DYADIC LINKS BETWEEN HOSTILITY, SOCIAL DISCONNECTION, AND APPETITE REGULATION

by

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ABSTRACT

Experiences of social disconnection, like hostile marital interactions, have the ability to "get under our skin" and cause deleterious health outcomes by thwarting our fundamental need to belong. Appetite regulation, a biological process that is susceptible to stress and implicated in many health outcomes, may help to clarify the physiological mechanisms involved in the relationship between social disconnection and health outcomes. Using multilevel structural equation modeling in an actor-partner interdependence framework, the current study aimed to determine if observed hostility from a spouse during a marital conflict discussion predicted their partner's ghrelin levels (i.e., an appetite-relevant hormone implicated in meal initiation) via increases in their partner's disconnection. We hypothesized that greater amounts of hostility from an actor during the discussion would predict higher partner reports of disconnection, thereby predicting increased partner ghrelin levels. Forty-seven couples completed two counterbalanced study visits that were identical aside from the discussion topic (i.e., conflict or control). Data utilized in this study were from the conflict discussions, which were observationally coded to assess hostility. Additionally, couples separately rated their subjective feelings of disconnection after the conflict and provided 5 blood samples (i.e., 1 upon arrival to the lab and 4 after the conflict discussion). The samples were assayed to determine levels of total and active ghrelin at each time point. Results did not support the hypothesis that partner disconnection mediated the relationship between actor hostility and partner ghrelin. Moreover, in contrast to prior findings,

partner hostility and actor disconnection were also not found to be related to ghrelin. Due to the puzzling pattern of results, further analysis and exploration of study measures needs to be conducted before meaningful interpretations can be made.

Chapter 1

INTRODUCTION

Human beings have long been conceptualized as hyper-social creatures who seek out connection with others. In fact, humans evolved with an advanced capacity for cognitive skills pertaining to socialization (Herrmann et al., 2007) to help them capitalize on adaptational advantages associated with being socially connected. These survival benefits include the facilitation of social learning (Boyd & Richerson, 1996; Boyd et al., 2011) and the ability to garner interpersonal trust, cooperation, and social capital (Cook, 2014; Edelman et al., 2004; Portes & Landolt, 1996; Putnam, 1993). The hyper-sociality of humans persists even in modern times. For instance, data from the Bureau of Labor Statistics' American Time Use Survey documents that the average individual aged fifteen or above spends approximately half of their waking hours in the presence of at least one other person (U.S. Bureau of Labor Statistics, 2021). Furthermore, the strong need for human connection continues to be demonstrated in the modern age, where people seek out more interpersonal connections than ever before. This is exemplified in part by the large uptake and retention of social networking sites such as Facebook, Instagram, and Tiktok. In fact, 88% of adults aged 18-29 report continued engagement with social media on a regular basis (Greenwood et al., 2016). This evidence strongly suggests that hyper-sociality and its associated benefits (e.g., social capital) have adapted to the digital age (Domahidi, 2018; Steinfeld et al., 2008). As such, it is unsurprising that the

fundamental need to belong, defined as “a pervasive drive to form and maintain at least a minimum quantity of lasting, positive, and significant interpersonal relationships" (Baumeister & Leary, 2017), remains a persistent and universal facet of the human experience.

1.1 Fundamental Need to Belong and Health

Fulfilling the fundamental need to belong is linked to improvements in mental and physical health. For example, daily sharing of enjoyment with others, a form of social connection, is associated with more resilient cognitions and daily positive affect (Arewasikporn et al., 2019). Moreover, supportive social ties and lower loneliness levels are linked with reductions in blood pressure, heart rate, momentary fatigue (Goldman & Cornwell, 2023) and stress hormones (Uchino et al., 2004), as well as better cognitive functioning (Shankar et al., 2013), lung functioning in older adulthood (Crittendon et al., 2014), and overall improvements in health behaviors (Cohen et al., 2004). While social connection is a protective factor for multiple domains of functioning, feeling socially disconnected (i.e., lonely or isolated, being in a hostile marriage), is a risk factor associated with deleterious consequences (Holt-Lunstad et al., 2010; Holt-Lunstad, 2021; Jaremka et al., 2022). In fact, these negative consequences are so severe that social disconnection was recently deemed an “urgent public health issue” by the U.S. Surgeon General (Office of the Surgeon General, 2023). For example, insufficient social relationships are associated with a 50% increased likelihood of mortality when compared to individuals who have adequate social connection, which is an equivalent mortality likelihood as smoking approximately fifteen cigarettes a day (Holt-Lunstad et al., 2010). Furthermore, a recent meta-analysis found that both objective and subjective reports of multiple

indicators of social isolation (e.g., alienation, thwarted belongingness) were linked to increased suicidal ideation and behaviors (Calati et al., 2019). These results hold true transculturally and across the lifespan. Given the severe negative outcomes associated with social disconnection, it is of paramount importance to understand the ways in which feeling disconnected effectively "gets under our skin" and impacts physical health (Shrout, 2021).

1.2 Social Disconnection and Appetite Regulation

Researchers have become increasingly interested in the biological pathways that may act as potential mechanisms explaining the association between social disconnection and health. Social disconnection is linked to worse cardiovascular responses (Teoh & Hilmert, 2018; Williamson et al., 2018), reduced antiviral immunity (Leschak & Eisenberger, 2019), higher blood pressure (Fortmann & Gallo, 2013; Grant et al., 2009), increased cortisol release (Grant et al., 2009) and oxidative stress (Li & Xia, 2020), neuroendocrine dysregulation (Cacioppo et al., 2015), as well as higher levels of inflammation (Jaremka et al., 2013; Uchino et al., 2018). Although important advances have been made, there is still much scientists have to learn. For example, appetite regulation, a significant understudied biological process that has been linked with negative health outcomes and may be affected by social disconnection, is relatively unexplored. Appetite regulation and associated eating behaviors are shaped by a combination of biological, psychological, pathophysiological, social, and environmental factors. Additionally, appetite is fundamentally linked to the foods we consume, and our dietary choices are key determinants of ongoing health. Evidence suggests around 60% of U.S. adults have poor overall diet quality (e.g., high sodium, high processed meats, low produce, etc.)

(Long et al., 2022), which is significantly associated with instances of cancer, heart disease, stroke, type 2 diabetes, and premature death (Micha et al., 2017; Zhang et al., 2019). Furthermore, stress is a common risk factor for both obesity and dysregulated eating (Sinha & Jastreboff, 2013). Accordingly, ghrelin and leptin, two principal hormones used to measure processes of appetite regulation (which has downstream consequences for food consumption), may provide critical insight on the relationship between social disconnection and health.

1.3 Stress and Appetite Relevant Hormones

Although ghrelin and leptin are both involved in appetite regulation, body adiposity, and energy storage, they serve contrasting biological functions. Specifically, ghrelin is used to stimulate appetite and promote increases in homeostatic and hedonic food intake as well as body weight (Greenman et al., 2004; Monteleone et al., 2013). Within humans, ghrelin reliably increases during periods of fasting and subsequently decreases upon consumption of food. This suggests that pre-meal ghrelin serves an essential role in communicating the need for meal initiation (Cummings et al., 2001). In contrast, leptin signals the availability of long-term energy stores, such that when energy stores from food are high, leptin production increases and begins to suppress appetite through anorectic effects (Arora & Anubhuti, 2006). Leptin increases after consumption of a meal to limit further food intake (Klok et al., 2007) by signaling the replenishment of energy stores. Importantly, according to reviews of the literature, both leptin and ghrelin may be particularly susceptible to dysregulation during times of stress (Abizaid, 2019; Yau & Potenza, 2013). However, these studies have

primarily utilized rodent samples and/or focused on specific types of foods (e.g., high in sugar or fat) eaten during times of stress. As such, more studies examining the effects of stress on peripheral hormones among humans is needed.

Animal work examining the relationship between stress and appetite-relevant hormones has demonstrated that stress is associated with higher levels of ghrelin and lower levels of leptin. For instance, rodent studies have demonstrated that exposure to both acute and chronic biopsychosocial stressors predicted increased ghrelin gene expression in the stomach (Asakawa et al., 2001), increased plasma ghrelin (Kristenssson et al., 2006; Ochi et al., 2008), and stress-induced food reward responses due to ghrelin signals (Chuang et al., 2011). Furthermore, mice exposed to chronic social defeat stress as well as rats exposed to chronic restraint stress experienced lower levels of leptin compared to control groups (Chuang et al., 2010; De Oliveira et al., 2014). However, few studies have examined the relationship between stress and appetite-relevant hormones in humans. Moreover, while rodent studies have established a strong foundation of the relationship between general stress and appetite-relevant hormones, there are important differences to consider in human populations. For instance, given the more advanced evolutionary need for socialization that humans experience compared to rodents (Herrmann et al., 2007), it is likely that experiencing threats to belonging are particularly potent among humans. As such, it is important to examine social disconnection as a specific and potentially unique form of stress that may impact appetite-relevant hormone levels in humans.

A handful of studies have examined the impact of social disconnection on appetite-relevant hormones in humans. These studies span a variety of ways that social disconnection can be operationalized, including loneliness, experiences of rejection, or interpersonal hostility. For example, one study showed that non-obese women who reported experiencing more interpersonal stressors had higher ghrelin and lower leptin levels compared to women reporting fewer interpersonal stressors (Jaremka et al., 2014). Importantly, results demonstrated that no other types of stressors were related to ghrelin or leptin levels in women. Other studies examining the relationship between social disconnection and appetite-relevant hormones found similar results, suggesting that higher self-reported loneliness was predictive of increased ghrelin and decreased leptin levels in non-obese individuals (Jaremka et al., 2015). Furthermore, marital hostility, derived from the average observed marital conflict exhibited by non-obese couples during an objectively coded conflict discussion, was positively correlated with postprandial ghrelin (Jaremka et al., 2016).

1.4 Limitations of Prior Studies

Taken together, these studies support the notion that objective behaviors (i.e., marital hostility) and subjective reports of social disconnection (i.e., loneliness) are predictive of ghrelin and leptin levels. However, this literature is in its infancy; only a few studies have been conducted with relatively small sample sizes (Jaremka et al., 2014; Jaremka et al., 2015; Jaremka et al., 2016). To our knowledge no study has explored the objective occurrence of socially disconnecting behaviors within an actor-partner interdependence model (APIM; Kenny et al., 2020) framework; how social disconnecting behaviors exhibited by one individual (i.e., actor), and the resulting subjective feelings of disconnection reported by the receiving individual (i.e., partner)

lead to changes in appetite-relevant hormones. This is significant because an individual's subjective interpretation does not always match objective events, such that interpretations may change depending on intrapersonal factors, (Klein et al., 2016; Wickham et al., 2016) yet still be predictive of health outcomes (Jaremka et al., 2015). Exploring the mediating role of subjective disconnection on the relationship between objective hostility and appetite-relevant hormone outcomes will allow us to better understand the mechanisms facilitating this connection. Accordingly, it is essential that we explore social disconnection within interpersonal relationships to capture actor behaviors that may lead to changes in the partner's hormone levels.

1.5 Sampling Barriers to Studying Interpersonal Relationships

Although social disconnection can occur across a broad array of interpersonal relationships including friendships, siblings, or coworkers, there are significant barriers to examining these populations in an empirical setting. Specifically, recruiting individuals and their self-identified close non-romantic relationship partners can present numerous practical challenges, such as varied amounts of contact within and between subjects or different geographic locations of the subjects. Because of this, many studies examine close relationships in married couples, as they offer an ideal context for studying the actor and partner relationships involving social disconnection. This is largely due to the fact that one's intimate or romantic partner usually represents the most significant and salient relationship that an individual has at any given time, which is a phenomenon that has persisted across historical and cross-cultural contexts (Karendashev, 2016). Moreover, couples frequently cohabitate, live in the same general location, or see each other on a regular basis, thereby eliminating some of the practical challenges associated with recruiting other forms of close relationships. Prior

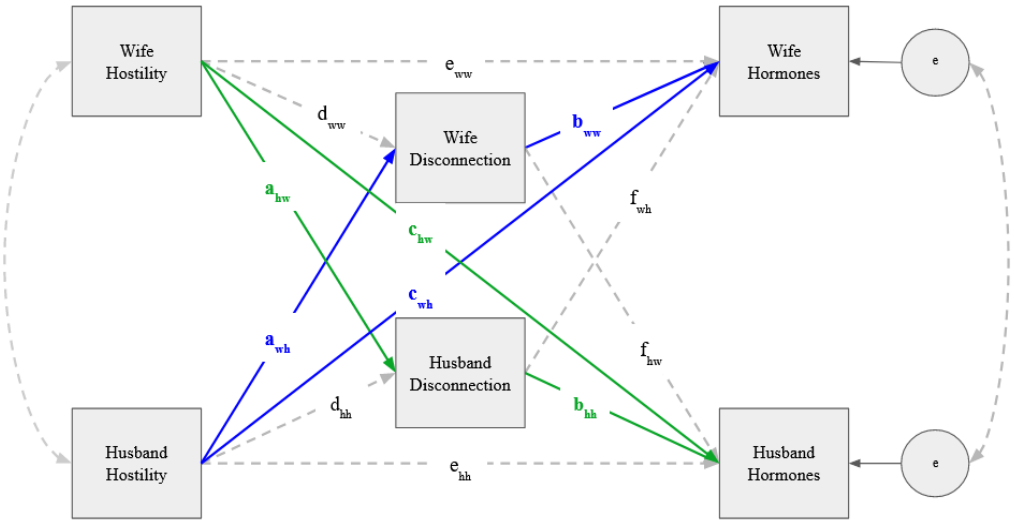
studies also suggest that factors of intimate relationships are strongly correlated with health outcomes. For instance, couples in high-quality romantic relationships had lower blood pressure than those in ambivalent relationships (Birmingham et al., 2015). Furthermore, when compared to couples who reported high levels of marital happiness, those in unhappy marriages reported double the number of health problems and had a 40% higher mortality rate (Lawrence et al., 2019). As such, examining social disconnection within intimate relationships allows us to more easily and accurately capture the effects of observed instances of social disconnection, the resulting emotional perception of the event, and physiological responses of individuals within a controlled setting. Furthermore, exploring objective indicators of disconnection (e.g., hostility) can be done with intimate relationships through the use of existing marital discussion paradigms (i.e., talking about aspects of the relationship) and subsequent coding of hostile behaviors.

1.6 Overview of the Present Study and Hypotheses

The present study was the first to our knowledge to examine couples' objective hostility and the subjective experience of social disconnection in relation to appetite-relevant hormones using an APIM framework. The principal aim of this study was to determine if observed hostility from an actor during a conflict predicts ghrelin levels, via increased partner feeling of disconnection. This aim is visually displayed in Figure 1. We employed observationally-coded data of a marital conflict discussion to obtain objective ratings of hostility for both members of the couple. Following the discussion, we asked each partner to rate their subjective feelings of disconnection related to the conflict. Furthermore, 5 blood draws were taken from each participant to

measure hormone levels both before and after the conflict discussion. We hypothesized that greater amounts of hostility from an actor during the discussion would predict higher partner reports of disconnection and subsequent increases in partner ghrelin (i.e., appetite stimulant), both following the discussion and over the remainder of the visit. Due to the small sample size for which leptin values were obtained in this study (n = 23 out of 47 total couples), we refrained from reporting leptin in our analyses.

Figure 1. Path Model of Proposed Multilevel Structural Equation Model in an Actor Partner Interdependence Model Framework



Note. Hypothesized pathways of primary interest are depicted in solid green (pathways leading to husband hormonal changes) and solid blue (pathways leading to wife hormonal changes). The first subscript represents a husband (h) or wife (w) outcome and the second subscript represents a husband (h) or wife (w) predictor (e.g. a_{hw} = husband disconnection regressed on wife hostility). All other paths are depicted in dashed gray.

Chapter 2

METHODS

Data for this paper were drawn from a larger Institutional Review Board-approved randomized cross-over experimental study conducted at the University of Delaware.

2.1 Recruitment and Eligibility

Married couples were recruited for participation from the local community using media announcements (i.e., posts on Craigslist and local Facebook pages), as well as printed flyers posted at local businesses (e.g., coffee shops) between 2017 and 2018. Couples were eligible to participate if both partners (a) were between 30 and 60 years of age, (b) had been married to their current partner at least 3 years, (c) had no major medical conditions, (d) had no needle and/or blood phobias, (e) had no allergies to foods used in the study, (f) were not on a structured diet or limiting food intake in a significant way, (g) had no identified eating-related psychological diagnosis, (h) identified as non-smoking, (i) were classified as non-obese (BMI < 30.00), (j) were not regularly performing shift work, (k) and were not currently pregnant. All eligible participants were identified as distressed or non-distressed on the Dyadic Adjustment Scale (Spanier, 1989). Couples were assigned to one of two condition orders (i.e., conflict or control discussion), with the aim of having the distribution of marital distress be similar across groups.

A preliminary electronic eligibility survey was used to identify and screen 750 people (couples: *n* = 322 [644 paired individuals]; *n* = 106 individuals [i.e., partner did not apply]) who expressed initial interest in participation. This resulted in 89 couples (*n* = 178 paired individuals) being deemed eligible. All eligible couples were then contacted by phone and email to schedule an initial study visit. Among those who were contacted, 30 couples passively declined to participate (i.e., did not schedule a visit) and 12 couples either canceled or did not attend their visit, leaving a final sample of 47 consented couples (total sample *n* = 94 paired individuals).

2.2 Participant Demographics

Participant demographics are displayed in Table 1. At the time of data collection, all 47 couples were in opposite-gender marriages and had been married 10 years on average (*M* = 10.2, *SD* = 6.73), with a majority of participants indicating this was their first marriage (86.2%, *n* = 75). All participants identified as cisgender with an average age of 39 years (*M* = 39.13, *SD* = 7.42), and they primarily identified as White (70.9%, *n* = 61) and non-Hispanic/Latino (100%, *n* = 94). The remaining participants reported their race as Black (18.6%, *n* = 16), other/multiracial (1.2%, *n* = 1), and Asian (9.3%, *n* = 8). Over half of the sample worked full- or part-time (83.8%, *n* = 72) and 96% of participants reported an average annual income over $60,000.

2.3 Procedures

Each couple completed two five-hour study visits at the lab, which were scheduled approximately two to four weeks apart. During one visit, couples discussed an area of disagreement in their marriage. During the other visit, they completed a

control discussion. The order of discussions was randomized across couples and appetite-relevant hormones were assessed before and after each discussion. To reduce variability in baseline appetite-relevant hormone levels due to time of day and food intake, all study visits began at 9:00 am and participants were required to fast for 12 hours prior to their visit. Upon arrival, couples were separated and given a standardized breakfast (i.e., chocolate Ensure drink), further reducing variability in baseline blood samples. Participants then provided a baseline blood sample through an intravenous catheter and completed a brief set of questionnaires. Couples were then reunited to participate in a marital discussion paradigm (i.e., problem solving or conflict discussion) introduced by a trained experimenter. After the discussion, each partner was separated again and was asked to complete additional questionnaires, as well as provide four additional blood samples approximately every 50 minutes. Both visits were identical aside from the content of their discussion task and couples were randomly assigned to a counterbalanced discussion order. For the purposes of the parent study, participants also ate ad libitum from a prepared food buffet at the end of each visit. Data from the buffet task were not utilized for the current paper and are thus not discussed further. The subset of data used in this paper was collected during each couple's conflict discussion visit. We chose to selectively utilize data from conflict discussion visits due to our hypotheses regarding the effects of conflictual communication on appetite-relevant hormones. Additionally, discussions were coded using the Rapid Marital Interaction Coding System, 2nd generation (RMICS2;

Heyman et al., 2015), which has only been validated to evaluate conflictual interactions.

Table 1. Participant Socio-Demographic Characteristics (N = 47 dyads/94 paired individuals)

Participant Socio-Demographic Characteristics	*n* or *M* (% or *SD*)
Age (years)	39.13 (7.42)
Relationship Length (years)	10.20 (6.73
Prior Marriage	
No-Prior	75 (86.2%)
≥ 1 Prior	19 (13.8%)
Relationship Type	
Opposite-Gender Marriage	94 (100%)
Race*	
White	61 (70.9%)
Black	16 (18.6%)
Asian	8 (9.3%)
Other/Multiracial	1 (1.2%)
Ethnicity	
Non-Hispanic/Latino	94 (100%)
Household Income**	
40,000 - 60,000	3 (3.7%)
60,001 - 80,000	18 (21.9%)
80,001 - 100,000	19 (23.2%)
≥ 100,001	42 (51.2%)
BMI ≤ 30	
Wives	37 (78.7%)

Husbands	38 (80.9%)

Note. Data were collected from 47 couples. Percentages reflect all participants who responded to the prompt (* Missing $n = 8$; ** Missing $n = 12$). Some participants exceeded a BMI of 30 either because their measured height and weight differed from what they indicated on the screening questionnaire, or because a few people were allowed to participate with a higher BMI due to recruitment difficulties (Husbands: $n = 9$; Wives $n = 10$).

Chapter 3

MEASURES

3.1 Conflict Discussion Task

Objective measurements of hostile marital behavior have been shown to be more predictive of physiological change than self-reported hostility (Kiecolt-Glaser & Newton, 2001). Accordingly, in this study partner hostility and positivity were assessed through a commonly used marital conflict discussion task which was video-recorded and objectively coded. The purpose of the task is to have couples discuss an area of disagreement in their marriage, providing insight into their interaction patterns when they discuss these topics in other contexts. Prior to the discussion, each partner separately completed the Relationship Problems Inventory (RPI; Knox, 1971), which asks participants to rate the extent to which they disagree with their partner on certain topics (e.g., intimacy, finances, children, communication, etc.). Importantly, a trained experimenter then identified topics that both partners rated as most conflictual on the RPI and guided a 10-20 minute discussion with the reunited couple to further narrow down the topics about which the couple currently disagreed. This facilitated discussion was done to clarify the discussion prompt (e.g., ensure disagreement is current and/or that the topic is not something mutually stressful that they share the same views on), as well as to prime conflictual discussion once the experimenter left the room. Once

the experimenter identified 2-3 topics, couples were then instructed to resolve these disagreements as much as possible during a video-recorded 20-minute discussion.

Upon completion of the study, trained coders scored the conflict discussions using the Rapid Marital Interaction Coding System, 2nd generation (RMICS2; Heyman et al., 2015). The RMICS2, the most recent iteration of the well-validated RMICS (Heyman, 2004), is an intensive observational coding system that assigns a code to each partner's behavior (i.e., affect, motor, paralinguistic, and linguistic) every 5 seconds throughout the dyadic discussion (240 possible codes per partner). The primary codes include, high-intensity hostility (HH; intense negative affect such as contempt or belligerence), low-intensity hostility (HL; mildly intense negative affect such as blame or demanding), constructive problem discussion (PD; neutral descriptions or solutions), low-intensity positivity (PL; positive affect and bonding such as mild humor or self-disclosure), and high-intensity positivity (PH; intense positive affect and/or deep connection such as highly intense self-disclosure). According to the RMICS2 manual, these codes are conceptualized to roughly fall on a hostility to positivity continuum. Two additional codes account for dysphoric affect (DY; sad or depressed emotional states such as withdrawal or negative self-talk), as well as any conversation unrelated to the task (i.e., other (OT)). However, these latter codes are not a part of the hostility to positivity continuum and are not typically used in RMICS2 research (Heyman et al., 2022a; Heyman et al., 2022b; Otto et al., 2021). As such, they are not discussed further.

Three coders were required to complete rigorous RMICS2 training prior to reviewing discussions. Specifically, all coders participated in a 4-day in-person training with a member of the RMICS lab, in which the trainees were given instruction on the manual and asked to practice assigning codes. Trainees then were asked to code two training videos a week for approximately 5 months and compare them to a master coding sheet to increase reliability with the trained master coder. Trainees then completed secondary training for an additional month in which they coded a few videos to increase their inter-coder reliability. After successful completion of training, three coders were asked to independently score each conflict discussion video. If all three or any two coders agreed on a code for a given moment and partner, that agreed upon code was used for the final set of codes. If all three coders disagreed, they all met to discuss the discrepancy and agree on a single code for that time point.

We created 3 composites for analysis: hostility, positivity, and problem discussion. There were up to 240 possible codes per partner (20-minute videos, coded each 5 seconds) depending on the number of codable behaviors exhibited during the discussion. For instance, if a partner was silent and engaging in no obvious nonverbal behaviors, no code was given. Overall husbands and wives were found to have approximately the same number of codes (Husbands: M = 164, *SD* = 34; Wives: M = 163, *SD* = 36). To create composites for analysis, we summed each category of codes and divided by the number of coded behaviors to create a percentage for each partner. This method allowed us to determine the percentage of a partner's behaviors that fell into each category. However, due to the limited number of high-intensity hostility and

high-intensity positivity codes across participants, all high- and low-intensity hostility codes, as well as all high- and low-intensity positivity codes were respectively collapsed into a single hostility percentage and a single positivity percentage. Importantly, even though the RMICS2 conceptualized hostility and positivity to be on a continuum, we treated hostility as an independent and distinct variable due to the differential impact that partner hostility and may have on the other partner. Assessing positivity and hostility on the same continuum creates the assumption that these constructs cancel each other out, thus ignoring important variability. However, by separating hostility from positivity and creating one hostility composite, we are able to examine hostility's unique contribution to outcomes of interest irrespective of positivity. This separation of hostility from positivity is consistent with other publications that have utilized the RMICS2 to date (Heyman et al., 2022a; Heyman et al., 2022b; Otto et al., 2021).

3.2 Social Disconnection

Immediately following the conflict discussion, self-reported feelings of social disconnection were assessed for each partner using a 5-item questionnaire created for this study. Participants were asked to rank on a Likert scale ranging from 0 (*strongly disagree*) to 6 (*strongly agree*) how they felt during the discussion they just had with their partner. Items included "*I felt rejected by my spouse*", "*I felt misunderstood by my spouse*", "*I felt loved by my spouse*" (reverse coded), "*I felt emotionally distant from my spouse*", and "*I felt disconnected from my spouse*". Items were then averaged to create a single disconnection variable that demonstrated acceptable reliability

(Husbands: $\alpha = 0.78$; Wives: $\alpha = 0.92$). More information regarding how a composite was created using these items can be found in the preliminary results section.

3.3 Hormonal Assays

Objective assessments of ghrelin were obtained through 5 blood draws from each participant throughout the course of each visit. Upon arrival at the lab, each participant had an IV catheter placed in their arm by a trained technician to allow for multiple blood draws over 5 hours. Blood samples were taken from each partner once before the marital conflict discussion, followed by four more blood draws every 50 minutes after their discussion. Strict protocol guidelines ensured that all participants in the sample had each blood draw occur at approximately the same time to ensure continuity across subjects. Blood samples were then stored in the lab freezer at -80 degrees and were identifiable by participant ID (i.e., numeric code) and blood draw number. Upon completion of data collection, all 5 blood vials for each participant were sent to be assayed at the University of Pennsylvania's RIA Core Penn Diabetes Center, who follow standard quality control procedures for assaying. All blood samples were transported by car on dry ice by the study's lab manager directly to the Center, thus ensuring all samples remained frozen. Values measuring each participant's active ghrelin and total ghrelin, two measurements of appetite stimulation that are distinct but highly related, were subsequently returned to the lab. Based on established precedents used to analyze physiological data, all assay values that were greater than 4 standard deviations above the mean were deemed outliers and coded as missing (Jaremka et al., 2013; Jaremka et al., 2020). Additionally, all hormone variables were $\log_{10}$ transformed prior to analyses to correct for skew.

Chapter 4

ANALYTIC APPROACH

4.1 Preliminary Analyses

Preliminary confirmatory factor analyses (CFA) were conducted to determine the acceptability of a correlated two factor model of social disconnection. Due to the large number of items assessing disconnection at the time of data collection, the CFA was used to narrow down the most applicable items for a composite based on the strength of item loadings and model fit indices. Our final CFA model included five self-report questionnaire items of disconnection for each partner, loaded onto a latent wife disconnection factor or a latent husband disconnection factor, respectively. Model fit was assessed using a combination of fit indices, including the chi-square value, the root mean square error of approximation (RMSEA), the standardized root mean squared residual (SRMR), as well as the comparative fit index (CFI).

4.2 Primary Analyses

Data were analyzed at the dyadic level in M*plus* v8.7 (Muthén & Muthén, 2017) using multilevel structural equation modeling in an actor-partner interdependence framework. We investigated whether observed actor hostility during a conflict discussion was predictive of a partner's self-reported feelings of social disconnection and subsequent active and total ghrelin levels, as seen in the solid green and blue paths in Figure 1. More specifically, in all models observed hostility was used as the predictor, subjective disconnection was used as our mediator, and ghrelin levels were used as our outcomes. Our primary analyses explored a model with no covariates. Between-person linear regressions were conducted to determine the actor

and partner effects of husband's and wife's observed hostility on resulting social disconnection. When similar in size, actor and partner effects were pooled to increase statistical power and model parsimony. Linear latent growth curve models were then conducted to determine random actor/partner intercepts and slopes for the distal outcomes (i.e., hormones) for both husbands and wives. Specifically, the second hormone assay taken immediately following the conflict discussion was set as the intercept, controlling for the first assay. These preliminary steps were not used to test our hypothesis, but rather to identify path constraints prior to running our full model and are not reported in the results section. The above models were then combined into a single model for our primary analyses to examine the relationships between all variables of interest, as depicted in Figure 1. Finally, the hypothesized indirect effects of actor hostility on partner ghrelin were obtained by calculating the product of both paths and examining the respective bootstrapped confidence intervals for each partner.

4.3 Secondary Analyses

To test whether the results were robust to the inclusion of covariates, a set of secondary analyses were then performed. The analyses were identical to the primary analyses, except they controlled for participant BMI, age, and number of hours slept the night prior. These covariates were chosen due to their theoretical relationship with the processes of interest, as well as prior precedent set by previous papers about marital distress and appetite-relevant hormones (Jaremka et al., 2014; Jaremka et al., 2015; Jaremka et al., 2016).

Chapter 5

RESULTS

5.1 Preliminary Results

Standardized parameter estimates of the correlated two-factor confirmatory factor analysis are shown in the path model in Figure 2. The final model including the latent factor wife disconnection and the latent factor husband disconnection demonstrated good model fit for the data (χ^2 (29) = 38.846, p = 0.105; RMSEA = 0.087 (90% CI: 0.000, 0.152); CFI = 0.965; SRMR = 0.076). Standardized bivariate correlations between all study variables are presented in Table 2. Greater amounts of objective wife hostility were strongly associated with higher levels of objective husband hostility (r = 0.67, $p \leq .001$). Furthermore, increases in husbands' and wives' own hostility was associated with increases in their own feelings of disconnection after the conflict discussion (wives: r = 0.54, $p \leq .001$; husbands: r = 0.29, $p < .05$). Finally, subjectively-reported wife disconnection was associated with reported husband disconnection, such that when wives reported feeling more disconnected from their partner husbands also reported feeling increased levels of disconnection (r = 0.68, $p \leq .001$).

5.2 Primary Results: Active Ghrelin

Our primary aim was to determine whether the relationship between objective hostility and objectively measured ghrelin was mediated by subjectively reported

social disconnection for both husbands and wives after a conflict discussion. Unstandardized results for active ghrelin are shown in Figures 3 (intercept as outcome) and 4 (slope as outcome). Our first active ghrelin model examined the effects of hostility and disconnection on the intercept for active ghrelin (i.e., measurement taken immediately following the conflict discussion) controlling for baseline active ghrelin. Contrary to our hypotheses, neither husband or wife hostility was related to their partner's feelings of disconnection (i.e., impact of actor hostility on partner disconnection) (Path a_{hw} = -0.003, *SE* = 0.01, *p* = .77; Path a_{wh} = 0.03, *SE* = 0.01, *p* = .08) or their partner's active ghrelin (i.e., actor hostility on partner disconnection) (Path c_{hw} = 0.001, *SE* = 0.002, *p* = .40; Path c_{wh} = 0.001, *SE* = 0.003, *p* = .64) following the discussion. Additionally, neither husband's nor wife's feelings of disconnection were related to their own active ghrelin post conflict (Path b_{hh} = 0.03, *SE* = 0.02, *p* = .11; Path b_{ww} = 0.05, *SE* = 0.04, *p* = .18). Surprisingly, for both husbands and wives, higher levels of their own observed hostility were predictive of increases in their own feelings of disconnection (Husband and wife pooled estimate (Paths d_{hh} and d_{ww} = 0.04, *SE* = 0.01, $p < 0.001$) when the paths were constrained to be equivalent (Deviance statistic: $D(1) = 1.466$, ns). Furthermore, wives had lower levels of ghrelin after the conflict if their husband reported more feelings of disconnection (Path f_{wh} = -0.06, *SE* = 0.02, *p* = .02). However, this finding was not revealed for husbands (Path f_{hw} = -0.02, *SE* = 0.02, *p* = .30).

Our second model was largely identical to the first, but we examined the average linear change in ghrelin experienced by spouses following their conflict discussion (i.e., slope) as our outcome with baseline active ghrelin as a covariate. All actor and partner effects between hostility and disconnection in this model were

identical to the model above (since these variables were identical to the first model). Opposite of our hypothesis, we found that higher levels of wife hostility predicted lower rates of change in the slope of their husband's active ghrelin (Path c_{hw} = -0.001, *SE* = 0.001, *p* = .03). Yet, higher levels of husband hostility were unrelated to changes in their wife's active ghrelin over time (Path c_{wh} = -0.002, *SE* = 0.001, *p* = .15). Husbands and wives reported feelings of disconnection were also unrelated to their own active ghrelin slope (Path b_{hh} = -0.01, *SE* = .01, *p* = .19; Path b_{ww} = -0.002, *SE* = 0.01, *p* = .85) or their partner's active ghrelin slope (Path f_{hw} = 0.01, *SE* = 0.01, *p* = .06; Path f_{wh} = 0.002, *SE* = 0.02, *p* = .90). However, when constrained to be equivalent (Deviance statistic: $D(1) = 0.002$, ns), increased levels of hostility for both husbands and wives were predictive of steeper linear slopes for their own active ghrelin (Husbands and wives pooled estimate (Paths e_{hh} and e_{ww} = 0.001, *SE* = 0.000, *p* < 0.01).

5.3 Primary Results: Total Ghrelin

Unstandardized results for total ghrelin are shown in Figures 5 (intercept as outcome) and 6 (slope as outcome). We first examined a model depicting the effects of hostility and subsequent disconnection on the intercept for total ghrelin controlling for baseline total ghrelin. Husbands who displayed more hostility during the discussion also reported feeling more disconnected from their wives than husbands who displayed less hostility. This same finding was true for wives (Husband and wife pooled estimate (Paths d_{hh} and d_{ww} = 0.04, *SE* = 0.01, *p* = 0.02; Deviance statistic: $D(1) = 1.466$, ns). All other paths in the model were not found to be significant.

In our second total ghrelin model we changed our outcome to reflect the slope of total ghrelin after the conflict discussion. All actor and partner effects between hostility and disconnection in this model were once again identical to the model above (since these variables were identical to the first model). However, there was a marginally significant effect between wife hostility and the slope of total ghrelin for husbands, such that increases in wife hostility were associated with increases in the slope of their husband's total ghrelin (Path c_{hw} = -0.001, *SE* = 0.001, *p* = 0.04). All other paths in the model were nonsignificant.

5.4 Secondary Results: Active Ghrelin

Our secondary analyses for the active ghrelin intercept and slope included age, hours slept the night before, and BMI as covariates. Results primarily remained consistent with the primary analyses, with a few notable exceptions. First, when analyzed with covariates, husbands who reported feeling more disconnected from their wife during the conflict had higher levels of active ghrelin following the discussion than husbands who felt more connected (Path b_{hh} = 0.05, *SE* = 0.02, *p* = 0.03). However, when husband's active ghrelin slope was the outcome, we found that increased feelings of husband disconnection was actually associated with husbands exhibiting less change in their own ghrelin levels over time (Path b_{hh} = -0.02, *SE* = 0.006, *p* = 0.002). The findings for active ghrelin were not significant for either of our outcomes for wives.

5.5 Secondary Results: Total Ghrelin

Results for total ghrelin also remained largely unchanged when covariates were added to the model. However, in this model husbands who were observed to be more hostile during the conflict discussion had steeper rates of change in their total ghrelin over the course of their visit than husbands who exhibited less hostility (Path $e_{hh} = 0.001$, $SE = 0.001$, $p = 0.04$)

Figure 2. Confirmatory Factor Analysis with Standardized Loadings for Wife and Husband Disconnection

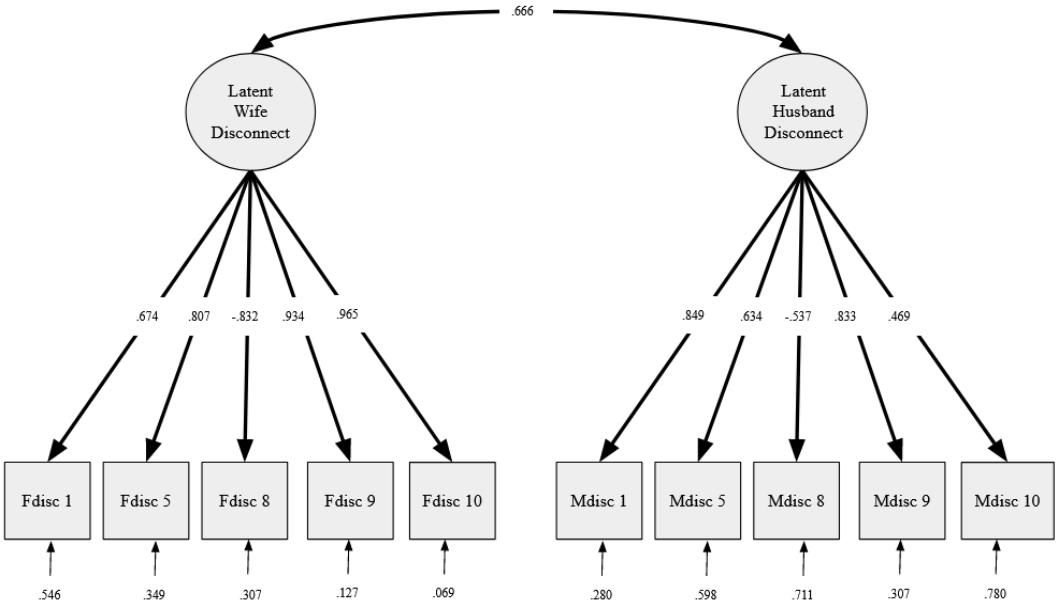
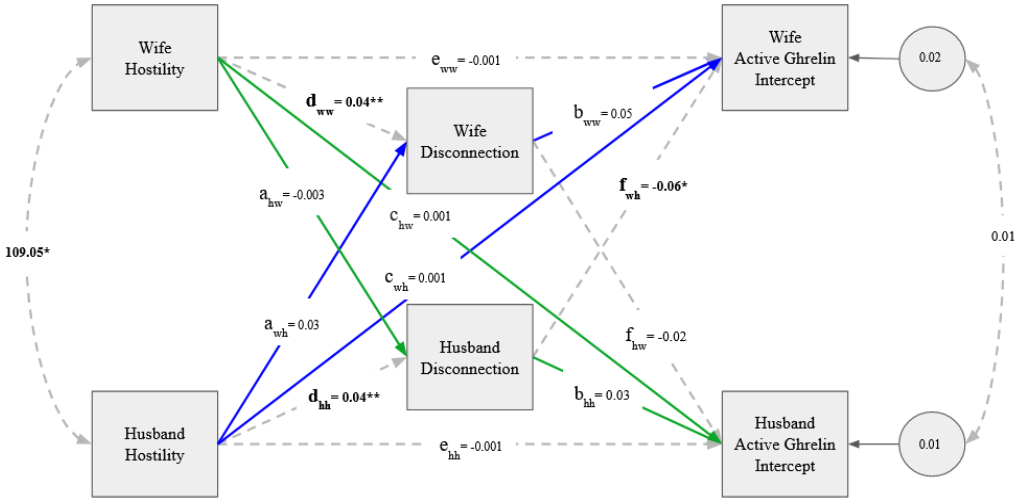


Table 2. Bivariate Correlations Between Key Study Variables.

Variable	1	2	3	4	5	6	7	8
1. Wife Hostility	—							
2. Husband Hostility	0.67***	—						
3. Wife Disconnection	0.54***	0.44**	—					
4. Husband Disconnection	0.23	0.29*	0.68***	—				
5. Wife Active Ghrelin	-0.04	-0.01	0.15	-0.02	—			
6. Husband Active Ghrelin	-0.18	-0.18	-0.12	0.10	0.16	—		
7. Wife Total Ghrelin	-0.18	-0.18	-0.03	0.003	0.20	-0.03	—	
8. Husband Total Ghrelin	-0.21	-0.06	-0.01	0.18	0.30*	0.52***	0.38**	—
Mean (*M*)	10.03	7.34	2.11	2.04	76.07	63.07	792.21	713.78
Standard Deviation (*SD*)	13.25	12.04	1.47	1.12	44.75	28.51	347.48	293.57

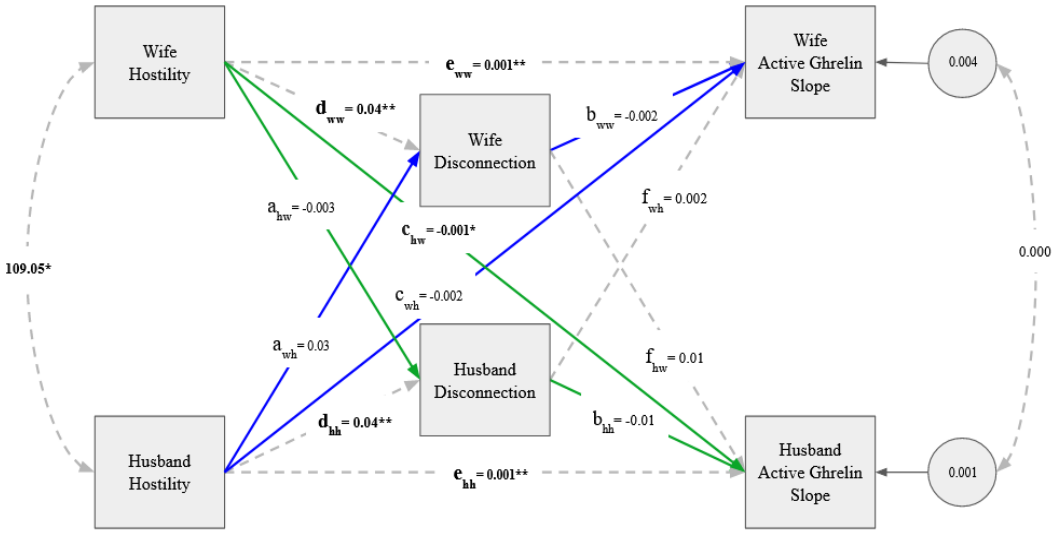
Note. Wife/Husband Hostility = RMICS hostility composite and Wife/Husband Disconnection = 5 item disconnection composite. All Hormone correlations shown represent correlations with the hormone intercept (i.e., blood draw after conflict discussion). $n = 63$ couples. $^{*}p \leq .05$, $^{**}p \leq .01$, $^{***}p \leq .001$.

Figure 3. Unstandardized Active Ghrelin Intercept Results



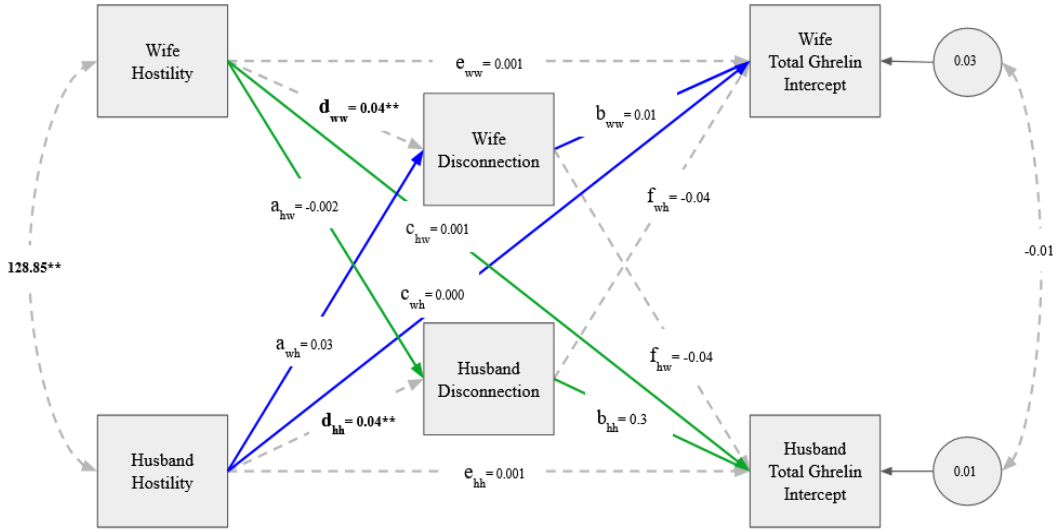
Note. Hypothesized pathways of primary interest are depicted in solid green and blue. All other paths are depicted in dashed gray. Residuals and the residual correlation for husband and wife disconnection were included in analysis but are not shown. Sample: $n = 43$ couples. *$p \leq .05$, **$p \leq .01$

Figure 4. Unstandardized Active Ghrelin Slope Results



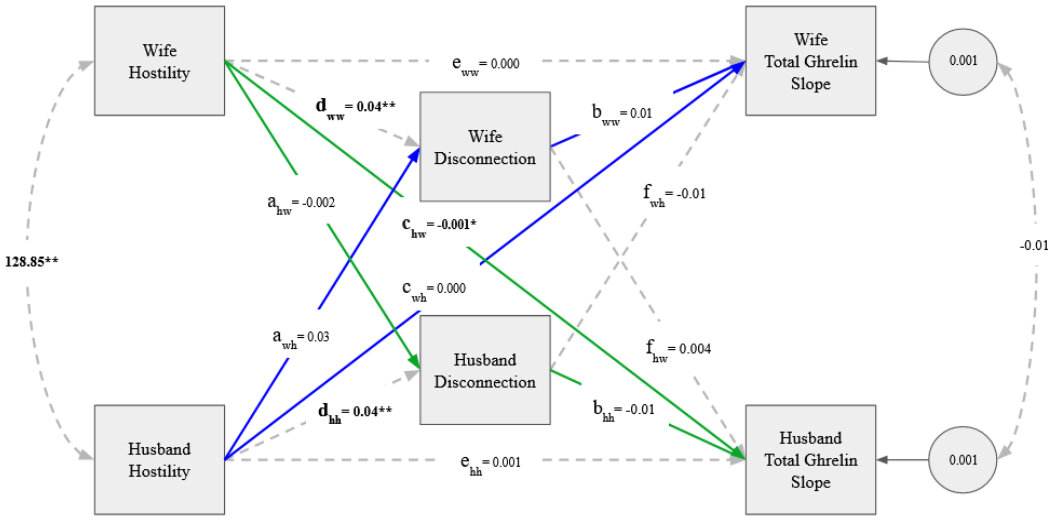
Note. Hypothesized pathways of primary interest are depicted in solid green and blue. All other paths are depicted in dashed gray. Residuals and the residual correlation for husband and wife disconnection were included in analysis but are not shown. Sample: $n = 43$ couples. *$p \leq .05$, **$p \leq .01$.

Figure 5. Unstandardized Total Ghrelin Intercept Results



Note. Hypothesized pathways of primary interest are depicted in solid blue and green. All other paths are depicted in dashed gray. Residuals and the residual correlation for husband and wife disconnection were included in analysis but are not shown. Sample: $n = 45$ couples. *$p \leq .05$, **$p \leq .01$.

Figure 6. Unstandardized Total Ghrelin Slope Results



Note. Hypothesized pathways of primary interest are depicted in solid blue and green. All other paths are depicted in dashed gray. Residuals and the residual correlation for husband and wife disconnection were included in analysis but are not shown. Sample: $n = 45$ couples. *$p \leq .05$, **$p \leq .01$.

Chapter 6

DISCUSSION

6.1 Summary of Findings

Prior evidence strongly supports the argument that experiences of social disconnection can "get under our skin" and lead to deleterious health outcomes by thwarting our fundamental need to belong. Appetite regulation, a biological process that is susceptible to stress and implicated in many health outcomes, may help to clarify the physiological mechanisms involved in the relationship between objective social disconnection and health outcomes. However, objective and subjective experiences of disconnection are not always concordant and may have differential impacts on an individual's physiology. Taken together, the current study aimed to determine if observed hostility from an actor during a conflict discussion influenced the objective ghrelin of their partner through an increase in the partner's feelings of disconnection. Additionally, this was the first study to our knowledge to examine couples' objective hostility and the subjective experience of social disconnection in relation to appetite-relevant hormones using a dyadic framework. We hypothesized that larger amounts of hostility from an actor during a marital conflict discussion would lead to higher partner reports of disconnection, thereby resulting in increased levels of active and total ghrelin (i.e., appetite stimulant) for the partner.

Overall, findings for our pathways of primary interest were mixed. Contrary to our hypothesis, we found no significant indirect effect of either husbands' or wives'

hostility predicting their partner's ghrelin levels (i.e., active or total ghrelin) via their partner's reported social disconnection following the conflict visit (i.e., intercept). This was also true for changes in active and total ghrelin over time (i.e., slope). Furthermore, across all our models we found that neither husband nor wife hostility predicted their partner's feelings of disconnection. Moreover, more hostility from a wife was predictive of lower rates of change in their husband's active and total ghrelin over the visit when examined with and without covariates in the model (i.e., primary and secondary analyses). Taken together, these findings suggest that wives observed hostility was unrelated to their husband's feelings of being disconnected directly following the conflict but may be related to their husband's subsequent active and total ghrelin levels over the course of the visit in the non-hypothesized direction. On the other hand, a husband's observed hostility was unrelated to any of their wife's active or total ghrelin outcomes. We also found a significant hypothesized effect for the relationship between husband disconnection and the active ghrelin intercept when covariates were included in the model, such that husbands who reported more feelings of disconnection had higher active ghrelin levels immediately after the conflict visit than husbands who reported feeling more connected. However, this actor effect was not found to be significant for other husband ghrelin outcomes (i.e., active ghrelin slope, total ghrelin intercept and slope) or for wives entirely. Further complicating the relationship, husbands who felt more disconnected had lower rates of change in their active ghrelin than husbands who felt more connected when examined with covariates.

Results demonstrated unexpected significant findings for non-hypothesized pathways. For instance, higher levels of husband hostility during the conflict were associated with increases in husband reported feelings of being disconnected from their wife across all four models. Similarly, since these paths were constrained to be equivalent, higher levels of wife hostility during the conflict also predicted higher levels of their own feelings of disconnection from their husbands in all models. Surprisingly, we also found that increases in a husband's feelings of disconnection predicted lower active ghrelin levels for their wife at the time point after the conflict. Finally, husbands who were observed to be more hostile during their discussion also experienced more change over time for active ghrelin (i.e., primary analyses) and total ghrelin (i.e., secondary analyses). On the other hand, increased levels of hostility from a wife only predicted more change over time in her active ghrelin slope. Taken together, these results did not support the proposed idea that being socially disconnected leads to appetite dysregulation. Specifically, the hypothesis that the relationship between a husband's or wife's observed hostility and their partner's ghrelin levels post conflict would be indirectly affected by their partner's subjective reports of disconnection was not supported in this study.

There are multiple possible explanations for the null and non-hypothesized results. First, it is always possible that there is truly no relationship between one spouse's hostility, their partner's disconnection, and their partner's subsequent ghrelin levels. However, we think this possibility is unlikely because the findings are inconsistent with prior literature (Jaremka et al., 2014; Jaremka et al., 2015; Jaremka

et al., 2016). Other possibilities are issues in the way we operationalized hostility and measurement error. We relied on the RMICS2 to code hostile behaviors. However, the RMICS2 is relatively new, and most of the data validating this coding system comes from the original RMICS. With that being said, we have confidence in the hostility composite: we conducted post hoc correlations to determine whether observed hostility for both husbands and wives was appropriately correlated with an item of global relationship satisfaction from the Dyadic Adjustment Scale (DAS). As expected, spouses who reported higher levels of global relationship satisfaction on the DAS item were less likely to have exhibited hostility during the conflict discussion, evidencing sound criterion validity between the DAS and our hostility composite. However, it remains possible that there may be a fundamental flaw with the marital conflict discussion coding that did not allow us to accurately capture observed hostility. Furthermore, due to the scope of this project, we did not include observed positivity in our analyses. As a future direction, models including both composites of hostility and positivity should be examined to determine their differential effects on appetite-relevant hormones, as well as to account for potentially important variability.

Another possibility for these unexpected findings could be measurement issues with ghrelin. Although husbands' active and total ghrelin were strongly correlated (r = 0.52, p = < .001), wives' active and total ghrelin were found to be uncorrelated with each other (r = -0.03, p = .178). Given that active and total ghrelin are two overlapping measures of ghrelin more broadly, we would expect to see both measures correlate for husbands and wives. One possible explanation is that the method used to remove

outliers in the current study may have contributed to the lack of correlation for husbands and wives. In line with prior publications examining social disconnection and appetite-relevant hormones in humans (Jaremka et al., 2013; Jaremka et al., 2020), we removed all outliers for total and active ghrelin that were greater than 4 standard deviations from the mean. However, it is possible that this method allowed some outliers to remain due to the mean being skewed. Because the mean for both active and total ghrelin were calculated using all available measurements, any very extreme outliers in the data at that time may have overinflated the mean, thereby not capturing the true central tendency of the data. Given our small sample size (n = 47 couples), any remaining outliers would have a greater potential of influencing relationships between variables. Furthermore, this may have resulted in a reduction of statistical power to detect effects, causing estimates to be unreliable and uninterpretable. As a result, it may be prudent to re-examine the data and remove very extreme values (e.g., a value that is 8 *SD* above the mean) prior to calculating the mean and standard deviation.

Finally, we considered the possibility that our lack of significant findings may be attributable to high degrees of multicollinearity among predictor variables, impacting our ability to appropriately detect individual differences in this dyadic context. Specifically, the correlation between husband and wife hostility as well as the correlation between husband and wife disconnection were both large (Hostility: r = 0.67; Disconnection: r = 0.68). From a conceptual standpoint, this is expected. Specifically, husbands and wives were engaged in an interaction together, so as a

result, behaviors and perceptions of the interaction would naturally covary with each other. However, from a statistical perspective, this high degree of correlation could have caused issues with multicollinearity. Furthermore, the way we measured both composites did not explicitly account for moment-by-moment reciprocity between partners (e.g., more husband hostility is likely to lead to more wife hostility). Thus, it is plausible that the estimates and/or standard errors of our results may be unreliable. As such, an important future direction may be reanalyzing the data using separate models for husbands and wives that do not account for partner effects or a combined hostility composite that accounts for the multicollinearity amongst these variables.

6.2 Strengths and Limitations

Despite the lack of significant findings, our study had numerous strengths. First, strict protocols ensured that visits were standardized across visits, thereby limiting many possible confounds that would affect ghrelin levels during data collection. For example, all participants were required to fast before each visit, eat a standardized snack, and had all blood draws taken at approximately the same time. This ensured that food eaten prior to the visit and timing of the blood draws would not significantly impact ghrelin across participants. Furthermore, repeated measurements of active and total ghrelin were taken 5 times over the course of each 5-hour visit. Thus, we can be somewhat confident that ghrelin levels captured during the experiment are reliable indicators of each participant's appetite-relevant hormones at that time. Another significant strength of this study was that participant visits were counterbalanced

based on the discussion task to ensure that discussion order did not have an impact on variables of interest. Finally, this study integrated numerous data formats including intensive observationally-coded conflict discussions, self-reported feelings of disconnection from each spouse, as well as repeated biometric measures of active and total ghrelin. This allowed us to examine the connections between objective events, subjective experience, and subsequent physiological outcomes within the scope of one project.

However, there also were some limitations of note in our study. Principally, due to restrictive study exclusion criteria, our study may only be representative of a small population. While these criteria allowed us to eliminate heterogeneity between participants on key factors that may have created noise in the data (particularly the ghrelin data), this also means the sample is likely not representative of the general population. Additionally, the small number of participants in our study also significantly lowered our statistical power to detect true relationships between study variables. Future studies should consider eliminating some exclusion criteria and increasing sample size in order to improve generalizability and statistical power. Another important limitation relates to study design. While the measurements of observed hostility during the conflict discussion and reported levels of disconnection were taken sequentially, the time between measurements was so small that the design is more cross-sectional in nature. More specifically, directly following the conflict discussion, husbands and wives were once again separated to complete their next set of questionnaires, which included our measure of social disconnection. The amount of

time that passed between the potentially hostile interaction and the reports of disconnection were merely a few minutes apart. Thus, while time elapsed between measures of interest, mediation analyses may not be appropriate to conduct. Finally, even though we obtained 5 measures of ghrelin during the conflict visit, we are unable to compare them to ghrelin levels in the control visit since the control visit discussion is not coded. Future studies should consider examining appetite-relevant hormones during both the control and conflict visits to assess for change across conditions.

6.3 Conclusions

Humans have evolved with an advanced capacity for social cognition which drives us to fulfill our fundamental need to belong. Accordingly, threats to belonging, such as feeling socially disconnected from one's romantic partner, represent significant risk factors for morbidity and mortality due to their harmful effects on physiological processes like appetite regulation. While the present results did not support our hypothesis that a spouse's actions can lead to their partner feeling disconnected and experiencing increases in ghrelin, the puzzling pattern of results necessitates further exploration into these relationships. Namely, this study is inconsistent with all prior published literature in humans suggesting that social disconnection and appetite-relevant hormones should be related to each other. We also saw that wife active ghrelin was not significantly correlated with their total ghrelin, which is an unlikely finding given the high degree of biological and functional overlap between the two forms of ghrelin. Moreover, based on study methodology that separated both spouses immediately after the conflict discussion, the finding that higher actor disconnection was associated with reductions in partner active ghrelin is

puzzling. In conclusion, further analyses and examination of key study variables need to be completed before findings on the relationship between objective hostility, subjective disconnection, and subsequent ghrelin levels can be meaningfully interpreted.

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Appendix A

HUMAN SUBJECTS APPROVAL

Institutional Review Board
210H Hullihen Hall
Newark, DE 19716
Phone: 302-831-2137
Fax: 302-831-2828

DATE:	June 14, 2019
TO:	Lisa Jaremka
FROM:	University of Delaware IRB
STUDY TITLE:	[897112-7] The Married Couples Study (AMCv1)
SUBMISSION TYPE:	Continuing Review/Progress Report
ACTION:	APPROVED
APPROVAL DATE:	June 14, 2019
EXPIRATION DATE:	June 6, 2020
REVIEW TYPE:	Expedited Review
REVIEW CATEGORY:	Expedited review category # *(4,7)*

Thank you for your Continuing Review/Progress Report submission to the University of Delaware Institutional Review Board (UD IRB). The UD IRB has reviewed and APPROVED the proposed research and submitted documents via Expedited Review in compliance with the pertinent federal regulations.

As the Principal Investigator for this study, you are responsible for and agree that:

- All research must be conducted in accordance with the protocol and all other study forms as approved in this submission. Any revisions to the approved study procedures or documents must be reviewed and approved by the IRB prior to their implementation. Please use the UD amendment form to request the review of any changes to approved study procedures or documents.
- Informed consent is a process that must allow prospective participants sufficient opportunity to discuss and consider whether to participate. IRB-approved and stamped consent documents must be used when enrolling participants and a written copy shall be given to the person signing the informed consent form.
- Unanticipated problems, serious adverse events involving risk to participants, and all non-compliance issues must be reported to this office in a timely fashion according with the UD requirements for reportable events. All sponsor reporting requirements must also be followed.

Oversight of this study by the UD IRB REQUIRES the submission of a CONTINUING REVIEW seeking the renewal of this IRB approval, which will expire on June 6, 2020. A continuing review/progress report form and up-to-date copies of the protocol form and all other approved study materials must be submitted to the UD IRB at least 45 days prior to the expiration date to allow for the required IRB review of that report.

If you have any questions, please contact the UD IRB Office at (302) 831-2137 or via email at hsrb-research@udel.edu. Please include the study title and reference number in all correspondence with this office.