's lower intercepts.

Furthermore, as indicated in all growth curve models, there were significant associations between lower cortisol intercepts and flatter cortisol slopes for both men and women as well as across partners. This pattern suggests that some individuals were likely to display attenuated HPA axis functioning across early morning and later in the day levels, whereby morning levels are lower and diurnal cortisol slopes are flattened. This pattern of unhealthy diurnal cortisol secretion has been related to family adversity (Koss, Mliner, Donzella, & Gunnar, 2016) as well as emotional and health problems (for a review, see Edwards, Heyman, & Swidan, 2011), and is indicative of greater allostatic load (Fries, Hesse, Hellhammer, & Hellhammer, 2005).

Interestingly, these findings also suggest that those with diurnal cortisol patterns indicative of attenuated HPA axis functioning tend to have partners with similarly unhealthy diurnal cortisol rhythms. These findings are consistent with research that suggests that partners' levels of diurnal cortisol output (Saxbe & Repetti, 2010) as well as diurnal cortisol slopes (Hsiao, Jow, Kuo, Huang, Lai, Liu, & Chang, 2014; Liu, Rovine, Cousino Klein, & Almeida, 2013) are positively associated. Research has found that individuals' within-person fluctuations in their own diurnal cortisol patterns are associated with similar changes in their partners' cortisol patterns (Liu, Rovine, Cousino Klein, & Almeida, 2013), suggesting that such similarities in diurnal cortisol patterns are likely the result of partners coregulating their physiology over time, whereby spouses directly influence each other's stress physiology, or through shared marital stressors (Liu, Rovine, Cousino Klein, & Almeida, 2013; Saxbe & Repetti, 2010). Given that participants in our study were in relatively long-term relationships, it may be that partners' diurnal cortisol patterns have synchronized through many years of coregulation, or that shared marital interactions have contributed to each partner's allostatic load throughout time and thus partners diurnal cortisol patterns have become more similar over time. However, longitudinal research should be conducted to examine these possibilities.

Our findings that some measures of observed communication quality predicted diurnal cortisol patterns are consistent with research that links less positive or more negative observed communication quality to less healthy patterns of acute cortisol responding (e.g., Aloia & Solomon, 2015b; Laurent et al., 2013) as well as research that finds associations among self-reported communication behaviors and diurnal cortisol (e.g., Birditt, Nevitt, & Almeida, 2015; Floyd & Riforgiate, 2008). However, our study extends the literature in being the first to link observed communication quality to individuals' day-to-day diurnal cortisol patterns. Results suggested that men's greater observed communication quality is significantly associated with men's steeper cortisol slopes (in all models except those with health behavior covariates), women's higher cortisol intercepts (in all models except for with women's age), and marginally associated with women's steeper cortisol slopes. Men's greater communication quality is thus negatively associated with patterns suggestive of physiological dysregulation for both men and women. It may be that the stress of conflict with men who are more negative and/or less positive in couple interactions contributes to greater allostatic load, leading to men's flatter diurnal cortisol slopes and women's lower waking levels. Alternatively, men who display patterns of diurnal cortisol production indicative of greater allostatic load may, as a result, behave more negatively in couple interactions, and women who display such cortisol patterns may provoke such lower communication quality in their husbands.

Previous research has found cross-partner associations between men's communication behavior and women's physiological stress functioning; for example, men's greater positive interaction behaviors during marital conflict are associated with women's steeper cortisol slopes from pre- to post-discussion (Robles, Shaffer, Malarkey, & Kiecolt-Glaser, 2006) and days with higher frequencies of husbands' support behavior are associated with women's steeper diurnal cortisol slopes (Crockett & Neff, 2013). It is interesting that only men's observed communication quality and only men's self-reported frequency/intensity of marital conflict predicted women's cortisol patterns. These findings are in line with other research suggesting that women are more physiologically sensitive to their partners' communication behavior than to their own behavior (e.g., Kiecolt-Glaser et al., 1996) as well as to marital interaction qualities in general (for review, see Kiecolt-Glaser & Newton, 2001). Researchers have suggested that this may be due to women holding more "relationally interdependent self-representations", leaving their physiology more vulnerable to both positive and negative marital interactions than men (for review, see Kiecolt-Glaser & Newton, 2001). In contrast, research suggests that men's physiology is more strongly associated with their own behavior than with their wives' (Miller et al., 1999), consistent with our findings.

Congruous with past research that links self-report measures of marital interaction with diurnal cortisol patterns (e.g., Barnett, Steptoe, & Gareis, 2005; Hicks & Diamond, 2011; Keneski, Neff, & Loving, 2017), our study found that there were associations of self-reported frequency/intensity of marital conflict and resolution of marital conflict with diurnal cortisol patterns. Specifically, men's greater self-reported marital conflict predicted women's lower cortisol intercepts (in all models). As the stress of more frequent/intense marital conflict may lead to greater allostatic load (e.g., Taylor, Repetti & Seeman, 1997), it may be that women who are with men who report greater marital conflict are more frequently involved in marital conflict, and thus display a lower cortisol intercept as a result of allostatic load and attenuated HPA axis functioning. Women who display patterns of diurnal cortisol more indicative of allostatic load may also, as a result of less than optimal physiological health, be more likely to participate in marital conflict, and thus their husbands may report greater levels of marital conflict.

Interestingly, women's greater self-reported resolution (in models with family income and women's education) significantly predicted, and men's greater self-reported resolution marginally predicted (in models with women's education and women's depressive symptoms), women's *lower* cortisol intercepts. It may be that greater resolution of conflict is stressful for women, as they are often the ones who carry the burden of resolving conflicts in their relationships (Christensen & Heavey, 1990). Thus, greater resolution of conflict may be a reflection of the greater effort that women must put into resolving conflicts with their spouses, which could explain a greater allostatic load for women who report greater levels of resolution.

Results also suggested that women's greater self-reported resolution significantly (in models with women's depressive symptoms) and marginally (in models with family income) predicted men's steeper cortisol slopes. Men who have healthier physiological stress functioning may be better able resolve conflict with their wives, or women's more positive perceptions of marital conflict resolution may have a positive effect on men's physiological stress functioning. This is in opposition to the above findings that resolution negatively affects women's stress functioning; it may be that resolution of conflict is more helpful in reducing allostatic load for men than for women, as men may feel less responsible for initiating conflict resolution (Christensen & Heavey, 1990), and thus, for men, reported resolution of conflict is more of a reflection of conflict being resolved and less of a reflection of the greater effort put into resolving conflict.

Although this study makes important contributions to our knowledge, there are several limitations that are important to note. Our sample size was relatively small for such a complex model. This was likely the cause of a few issues in our analyses. There were a few instances when adding covariates into the model resulted in originally significant results disappearing. When adding women's age into the women's SEM, men's P/N communication behavior no longer predicted women's cortisol intercepts, and when adding men's health behaviors into the men's SEM, men's P/N communication behavior no longer significantly predicted men's slopes. It is likely that reductions in power that occurred in shrinking the sample size when these covariates were added caused our results to no longer be statistically significant. In addition, results of MCAR tests suggested that there were some differences in the groups based on whether they completed the daily diary of health behaviors or not; these differences could explain why addition of men's health behaviors into the model resulted in men's P/N communication behavior no longer predicting men's slopes, as men who completed the daily diary had higher incomes, greater P/N communication behavior, and had lower cortisol levels at bed than those who did not complete the daily diary. When SEMs were tested without covariates with the samples restricted to those who had complete data on these variables, results mimicked the results of analyses with the covariates, no longer being significant. These findings suggest that changes in the results may be due to changes in the sample when these covariates were added into the model.

Although model fit was adequate for most key models, a few of the models (e.g., women's: with health behavior covariates, with age, with depressive symptoms, with ethnicity;

men's: without covariates, with health behavior covariates, with family income, with age, with ethnicity, with men's depressive symptoms) demonstrated less than adequate model fit, likely as a result of our small sample size. However, even when model fit in these models was less than adequate, most results suggested the same key findings.

Methodologically, limitations of this study included that diurnal cortisol was only collected for two back-to-back days, which is the minimum number of days suggested for conducting high-quality diurnal cortisol research (Ryan, Booth, Spathis, Mollart, & Clow, 2016). In addition, although the sample was ethnically and economically diverse, the sample tended to be relatively high income and mostly Caucasian (women 72.1% Caucasian, men 65.6% Caucasian). The findings of this study should be replicated with a larger, more ethnically and economically diverse sample and with collecting diurnal cortisol over more than two days.

Given that our sample was composed of parents in relatively stable relationships, future studies should also investigate whether our results generalize to couples who are not parents and/or who are in different stages (e.g., dating phase) of their relationships. In addition, given that our study was cross-sectional and not experimental in nature, longitudinal studies could assess the potential effects over time of conflict behaviors on diurnal cortisol patterns, and experimental studies could be conducted to facilitate the drawing of cause and effect conclusions for associations among diurnal cortisol patterns and couple conflict behaviors.

The findings of the current study may inform the work of therapists. Given that all models suggested associations among men's greater self-reported marital conflict with women's less healthy diurnal cortisol rhythms, couples therapists may wish to use husbands' reports of marital conflict to assess health risks in female clients. In light of associations among men's greater observed communication quality and both women's and men's healthier diurnal cortisol rhythms in most models, therapists may choose to target husbands' communication behavior in preventing negative health outcomes in couples.

In conclusion, this study found relations of both self-report communication behaviors and observed communication behaviors with diurnal cortisol patterns. Specifically, in most models, men's greater observed communication quality was related to women's higher intercepts and men's steeper slopes, men's greater self-reported marital conflict was associated with women's lower intercepts, and, in some models, women's greater reported resolution was associated with women's lower intercepts and men's steeper slopes. These results support that, in general, less positive and more negative marital conflict is a stressor that appears to contribute to allostatic load for couples. Our findings suggest that dysfunctional diurnal cortisol functioning may serve as a link between the stress of marital conflict and health. In being the first to investigate the association among individuals' characteristic diurnal cortisol patterns and observed couple communication behaviors, this research adds to a body of literature that investigates the possible pathways between marital interaction and health, with implications for interventions that target partner communication behaviors.

Table 1. *Bivariate Correlations and Descriptive Statistics for Communication Predictor Variables, Observed Cortisol Variables, and Control Variables*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Positive relative to negative communication behavior																												
1. Women[b]	X	**.54**	-.25	**-.29**	**.41**	**.40**	.18	.05	.19	.17	-.16	-.09	-.12	-.14	**.60**	**.45**	.25	**.46**	.18	**.28**	**-.28**	.06	.02	**-.38**	.18	-.02	**-.51**	.18
2. Men[b]		X	**-.42**	**-.32**	**.52**	**.45**	**.30**	**.26**	.25	.12	-.04	-.21	-.22	**-.37**	**.60**	**.54**	.22	**.45**	**.26**	**.38**	**-.30**	-.20	.09	**-.48**	.04	.15	**-.56**	.05
Self-reported marital conflict																												
3. Women[a]			X	**.48**	**-.58**	**-.33**	-.18	-.20	-.21	-.20	.04	-.09	.13	.12	-.27	-.23	-.06	**-.36**	-.17	**-.27**	**.36**	.27	**-.36**	.05	.01	**-.29**	.16	-.01
4. Men[b]				X	**-.34**	**-.33**	**-.34**	-.18	**-.30**	-.18	-.12	-.18	-.15	-.07	-.1	.09	.01	-.16	-.02	-.09	.25	.15	.06	.01	.04	.00	.08	-.12
Self-reported resolution																												
5. Women[a]					X	**.38**	.13	.19	.04	.04	-.20	-.20	-.14	-**.31**	.26	.25	.12	**.38**	.22	**.42**	**-.62**	-.25	.22	-.14	-.09	.14	-.22	.03
6. Men[a]						X	.08	.09	.10	**.28**	-.11	.03	-.10	-.07	.24	**.38**	.13	**.29**	**.27**	**.26**	-.16	-.15	.03	-.09	-.02	.08	-.34	.11
Cortisol level at waking																												
7. Women[a]						.	X	**.37**	**.48**	**.34**	.09	.09	-.03	-.22	.16	.10	**.40**	.21	**.30**	.24	-.19	-.00	.09	**-.43**	.04	.12	**-.40**	.16
8. Men[a]								X	**.27**	**.61**	-.16	.23	**-.28**	-.16	.04	-.09	.22	.18	.14	.17	-.07	**-.29**	.09	**-.33**	-.06	-.06	-.18	.20
Cortisol level 30 minutes after waking																												
9. Women[a]									X	.25	-.09	-.08	-.15	-.21	.27	.11	**.39**	.17	**.29**	**.29**	-.23	-.17	-.04	**-.42**	.11	.03	**-.33**	.15
10. Men[a]										X	-.23	**.27**	**-.35**	-.14	.04	.13	.18	.16	.12	.17	-.01	**-.29**	-.05	**-.28**	.02	-.08	-.22	.17
Cortisol level at 4:00 PM																												
11. Women[a]											X	.13	**.31**	.18	-.06	-.18	-.09	-.13	-.20	-.19	.08	.16	-.07	.12	.05	.01	.13	-.18
12. Men[a]												X	-.05	**.28**	-.28	-.16	-.20	-.02	**-.26**	-.23	.26	-.16	-.07	.25	-.07	-.16	.18	.10
Cortisol level at bed																												
13. Women[a]													X	**.35**	**-.30**	**-.46**	**-.34**	**-.29**	-.23	**-.32**	.21	**.42**	-.09	**.27**	-.08	-.11	**.28**	-.04
14. Men[a]														X	**-.41**	**-.39**	-.24	-.15	**-.26**	**-.37**	.13	.23	-.23	**.34**	-.06	**-.27**	.24	.03
Age																												
15.Women[a]															X	**.77**	**.39**	**.65**	**.49**	**.60**	-.30	.01	.05	**-.45**	**.45**	**.32**	**-.52**	.08
16. Men[b]																X	.29	**.649**	**.52**	**.57**	**-.35**	-.12	.19	-.24	.26	.28	**-.41**	.07
17. Income[a]																	X	**.42**	**.63**	**.59**	-.13	-.15	**.26**	**-.59**	.12	.23	**-.55**	.03
18.Years together[b]																		X	**.47**	**.52**	**-.46**	.10	.13	**-.34**	.16	.14	**-.48**	.16
Education																												
19. Women[b]																			X	**.79**	**-.33**	-.13	**.28**	**-.43**	**.31**	**.38**	**-.54**	.02
20. Men[b]																				X	**-.33**	-.25	**.28**	**-.39**	**.35**	**.46**	**-.47**	.09
Depressive symptoms																												
21. Women[a]																					X	-.03	-.03	.24	-.16	.06	**.30**	.02
22. Men[a]																						X	-.13	.19	.11	-.13	.07	-.21
Womens' race[c]																												
23. Asian Race[c]																							X	-.12	-.08	**.65**	-.14	-.10
24. Black Race[c]																								X	-.10	-.10	**.83**	-.13
25. "Other"																									X	.20	-.12	-.09
Mens' race[c]																												
26. Asian Race[c]																										X	-.12	-.09
27. Black Race[c]																											X	-.16
28. "Other"																												X
M	.6	.62	2.88	4.65	2.47	5.37	11.28	11.71	14.85	13.90	3.15	4.08	2.20	2.73	43.36	44.40	$85936.86	16.03	3.90	3.88	9.12	7.31	.08	.13	.07	.07	.19	.10
SD	.2	.27	1.56	5.91	1.22	5.91	5.58	6.30	7.46	8.05	1.97	2.95	3.45	2.88	11.05	6.23	$68531.04	5.81	1.85	2.27	7.68	5.36	.29	.34	.25	.25	.39	.30

Note: Significant correlations are in bold. [a]Log-transformed; [b]Raw values [c]Dummy-coded variable Note: All means and standard deviations are raw values with the exception of ethnicity variables (variables 23-28), which are dummy coded

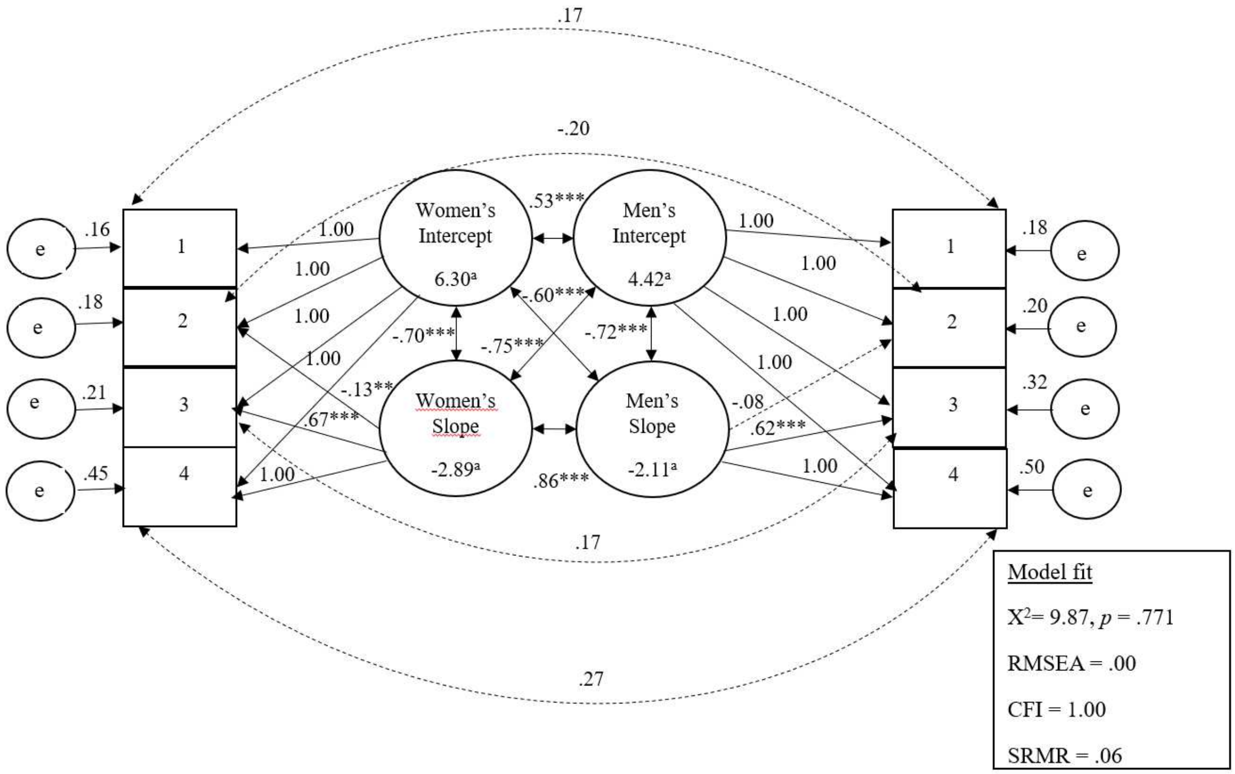

Figure 1. Growth curve model demonstrating associations among women's and men's diurnal cortisol patterns. + $p < .10$. *$p < .05$. ** $p < .01$. *** $p < .001$. [a]Fixed effect estimate. Note: Standardized estimates for paths are shown. Paths with solid arrows were significant, paths with dashed arrows were non-significant. Unstandardized estimates for factor loading coefficients and residual variances are shown. Numbered boxes represent diurnal cortisol samples taken at (1) waking, (2) 30 minutes after waking, (3) at 4:00 PM, and (4) right before bed. Errors are specified with 'e's'.

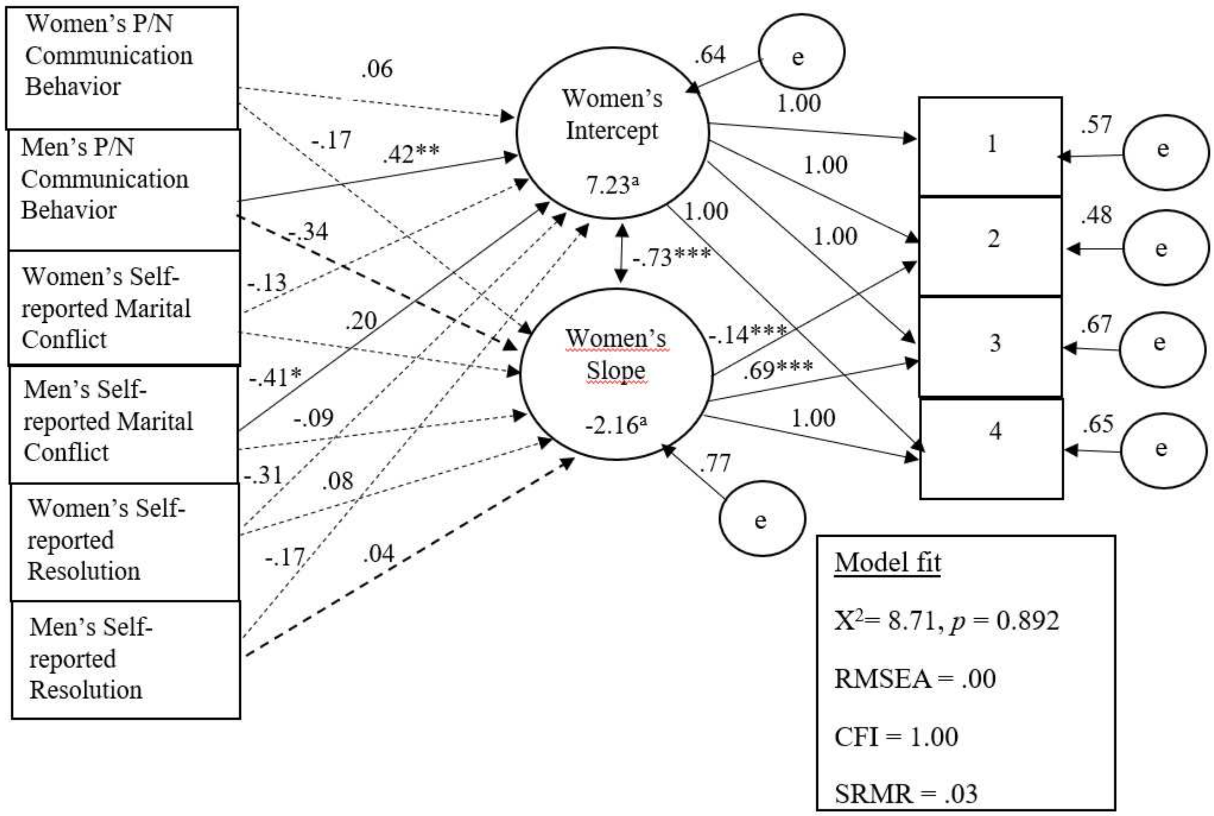

Figure 2. Results of the structural equation model testing the associations between communication variables and women's diurnal cortisol patterns. + $p < .10$. *$p < .05$. ** $p < .01$. *** $p < .001$. [a]Fixed effect estimate. Note: Standardized estimates for paths are shown. Paths with solid arrows were significant, paths with dashed arrows were non-significant. Unstandardized estimates for factor loading coefficients and residual variances are shown.Errors are specified with 'e's'. All communication predictor variables were significantly correlated in the model, with the exception of: men's P/N communication behavior with men's self-reported marital conflict ($p = .06$) and women's P/N communication behavior with women's self-reported conflict ($p = .05$).

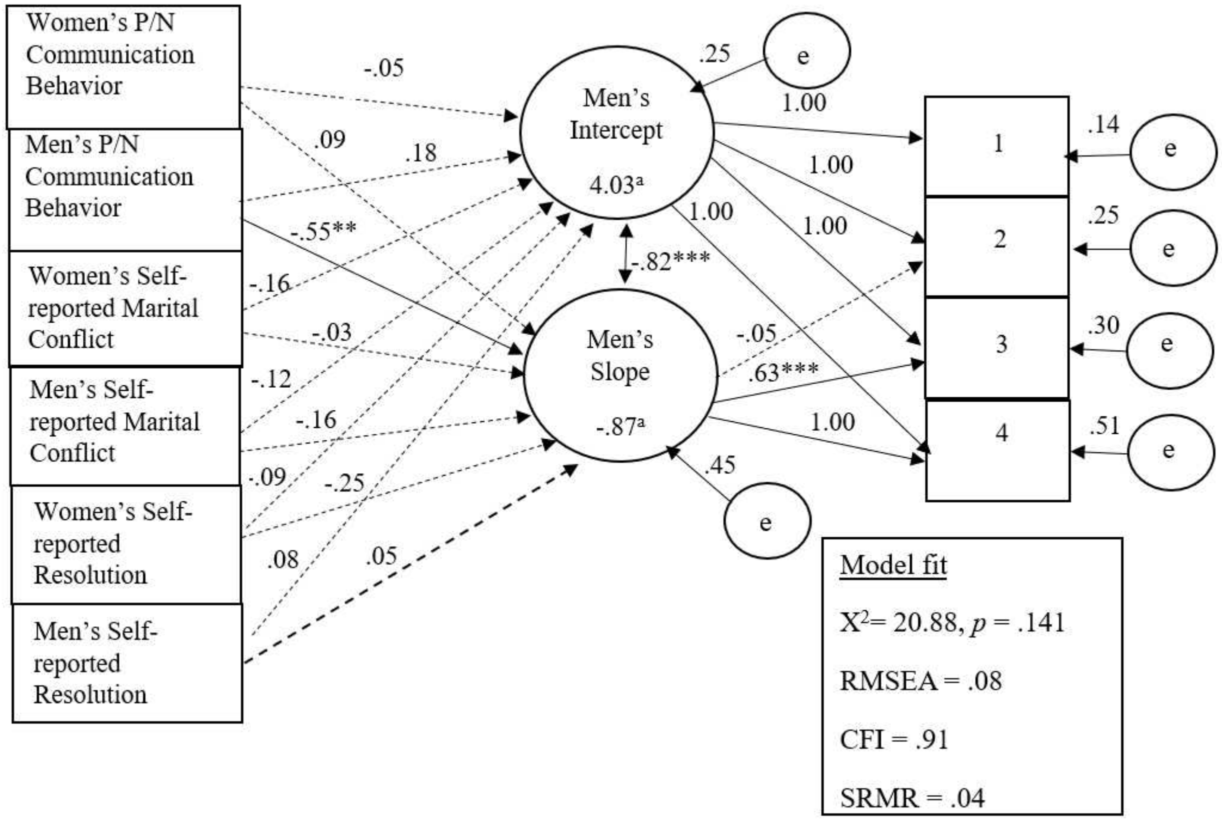

Figure 3. Results of the structural equation model testing the associations between communication variables and men's diurnal cortisol patterns. + $p < .10$. *$p < .05$. ** $p < .01$. *** $p < .001$. [a]Fixed effect estimate. Note: standardized estimates for paths are shown. Paths with solid arrows were significant, paths with dashed arrows were non-significant. Unstandardized estimates for factor loading coefficients and residual variances are shown. Errors are specified with 'e's'. All communication predictor variables were significantly correlated in the model, with the exception of: men's P/N communication behavior with men's self-reported marital conflict ($p = .06$) and women's P/N communication behavior with women's self-reported conflict ($p = .05$).

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