EMOTIONAL EXPERIENCE, RELATIONSHIP BEHAVIOR AND GLUCOSE REGULATION IN MARRIED COUPLES

by
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DEDICATION

I dedicate this work to God the Creator who made us the beautiful, wonderfully messy creatures we are; there is no end of mysterious and fascinating things about humankind to try to understand. To Jesus, whose daily presence got me through the difficult times when I so desperately wanted to give up. Thank You. To my wife Valorie: thank you for the sacrifices that you made to allow me to do this. I could not have done this without your constant support and undying faith in me. You are the love of my life. And to two very special young ladies: Mayra and Dulce, you are truly a blessing and the light of my life. No father could be more proud, or have more joy or love for his daughters than I have for you. And finally to Spooky, my constant lap companion during all the endless hours of reading and writing that such a work as this requires. Thanks little buddy.

The words of the wise are like goads, and the words of scholars are like well-driven nails, given by one Shepherd. And further, my son, be admonished by these. Of making many books there is no end, and much study is wearisome to the flesh. Let us hear the conclusion of the whole matter: Fear God and keep His commandments, for this is the whole duty of man. For God will bring every work into judgment, including every secret thing, whether it is good or whether it is evil. *Ecclesiastes 12:11-14* (Scripture taken from the New King James Version. Copyright © 1982 by Thomas Nelson, Inc. Used by permission. All rights reserved.)

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ABSTRACT

This daily diary study investigated the emotional experiences and relationship behaviors of married couples coping with the husband's Type 2 diabetes, and how those experiences and behaviors affected his blood glucose levels. Repeated measures multilevel models examined the effects of husbands' and wives' absolute levels of positive and negative emotional experiences, balance of positive to negative emotional experiences, absolute levels of positive and negative behaviors, and balance of positive to negative behaviors on husbands' glucose. Husbands' negative emotional experience and wives' positive balance of relationship behaviors predicted lower blood glucose levels. For husbands who were younger, in poorer general health, and whose wives were more satisfied with their marriage, husbands' positive emotional experience predicted lower blood glucose levels. For husbands in better general health, wives' reports of a higher balance of positive as opposed to negative emotional experience also predicted lower blood glucose levels. Overall, results indicate that positive emotional experience and a balance of emotional experience and relationship behavior that is predominantly positive predicts positive diabetes outcomes as measured by lower daily blood glucose levels.

INTRODUCTION

A large body of research indicates that close relationships play an important role in health outcomes. Merely being in a close interpersonal relationship with a significant other is associated with better health, improved coping, reduced psychological distress and more positive emotional experiences (Burman & Margolin, 1992; Kiecolt-Glaser & Newton, 2001; Robles & Kiecolt-Glaser, 2003; Uchino, Cacioppo & Kiecolt-Glaser, 1996; Berscheid & Reis, 1998; Taylor, Repetti & Seeman, 1997; Ryff, Singer, Wing & Love, 2001; Ryff & Singer, 2002; Segrin & Flora, 2005). A growing body of evidence demonstrates that shared positive emotional experiences have a positive influence on health and well-being (Baumeister, Bratslavsky, Finkenauer & Vohs, 2001; Fredrickson & Losada, 2005; Gable & Haidt, 2005; Ryff et al., 2001; Myers, 2000; Lyubomirsky, King & Diener, 2005; Fredrickson & Joiner, 2002; Fredrickson, 1998, 2001; Salovey, Rothman, Detweiler & Steward, 2000). Of course, significant others can also have a detrimental influence on one's emotional experiences and health. Negative emotional states are generally associated with physiological arousal and negative health outcomes (Coyne, 1976a; 1976b; Segrin & Dillard, 1992; Joiner & Katz, 1999; Bolger, Zuckerman & Kessler, 2000; Seidman, Shrout & Bolger, 2006; Dunbar, Ford & Hunt, 1998; Gleason, Iida, Bolger & Shrout, 2003; Shrout, Herman & Bolger, 2006; Maisel & Gable, 2009). An important function of close relationships is to manage or "regulate" emotional experiences to reduce physiological arousal and the cumulative adverse effects or "allostatic load" on health (Gottman & Levenson, 1992; Gottman 1993a, 1993b; Gottman, Coan, Carrerre & Swanson, 1998; Kiecolt-Glaser, Glaser, Cacioppo,

MacCallum, Snydersmyth, Cheongtag & Malarkey, 1997; Ryff et al., 2001; Ryff & Singer, 1998, 2000, 2002).

Although published studies to date are limited, existing research indicates that the *relative balance* of positive to negative emotional experiences may be a more important factor in human health and close relationship functioning than the absolute level of either positive or negative experiences, providing at least some general idea of the emotion regulation mechanism at work (e.g., Gottman, 1994; Fredrickson & Losada, 2005). Unfortunately, most studies have emphasized the effects of either positive emotional experiences (e.g., Gable, Reis, Impett & Asher, 2004) or negative emotional experiences (e.g., Gottman et al., 1998) within close relationships, and positive and negative experiences are seldom examined together. Although not explicitly stated, it appears to be assumed by many researchers that human emotional experience operates on a continuum with positive emotion at one polar end and negative emotion at the other, so that, for example, an increase in positive emotion assumes a decrease in negative emotion. However, research indicates that positive emotion and negative emotion are discrete constructs and operate independently of one another (Watson & Vaidya, 2003; Gray & Watson, 2007). Even when researchers treat positive and negative emotional experiences as independent, emotion is often examined in the context of observational studies of interpersonal behaviors that predict relationship outcomes (e.g., Gottman & Levenson, 1992; Keicolt-Glaser et al., 1993). While it is important to understand the interpersonal behaviors that elicit emotional experience within close relationships, the effect of emotional experience itself can easily be overshadowed by the emphasis on behaviors.

Another limitation of the existing literature is that many studies to date that have examined emotional experiences, behavior exchanges, and health within close relationships have been cross-sectional (e.g., Revenson, Schiaffino, Majerovitz & Gibofsky, 1991). Studies using longitudinal designs are clearly an improvement, but most existing longitudinal studies have relied on laboratory methods that preclude disentangling interpersonal behaviors such as criticism from emotional experiences such as anger (Gottman & Levenson, 1992; Keicolt-Glaser et al., 1993). Furthermore, laboratory studies may not accurately reflect the real-life daily experiences of couples due to the artificial conditions inherent in laboratory settings under contrived experimental conditions. Diary studies offer the advantage of examining relationship events and experiences in their natural environment, reducing retrospective recall effects and allowing researchers to better capture the dynamic aspect of relationship events and experiences (Bolger, Davis & Rafaeli, 2003; Laurenceau & Bolger, 2005). Studies using diary methods may better capture real-life conditions, but very few published studies to date (e.g., Kleiboer, Kuijer, Hox, Schreurs & Bensing, 2006; Scholz, Knoll, Roigas & Gralla, 2008; Vella, Kamarck & Shiffman, 2008) are directly related to health outcomes, and those that do exist rarely include any type of physiological or biological measure of health (e.g., Vella et al., 2008).

The present study addressed these issues by using daily diary data including discrete measures of interpersonal behaviors and emotional states collected from both partners in married couples coping with the husband's serious medical condition (diabetes mellitus), as well as a biological indicator of health, the diabetic husband's blood glucose

levels. In addition to examining absolute levels of positive and negative emotional experiences and the balance of positive to negative emotional experiences, the study also examined absolute levels of positive and negative behaviors and the balance of positive to negative behaviors. This allows for the examination of interpersonal relationship behaviors and emotional experiences separately. The multilevel models used in the study examined whether or not wives' relationship behaviors and emotional experiences influenced husbands' blood glucose beyond the effects of husbands' own relationship behaviors and emotional experiences.

CHAPTER 1. LITERATURE REVIEW

Relationship Emotional Experiences and Health

One need only pay attention for a short time to persons speaking about their significant others to realize that those conversations are filled with words expressing emotion. People often characterize their closest relationships using terms that convey affect, such as “happily married”, or perhaps expressing frustration, sadness, or anger. From popular magazines to scholarly journals, breakroom conversations to university lectures, people describe and define close personal relationships based at least in part on their subjective emotional experiences. And since laypersons and scholars alike find it difficult to define "close" relationships without reference to emotional experience (Berscheid, 1983), it is not surprising that this topic has long been the focus of close relationship research (e.g., Wills, Weiss & Patterson, 1974; Huston & Vangelisti, 1991; Gottman et al., 1998) or that emotional experience is a key component of most models of close relationships (e.g., Kelley, Berscheid, Christensen, Harvey, Huston, Levinger, McClintock, Peplau & Petersen, 1983). Reference is often made to the role of positive emotional experiences such as love, attraction, and happiness. And, undoubtedly, close relationships include positive emotional experiences. But negative emotional experiences are also a part of even the best of close relationships (Berscheid, 1983; Wills et al., 1974; Huston & Vangelisti, 1991; Gottman, 1993a, 1993b; Gottman & Levinson, 1992; Gottman et al., 1998).

Historically, close relationship research has been dominated by an emphasis on negatives (e.g., relationship conflict, coping with adverse events). For example, most

health-related research involving close relationships has focused on the buffering effect of social support in reducing the impact of illness or the effect of negative emotions on health and well-being (Cohen & Wills, 1985; Bolger & Eckenrode, 1991; Bolger, DeLongis, Kessler & Schilling, 1989; Gottman & Levenson, 1992; Gottman, 1993a, 1993b; De Vogli, Chandola & Marmot, 2007; Eaker, Sullivan, Kelly-Hayes, D'Agostino & Benjamin, 2007). There is a predominant belief that "bad is stronger than good", that is, that negative events are more salient and have greater impact than positive events (Baumeister et al., 2001; Fredrickson & Losada, 2005). Dominant (Western) cultural values dictate that negative events, suffering and hardship are "bad" and should be minimized or eliminated. Historically, for at least the last 50 years, much of the research funding in the United States has been prioritized to address the alleviation of mental health and social problems (Seligman & Csikszentmihalyi, 2000; Gable & Haidt, 2005). Due at least in part to these factors, most research has concentrated on the unpleasant aspects of close relationship and health.

Negative emotion. A large body of research provides clear evidence that negative emotional experiences within close relationships have a detrimental impact on health (Cohen & Wills, 1985; Gottman & Levenson, 1988; Burman & Margolin, 1992; Uchino, Cacioppo & Kiecolt-Glaser, 1996; Gottman, 1998; Kiecolt-Glaser & Newton, 2001; Robles & Kiecolt-Glaser, 2003). In one review, Kiecolt-Glaser & Newton (2001) analyzed 64 studies on marriage and health. When studies relied on objective or self-report measures of health, they found that negative emotional experiences within close relationships were consistently associated with poorer health outcomes. In studies

assessing marital problem discussions, they found clear indication that hostility and marital conflict in particular has an adverse impact on physiological functioning. Across studies, negative emotional experience during marital disagreement was associated with heightened blood pressure, increased heart rates and endocrine changes in epinephrine, norepinephrine, ACTH, growth hormone, and prolactin. Negative emotional experiences were also associated with immunological down-regulation. Changes were more pronounced with increasing levels of hostility and negativity. This finding is important, but confounds hostility with negative emotional experience so that it is impossible to determine if one or both provide the mechanism.

Kiecolt-Glaser and her colleagues (Kiecolt-Glaser, Malarkey, Chee, Newton, Cacioppo, Hsiao-Yin Mao & Glaser, 1993; Malarkey, Kiecolt-Glaser, Pearl & Glaser, 1994; Kiecolt-Glaser, Newton, Cacioppo, MacCallum, Glaser & Malarkey, 1996; Kiecolt-Glaser et al., 1997; Kiecolt-Glaser, McGuire, Robles & Glaser, 2002) have also examined the connection between emotional experiences within close relationships and physiology. Kiecolt-Glaser et al. (1993, 1996) studied the relationship between marital conflict and immunological, blood pressure and heart rate changes in 90 newlywed couples. Both partners were admitted to a hospital setting for 24 hours during the study. Marital conflict was associated with immunological down-regulation and increases in heart rate and blood pressure for both men and women. Couples who were more negative or hostile showed larger rates of immunological reactivity. In a 10-year follow-up study of the 90 participants in the original study, Kiecolt-Glaser et al. (2003) found that greater physiological reactivity during conflict at time one was associated with separation or

divorce 10 years later. Among couples who remained married, those demonstrating the most negative interaction patterns and greatest immunological reactivity to conflict tended to be the least satisfied with their marriage 10 years later. This has important implications for long-term health outcomes given that a number of studies have found that marriage itself is associated with better health (Burman & Margolin, 1992; Kiecolt-Glaser & Newton, 2001; Ryff, Singer, Wing & Love, 2001; Ryff & Singer, 2002). In another study, Kiecolt-Glaser et al. (1997) studied the effects of marital conflict on immunological and endocrinological indicators of health with 31 older couples (average age 67, average length of marriage 42 years). Similar to their previous study with newlywed couples, they found that negative emotional experiences during conflict were associated with adverse endocrinological changes and immunological down-regulation.

A number of studies have also found a strong link between negative emotional experiences within close relationships and outcomes related to specific health conditions. For example, in a study of married couples coping with diabetes, Trief, Orendorff, Himes & Weinstock (2001) found that marriages rated lower in emotional support predicted greater negative impact of the disease, more diabetes-related distress and lower overall quality of life. In a large prospective study of more than 9,000 British civil servants, De Vogli et al. (2007) found that for both men and women, individuals who reported more negative emotional experiences within their close relationships were at a significantly higher risk of developing heart disease over a period of 12 years. In another prospective study, Eaker, Sullivan, Kelly-Hayes, D'Agostino & Benjamin (2007) followed 8,682 men and women over 10 years, examining marital relationship qualities and risk for coronary

heart disease (CHD) and mortality. They found that marital disagreements and strain were not in themselves predictive of health outcomes. However, women who poorly managed negative emotion during conflict were at four times greater risk of dying, and men who reported that their wives' emotional upset was significantly disruptive to their home life were at 2.7 times greater risk of developing CHD.

Ryff (Ryff et al., 2001; Ryff & Singer, 1998, 2000, 2002) proposed that negative emotions are interconnected with various physiological systems and that physiological arousal results in high allostatic load or "cumulative wear and tear" on those systems (e.g., cardiovascular, metabolic, immune, and endocrine), resulting in numerous health problems over time. These include cardiovascular disease, cognitive impairment, declines in physical functioning, and mortality. The mechanism is one in which chronic physiological arousal or frequent activation results in cumulative damage (high allostatic load) leading to long-term negative health outcomes.

Positive emotion. Despite evidence for the important role that negative emotional experience plays in health outcomes, the role of positive experiences must also be included for a complete understanding of the connection between emotional experience and health. The historic fixation on negative emotional experiences has kept attention away from the study of positive events and experiences. This is unfortunate, because positive events occur in the lives of most people far more frequently than negative events, and nine out of 10 Americans report being happy more often than not (Gable & Haidt, 2005; Myers, 2000). The recent positive psychology movement is an attempt to rectify some of the shortcomings of prior research. Within the last 10 years researchers have

begun to study the role of positive emotional experiences in health and close relationships (Ryff & Singer, 2002; Ryff, Singer, Wing & Love, 2001; Kiecolt-Glaser & Newton, 2001). Beyond the influence of positive emotion on stress and coping, positive emotional experiences are a main contributor to *flourishing* or positive health even in the absence of hardship or illness (Ryff & Singer, 1998; 2000; Fredrickson & Losada, 2005).

Research evidence for the effects of positive emotional experience on health outcomes is relatively sparse in comparison with studies of negative emotional experience and health. Furthermore, studies examining positive emotional experience and health tend to be less specific and refined (e.g., most lack objective physiological measures of health). This makes direct comparison across studies to evaluate the relative contributions of positive vs. negative emotional experiences difficult. However, available research evidence indicates that strong, supportive social ties are associated with a variety of positive health outcomes (Taylor et al., 1997; Burman & Margolin, 1992; Berscheid & Reis, 1998; Uchino, Cacioppo & Kiecolt-Glaser, 1996; Ryff & Singer, 2002; Fredrickson & Losada, 2005). Studies have found that for married couples the emotional quality of the relationship has an impact on the health of both persons (Burman & Margolin, 1992; Uchino et al., 1996; Ryff, Singer, Wing & Love, 2001; Segrin & Flora, 2005). In a meta-analytic review, Burman & Margolin (1992) found evidence across studies that marriage is associated with positive health outcomes and that not being married placed one at greater risk for poor health. Ryff et al. (2001) reported findings from two large longitudinal studies that included data on interpersonal relationships and health outcomes. MIDUS is based on a national probability sample of English-speaking adults

aged 25-74 living in the contiguous 48 states and includes 1,880 respondents with complete data. In this study, men and women who reported the highest levels of understanding and appreciation in their marital relationships reported the lowest levels of negative health symptoms. The WLS is a longitudinal survey of a random sample of 10,317 men and women who graduated of Wisconsin high schools in 1957. Survey data was collected in 1957, 1975, and 1992-93. Ryff and colleagues (Ryff, Singer, Wing & Love, 2001) collected new data from a sample of 106 of the original respondents. The new data included information about family and marital interactions and biological measures. Couples reporting more positive relationships scored better on multiple biological indicators of health, including blood pressure, cholesterol, glycosylated hemoglobin, and urinary cortisol, epinephrine and norepinephrine levels.

Close relationships must be tracked longitudinally in order to understand the cumulative effects of emotional experiences on health. Ryff proposed the concept of positive and negative relationship pathways to differentiate relative long-term risk for high allostatic load. In a sample of 106 couples, Ryff et al. (2001) collected neurobiological and questionnaire data about current and past relationships. Individuals were categorized as being on a positive relationship pathway if they reported having at least one parent who was caring and affectionate during childhood and scored above the median on two measures of spousal intimacy. Subjects were categorized as being on a negative pathway if they reported negative bonds with both parents and/or scored low on both measures of spousal intimacy. Allostatic load was assessed with multiple measures of physiological function, including blood pressure, waist-hip ratio, cholesterol,

glycosylated hemoglobin, urinary cortisol, urinary epinephrine, urinary norepinephrine, and DHEA-S. As predicted, individuals on positive pathways had significantly lower allostatic load, suggesting that "positive, loving, caring, intimate relationships" with significant others provide a direct protective influence on health. This association was significant for men and women, but he was stronger for men. She found that living with cumulative economic disadvantage also placed individuals at increased risk for high allostatic load. However, positive relationship profiles moderated this effect, indicating that even under harsh economic conditions, positive relationships offset the likelihood of experiencing high allostatic load.

Relationship Behaviors and Health

Close relationships involve both emotional experiences and behaviors and the two are interconnected. It is difficult to imagine the experience of emotion without an associated action. For example, it is common for someone to say that another person "made me happy" or "made me angry" in relation to something the other person said or did. Or someone may say "I feel… when I …" when describing a favorite (or disliked) activity. It is therefore important to examine relationship behaviors as well as emotional experiences in order to understand the association between close relationships and health.

Laboratory studies. A number of studies have examined behavioral exchanges within close relationships. Researchers have found that negative behavioral exchanges within close relationships are more powerful predictors of relationship outcomes than pleasurable exchanges, and account for more day-to-day variability in relationship satisfaction (Wills et al., 1974; Huston & Vangelisti, 1991; Berscheid, 1983). Less

satisfying relationships are marked by more negative behavioral exchanges as well as higher levels of negative emotional experiences (Gottman, 1980; Levenson & Gottman, 1983, 1985; Gottman & Levenson, 1992; Kiecolt-Glaser et al., 1993, 1996) and negative health outcomes (Gottman, 1994; Gottman & Levenson, 1988, 1992; Kiecolt-Glaser et al., 1993, 1996; Kiecolt-Glaser et al., 2002; Robles & Kiecolt-Glaser, 2003; Rohrbaugh, Shoham, Coyne, Cranford, Sonnega & Nicklas, 2004; Rohrbaugh, Shoham & Coyne, 2006). Most studies examining relationship behaviors and health outcomes have used laboratory methods in which couples are observed (and their behaviors coded) during a contrived problem solving or conflict resolution exercise in a controlled setting. Health outcomes typically consist of various autonomic (e.g., heart rate, blood pressure) or hormonal (e.g., norepinephrine, cortisol) measures, taken before and after or during the exercise that are theoretically linked to long-term health outcomes (Kiecolt-Glaser et al., 1993, 1996, 1997; Smith & Gallo, 1999; Coyne, Rohrbaugh, Shoham, Sonnega, Nicklas & Cranford, 2001; Rohrbaugh et al., 2004, 2006; Heffner, Loving, Kiecolt-Glaser, Himawan, Glaser & Malarkey, 2006; Laurent & Powers, 2007).

These studies provide convincing evidence of a causal link between close relationship behaviors and health, but may not accurately reflect the real-life daily experiences of couples due to the artificial conditions inherent in laboratory settings under contrived experimental conditions. Another problem is that data are often collected at one point in time, even though studies have demonstrated considerable variation in the qualities of close relationships over time (Wills et al., 1974; Huston & Robins, 1982; Huston & Vangelisti, 1991). Furthermore, it is difficult if not impossible to disentangle

behaviors from emotional experience in published studies to date, so that the mechanism of action cannot be clearly understood.

Non-laboratory studies. The health psychology and social support literature provides ample non-laboratory evidence to firmly establish that positive, supportive behaviors during interactions within close relationships provide positive health benefits, while the opposite is true of negative, unsupportive behaviors (Uchino, 2006; Reblin & Uchino, 2008; Kiecolt-Glaser et al., 2002; also see Berkman, Glass, Brissette & Seeman, 2000; Cohen, 1988; House, Landis, & Umberson, 1988; and Seeman, 1996 for additional reviews). However, unlike the laboratory studies, many of these studies to date have lacked adequate specificity regarding behaviors so that it is difficult to determine at a microbehavioral level exactly what occurred within a given close relationship that was health promoting. Most non-laboratory research on close relationship behaviors and health has also been cross-sectional and often relied on retrospective recall of relationship interactions. Furthermore, many studies involving individuals coping with serious health problems have used outcome measures such as psychological distress or depression that are not directly related to the identified health condition.

Some typical examples of existing published research will serve to illustrate the current state of affairs. In one cross-sectional study, Revenson et al. (1991) used structured interviews to gather information from 101 recently diagnosed rheumatoid arthritis (RA) patients about specific close relationship interactions (though not restricted to a spouse or romantic partner) that were either supportive or problematic. Physician rating of disease severity was used as the outcome measure for RA, and a measure of

depression was included to assess psychological well-being. Positive, supportive interactions were correlated with less severe RA, and negative, problematic interactions were correlated with more severe RA, but neither class of behaviors reached statistical significance as a predictor of RA severity. However, both classes of behaviors were found to be independent and significant predictors of psychological health, with more positive relationship behaviors predicting less depression and more problematic relationship behaviors predicting greater depression. Similarly, Frazier, Tix & Barnett (2003) reported the results of two studies of couples coping with a kidney transplant. The first study was cross-sectional, two years post-transplant (121 couples). The second was longitudinal, with data collection at three months and 12 months post-transplant (112 couples). In both studies, positive relationship interactions were measured using clearly defined, specific behaviors. However, outcome measures were psychological distress and relationship satisfaction rather than health, and only spouses' reports of support behavior and patients' reports of psychological distress and relationship satisfaction were included in the model. In both studies, unsupportive spouse behaviors and patient dissatisfaction with the relationship predicted greater patient psychological distress.

Most of the longitudinal studies of close relationships and health published to date offer an improvement over their cross-sectional counterparts, but many of them also lack adequate relationship behavior specificity or direct measures of health. For example, Scholz et al. (2008) studied 77 couples coping with prostate cancer after laparoscopic radical prostatectomy. They examined the effects of spouse supportive behaviors on patient self-reported health-related quality of life at two weeks and six months post-

surgery. They found that patients' health-related quality of life was improved by their spouses' supportive behavior. The strengths of this study were the longitudinal design and inclusion of both partners' reports of relationship behavior. However, the behavior measure only included two items, and health-related quality of life may not be an adequate proxy for health. In another study, Newsome, Mahan, Rook & Krause (2008) reported findings from the Late Life Study of Social Exchanges (LLSSE), a national survey of the mental health effects of positive and negative social exchanges for older U.S. adults. Using a representative sample of 666 adults (age 65+) from the LLSSE data collected over a two-year period at six-month intervals (five waves of data), they examined the longitudinal health effects of negative social exchanges. At each survey time, participants were asked about the frequency of negative interactions with others over the past month, including (but not specifying) close relationship partners, using a series of behaviorally specific questions about the nature of the interaction. Health was assessed using a combination of self-reports of general health, specific health conditions and overall physical functioning collected at waves one and five. Over the two year period of the study, negative social exchanges significantly predicted lower self-rated health, higher number of health conditions and greater functional impairment after controlling for initial health. The strengths of this study are the longitudinal design, large representative sample, behaviorally specific interaction assessment and clear health-related outcome measures. However, the study relies on retrospective self-report, includes no objective physiological measures of health and is not specific to close relationships.

Diary studies. Some relationship behavior studies have used diary methods which

may better capture real-life conditions, but very few are directly related to health outcomes (e.g., Kleiboer et al., 2006; Scholz et al., 2008; Vella et al., 2008), and those that do exist rarely include any type of physiological or biological measure of health (e.g., Vella et al., 2008). In a study of 61 couples coping with multiple sclerosis (MS), Kleiboer et al. (2006) used computerized daily diaries to collect information from both partners over a period if 14 days. Once each day, participants provided information on mood, self-esteem, emotional and instrumental supportive interactions, daily hassles and MS-related health symptoms. Counter intuitively, they found that patients' well-being was related to providing positive emotional and instrumental support to their partners, and partners' well-being was related to receiving emotionally positive behaviors from patients. This finding not only highlights the interdependence of outcomes for both partners in close relationship, but also the complexity of dyadic data.

In another diary study, Vella et al. (2008) examined the effects of positive social interactions on ambulatory blood pressure and heart rate for 341 adults, assessed by electronic diary recording every 45 minutes during waking hours across six days. Diary recordings included behavioral details about positive interactions with others as well as scales measuring intimacy, agreeableness and social support. A measure of trait hostility was included during a one-time laboratory visit. Positive interactions, particularly those rated high in intimacy, were associated with lower blood pressure. More hostile individuals benefited less from positive social interactions; their blood pressure was not significantly reduced during intimate interactions, and actually increased during supportive interactions.

These recent studies are important because they address some of the previously mentioned problems within the domain of close relationships and health. Diary methods present an opportunity for researchers to better capture life as it is experienced by those persons being studied (Bolger et al., 2003; Laurenceau & Bolger, 2005), but few diary studies published to date are directly related to health outcomes. Furthermore, while studies have found that negative relationship behaviors in close relationships are associated with poor relationship and health outcomes (e.g., Levensen & Gottman 1983, 1985), little attention has been paid to the effects of positive relationship behaviors.

The present study used daily diary data that included discrete measures of interpersonal behaviors and emotional states collected from both partners, allowing for the examination of interpersonal relationship behaviors and emotional experiences separately. The positive and negative domains are kept distinct, as well as the relationship behavior and emotional experience domains. This allows for the disentangling of valence and domain (behavior, experience) effects of relationship processes on health outcomes. A biological health measure (the diabetic husband's blood glucose levels) provides a specific quantitative indicator directly relevant to the patients' health.

Balance of Positive to Negative Emotions and Behaviors

When examining the effects of positive and negative experiences within close relationships, it appears that "bad is stronger than good" (Baumeister et al., 2001; Fredrickson & Losada, 2005). However, this may be an oversimplification. The research of Ryff and colleagues (Ryff et al., 2001; Ryff & Singer, 1998, 2000, 2002) and Gottman and colleagues (Gottman, 1979, 1980, 1993a, 1993b, 1994; Levenson & Gottman, 1983,

1985; Gottman & Levenson, 1992; Gottman et al., 1998) suggests that health promoting marital relationships are marked by the ability to regulate the emotional climate within close relationships by balancing negative emotional experiences with positive so that the overall emotional climate of the relationship is more positive than negative.

In a series of pioneering studies examining the connection between emotional experience and physiology in married couples, Gottman and colleagues (Gottman, 1979, 1980, 1993a, 1993b, 1994; Levenson & Gottman, 1983, 1985; Gottman & Levenson, 1992; Gottman et al., 1998) found that the experience of negative emotion, particularly within couples engaged in marital conflict discussions, was consistently associated with autonomic nervous system (ANS) arousal, endocrine stress response (e.g., activation of epinephrine, norepinephrine and cortisol stress hormones), cardiovascular reactivity, immune system down-regulation and increased risk for illness. In one particular longitudinal study, Gottman & Levenson (1992) followed 73 married couples for four years. Couples were observed in a laboratory setting during a series of three interactive discussions, one involving pleasant topic, one involving a neutral topic ("events of the day") and one involving a problem area of continuing disagreement in the marriage. They used a series of physiological (heart rate, skin conductance, body movement and pulse rate), behavioral (observational coding of affect expression) and subjective self-report measures of couples' emotional experiences (using a 9-point scale ranging from "extremely negative" to "extremely positive") during the interactions. They also included a standardized measure of physical illness (the Cornell Medical Index). Couples were divided into two groups, "regulated" and "nonregulated" based on observed and self-

reported emotional experiences during the interactions; regulated couples were those having significantly positive slopes for the cumulative ratio of positive to negative emotion observed and experienced during discussions. At follow-up four years later, men and women in nonregulated couples (those with at least one partner showing a negative slope for the ratio of positive to negative behavior or experience at time one) were less satisfied with their marriages and were in poorer health than their counterparts in regulated couples.

One longitudinal study examined marriage quality, illness management and mortality in 189 congestive heart failure (CHF) patients and their spouses (Coyne et al., 2001; Rohrbaugh et al., 2004, 2006). Couples were interviewed to provide information about marital satisfaction, marital routines and useful illness discussions. Couples were also videotaped during a laboratory exercise in which they engaged in a 10-minute discussion of a problem topic. The tapes were later reviewed and rated by trained observers for positive and negative exchanges using a standardized microanalytic coding system. Behavioral indicators included facial expressions, verbal content and body posture. Every observed speech unit was categorized as positive, negative or neutral. A positive to negative ratio score was derived for each partner during each interaction segment by dividing the number of positive units by the sum of his or her positive and negative units, reflecting a balance of positive to negative exchanges. This procedure yielded a total positive to negative exchange score for each partner. For most analyses, self-report and observation data were combined into a composite measure of relationship quality due to correlations between the measures (refer to Coyne et al. 2001 for

rationale). Higher positive-to-negative behavior exchange scores during observed interactions predicted CHF outcomes including survival, while self-report marital satisfaction did not. At all measurement times over a period of eight years, positive marital quality predicted better CHF outcomes and reduced mortality even after accounting for severity of illness (Rohrbaugh et al., 2004, 2006).

In accord with the prior findings, Carol Ryff and her colleagues (Ryff et al., 2001; Ryff & Singer, 1998, 2000, 2002) suggested that what differentiates a health promoting marital relationship is not the absence of adverse interpersonal experiences but the ability to successfully negotiate negative emotion when adversity occurs. Like Gottman (Gottman, 1979, 1980, 1993a, 1993b, 1994; Levenson & Gottman, 1983, 1985; Gottman & Levenson, 1992; Gottman et al., 1998), they suggested that positive health requires the ability to successfully regulate negative emotional experiences within close relationships by balancing negative emotional experiences with positive so that the overall emotional climate of the relationship is more positive than negative.

More specifically, Gottman (1994) found that married couples unable to maintain a high ratio of positive to negative emotional experiences within the relationship (5-to-1 positive to negative) were much more likely to divorce. Subsequent research also supports the proposition that a high positive-to-negative emotional experience ratio is important for human flourishing in general. Fredrickson & Losada (2005) found that a 2.9 positive to negative ratio was associated with positive mental health in two samples of college students. Taken together, these studies indicate that for individuals or couples, positive outcomes or flourishing may depend on a high positive to negative emotional

experience ratio rather than absolute levels of either positive or negative experiences.

The present study examined levels of positive and negative interpersonal behaviors and emotional experiences, as well as the relative balance of positive to negative emotional experiences and behaviors as predictors of a specific health outcome (husbands' blood glucose levels). This study is an important addition to current scientific knowledge about the interdependence of relationship behaviors, emotional experience and health outcomes among marital dyads. Because of the specificity of the constructs and measures used and the rigor of the data analytic techniques, the results of this study have the potential to make a meaningful and lasting contribution to the existing literature.

CHAPTER 2. IMPORTANCE AND OVERVIEW OF THE STUDY

The number of people with diabetes has reached epidemic proportions in the United States and worldwide (King, Aubert & Herman, 1998; Wild, Roglic, Green, Sicree & King, 2004). It is estimated that 17.5 million people in the U.S. have diabetes (American Diabetes Association, 2008). More women than men have diabetes, but the prevalence is higher in men (Wild et al., 2004). Contributing factors are population growth, aging, urbanization, increasing obesity and physical inactivity (Wild et al., 2004). It is estimated that the worldwide prevalence of diabetes for all age groups combined was 2.8% or 171 million in 2000 and is projected to be 4.4% or 366 million by 2030 (Wild et al., 2004). The prevalence of diabetes in adults age 20 or older is estimated to be 5.4% or 300 million by 2025 (King et al., 1998). The most important demographic in the estimated growth in the prevalence of diabetes is the increase in the number of people age 65 or older in the U.S. and other developed countries, as the majority of people with diabetes are age 65 or older (King et al., 1998; Wild et al., 2004; American Diabetes Association, 2003). Diabetes is the 5th leading cause of death by disease in the U.S. (American Diabetes Association, 2003). Persons diagnosed with diabetes are at significantly greater risk for Coronary Heart Disease (Selvin, Coresh, Golden, Brancati, Folsom & Steffes, 2005), Congestive Heart Failure (Barzilay, Kronmal, Gottdiener, Smith, Burke, Tracy, Savage & Carlson, 2004), Peripheral Artery Disease (Selvin, Watanakit, Steffes, Coresh & Sharrett, 2006), ischaemic heart disease (Selvin et al., 2005), atherosclerosis (hard carotid artery plaques; Selvin et al., 2005), cardiovascular disease (Selvin et al., 2005), stroke (Bertoni, Krop, Anderson & Brancati, 2002) and all-

cause mortality (Selvin et al., 2005; Bertoni et al., 2002). Given the serious nature of this disease and its widespread prevalence, research that investigates day-to-day factors relevant to diabetes control and management is crucial.

Persons in close relationship function as a complex system of interpersonal exchanges in which each person influences the other behaviorally, emotionally and physiologically. In fact, interdependence is the defining feature of "close" relationships, particularly between romantic partners (Kelley et al., 1983). It is unclear if interpersonal exchanges primarily influence health directly through physiological arousal and activation of neurobiological systems (Kiecolt-Glaser & Newton, 2001) or indirectly through emotional processes (Kiecolt-Glaser et al., 2002; Uchino, 2006). It is possible that the influence of one person's emotional experience may impact the emotional experience of the other, affecting his or her health through a process variously called "mood induction", "emotional contagion" or "emotional transmission" (Coyne, 1976a; 1976b; Segrin & Dillard, 1992; Joiner & Katz, 1999; Caughlin, Huston & Houts, 2000; Larson & Almeida, 1999). Emotional experiences within close relationships are subjective conditions that change daily at the event level based on a number of environmental factors and as such have potential implications for the management of diseases like diabetes (Kelley et al., 1983; Huston & Vangelisti, 1991; Huston & Robins, 1982; Wills et al., 1974).

Studying these processes is complex and presents some unique challenges for researchers. Adequately accounting for variance within the social and health sciences is difficult when data are nested or hierarchical. Variance can occur at either the dyad or

individual level (Singer & Willett, 2003; Kashy & Kennedy, 2000; Campbell & Kashy, 2002; McMahon, Pouget & Tortu, 2006). For example, if outcome data is collected at several different times, then each individual has multiple time points nested within that person. Another problem with analyzing nested data is that statistical analyses relying on the general linear model assume independence within the data, and nested data inherently violate the assumption of independence. Therefore, special statistical methods are necessary for the analysis of hierarchically structured data. Multilevel models (also called hierarchical linear models or mixed models) are analytical techniques developed specifically to deal with the structure of hierarchical data. Multilevel modeling resolves the problem of nonindependence and allows for the simultaneous analysis of variance and interaction effects within and between levels (Singer & Willett, 2003; Kashy & Kennedy, 2000; Campbell & Kashy, 2002; McMahon et al., 2006; Laurenceau & Bolger, 2005). In the present study, multilevel modeling was used to investigate the daily effects of emotional experiences and behaviors on glucose levels for patients' coping with diabetes.

One problem with many previous studies is the measures used to assess health outcomes. Even in those studies using specific biological measures, many have relied on short term, point-in-time assessment using physiological tests that may not reflect long-term effects on health (e.g., Levenson & Gottman, 1983, 1985; Gottman & Levenson, 1992; Gottman et al., 1998; Kiecolt-Glaser et al., 1993, 1996). Other studies using specific biological health measures have tracked outcomes over time, but because of the design and analytic techniques used there is no means of adequately examining the specific mechanisms at work (Ryff et al., 2001; Ryff & Singer, 1998, 2000, 2002).

Finally, most studies rely on information from relatively healthy participants and there is no clear connection between biological measures used and the participants. Biological measures are instead most often used to provide generic indicators of physiological responses to the independent variables of interest. Although information obtained is useful in regard to understanding general processes, measures may not be the most appropriate to assess health outcomes for any particular individual. It may be important to more carefully define the target sample and to use measures that are logically connected to specific health issues and outcomes in that sample. Findings may be more meaningful if they provide insight into mechanisms that affect specific health outcomes of concern to participants. As such, an important element in the present study is the inclusion of a biological outcome measure directly relevant to diabetes. Blood glucose is the primary target in diabetes management and has been demonstrated to be a valid biological measure of physiological response to environmental events and experiences. Frequent daily blood glucose testing has adequate sensitivity to proximal environmental and interpersonal variables to be useful in examining the physiology of marital interactions as well as being an indicator of physical health (Lammers, Naliboff & Straatmeyer, 1984; Alvarez, Portilla, Gonzalez & Ezcurra, 1989; Gonder-Frederick, Carter, Cox & Clarke, 1990; Goetsch, Wiebe, Veltum & van Dorsten, 1990; Armario, Marti, Molina, de Pablo & Valdes, 1996; Fairclough & Houston, 2004; Gonder-Frederick, Cox, Bobbitt & Pennebaker, 1989; Halford, Cuddihy & Mortimer, 1990; Goetsch, Abel & Pope, 1994; Riazi, Pickup & Bradley, 2004; Skaff, Mullan, Almeida, Hoffman, Masharani, Mohr & Fischer, 2009).

Most studies of close relationships and health have examined the effects of one partner's behaviors or emotional experiences on the other partner's health. In most prior studies behaviors and emotional experiences have been impossible to disentangle from one another due to the methods used, and most have emphasized negative behaviors and emotional experiences with little focus on positive behaviors and experiences (e.g., Levensen & Gottman, 1983; Keicolt-Glaser et al., 1993). This study examined the effects of husbands' and wives' emotional experiences and relationship behaviors on husbands' health. The design allows for the examination of behaviors and emotional experiences separately. It also allows for positive and negative factors (both behaviors and emotional experiences) to be examined as independent constructs, serving as a *de facto* test of the 'bad is stronger than good' paradigm. The study also examined the balance of positive to negative for both emotional experience and relationship behaviors to determine if the balance of positivity to negativity is predictive of health outcomes beyond overall levels of positive or negative emotional experience or behavior.

Models

In order to better understand the mechanisms at work in the complex associations between relationship behaviors, emotional experiences and health outcomes, four models were developed for the study. Model 1 examines the unique effects of husbands' positive and negative emotional experiences and wives' positive and negative emotional experiences on husbands' daily glucose levels. Model 2 examines the unique effects of husbands' positive and negative relationship behaviors and wives' positive and negative relationship behaviors on husbands' daily glucose levels. Model 3 examines the balance

of positive to negative relationship behaviors and the balance of positive to negative emotional experiences and each balance score's effect on husbands' daily glucose levels. Model 4 adds the moderators age, general health and marital satisfaction to each of the previous models.

Moderators

Age. Age is important to consider because some research indicates that older adults may have better emotion regulation skills than younger adults and may attend more to emotional processes (Charles & Carstensen, 2009; Mather & Carstensen, 2005; Carstensen, Fung & Charles, 2003; Samanez-Larkin, Robertson, Mikels, Carsensen & Gotlib, 2009). As such, the health of older adults in close relationships may be differentially affected by emotional experiences. Thus, the potential effect of age will be accounted for in the study by including age in the fourth model as a moderator of all predictors.

Marital satisfaction. A number of studies have found that marital satisfaction has an impact on health and is therefore important to consider (e.g., Kiecolt-Glaser & Newton, 2001; Ryff et al., 2001; Robles & Kiecolt-Glaser, 2003; Coyne et al., 2001; Trief et al., 2001; Rohrbaugh et al., 2006). The health of individuals in more satisfying marriages may be less impacted by negative events or emotional experiences because of the social support that spouses provide to one another (Segrin & Flora, 2005; Bradbury, Fincham & Beach, 2000; Ross, Mirowsky & Goldsteen, 1990; Uchino, Cacioppo & Kiecolt-Glaser, 1996; Uchino, 2006). One explanation for this effect is that persons coping with serious illness who are in satisfying close relationships have been found to

better adhere to medical treatment (Sherbourne, Hays, Ordway, DiMateo & Kravitz, 1992). In the present study, a measure of marital satisfaction was examined as a moderator in the fourth model.

Health. Overall health is important to consider for several reasons. Health status has been found to be a determinant of marital quality for both spouses (Bradbury et al., 2000; Thompson & Pitts, 1992; Segrin & Flora, 2005). The health of an ill spouse often impacts the health of the other (Revenson, 1994; Revenson & Majerovitz, 1991; Carter & Carter, 1994; DesRosier, Catanzaro & Piller, 1992; Segrin & Flora, 2005). Some research evidence indicates that the health status of one or both spouses, particularly when one spouse is coping with a chronic illness, affects marital interaction patterns (Burman & Margolin, 1992; Revenson, 1994; Thompson & Pitts, 1992; Cannon & Cavanaugh, 1998). It is also possible that individuals who are in poorer general health are more impacted by interpersonal events and emotional experiences due to already taxed internal coping mechanisms from the stress of meeting the challenges and demands of everyday life (Segrin & Flora, 2005; Thompson & Pitts, 1992; Cannon & Cavanaugh, 1998). Additionally, factors that some studies have found to predict positive physical health outcomes (e.g., social support, marital status) have been found to have no beneficial effects when initial health status is controlled (Sherbourne & Hays, 1990). When examining outcomes related to a specific health condition, it is therefore important to account for comorbidity or general health status. Therefore, in the present study a measure of global health status was included as a potential moderator variable.

CHAPTER 3. RESEARCH QUESTIONS AND HYPOTHESES

As previously mentioned, four models were developed for the study to better understand the mechanisms at work in the complex associations between relationship behaviors, emotional experiences and health outcomes. Following are the specific questions generated for the study and the models designed to answer those questions.

Model 1 examines the unique effects of husbands' positive and negative emotional experiences and wives' positive and negative emotional experiences on husbands' daily glucose levels.

Research questions:

1. Are there independent main effects of husbands' *positive* emotional experience and *negative* emotional experience on husbands' own blood glucose readings?

Hypotheses:

a. Husbands' positive emotional experience should have a negative association with blood glucose, so that an increase in positive emotional experience predicts their own lower blood glucose levels.

b. Husbands' negative emotional experience should have a positive association with blood glucose, so that an increase in negative emotional experience predicts their own higher blood glucose levels. Furthermore, the strength of the association between husbands' negative emotional experience and glucose should be

greater than the strength of the association between husbands' positive emotional experience and glucose.

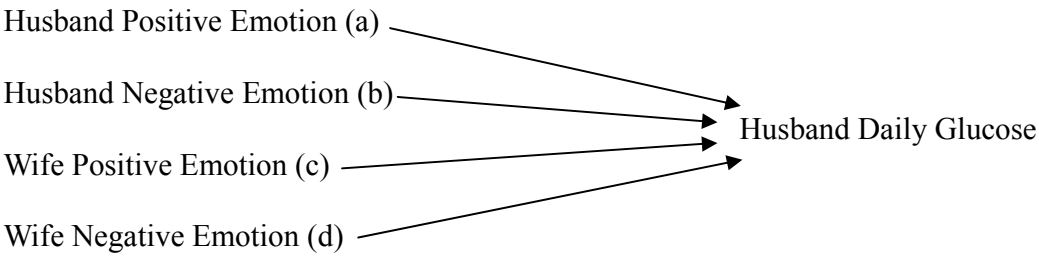
2. Are there independent main effects of wives' *positive* emotional experience and *negative* emotional experience on husbands' blood glucose readings after accounting for husbands' own positive and negative emotional experience?

Hypotheses:

a. Wives' positive emotional experience should have a negative association with husbands' blood glucose, so that an increase in positive emotional experience predicts lower blood glucose levels in their husbands.

b. Wives' negative emotional experience should have a positive association with husbands' blood glucose, so that an increase in negative emotional experience predicts higher blood glucose levels in their husbands. Furthermore, the strength of the association between wives' negative emotional experience and husbands' glucose should be greater than the strength of the association between wives' positive emotional experience and husbands' glucose.

Model 1



Model 2 examines the unique effects of husbands' positive and negative relationship behaviors and wives' positive and negative relationship behaviors on husbands' daily glucose levels.

Research questions:

3. Are there independent main effects of husbands' *positive* relationship behaviors and *negative* relationship behaviors on husbands' blood glucose readings?

Hypotheses:

a. Husbands' positive relationship behaviors should have a negative association with blood glucose, so that an increase in positive relationship behaviors predicts their own lower blood glucose levels.
b. Husbands' negative relationship behaviors should have a positive association with blood glucose, so that an increase in negative relationship behaviors predicts their own higher blood glucose levels. Furthermore, the strength of the association between

husbands' negative relationship behaviors and glucose should be greater than the strength of the association between husbands' positive relationship behaviors and glucose.

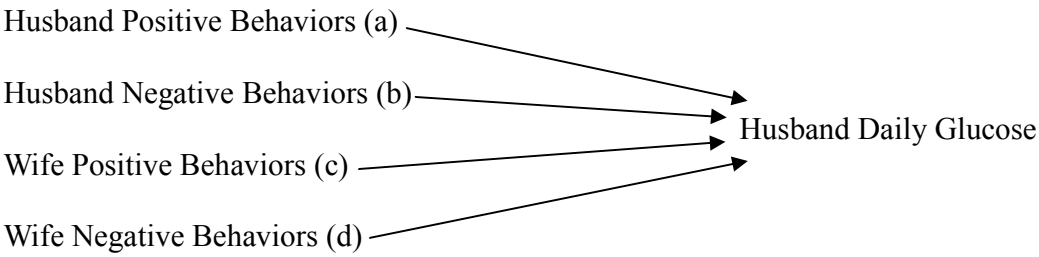
4. Are there independent main effects of wives' *positive* relationship behaviors and *negative* relationship behaviors on husbands' blood glucose readings after accounting for husbands' own positive relationship behaviors and negative relationship behaviors?

Hypotheses:

a. Wives' positive relationship behaviors should have a negative association with blood glucose, so that an increase in positive relationship behaviors predicts lower blood glucose levels in their husbands.

b. Wives' negative relationship behaviors should have a positive association with blood glucose, so that an increase in negative relationship behaviors predicts higher blood glucose levels in their husbands. Furthermore, the strength of the association between wives' negative relationship behaviors and husbands' glucose should be greater than the strength of the association between wives' positive relationship behaviors and husbands' glucose.

Model 2



Model 3 examines the unique effects of husbands' balance of positive to negative emotional experiences and positive to negative relationship behaviors, and wives' balance of positive to negative emotional experiences and positive to negative relationship behaviors on husbands' daily glucose levels.

Research questions:

5. Are there independent main effects of husbands' *balance* of positive to negative *emotional experiences* and *balance* of positive to negative *relationship behaviors* on husbands' blood glucose readings?

Hypotheses:

a. Husbands' positive balance of emotional experience should have a negative association with blood glucose, so that a higher positive balance of emotional experience predicts their own lower blood glucose levels.
b. Husbands' negative balance of emotional experience should have a positive association with blood glucose, so that a higher negative balance of emotional experience predicts their own higher blood

glucose levels.

c. Husbands' positive balance of relationship behaviors should have a negative association with blood glucose, so that a higher positive balance of relationship behaviors predicts their own lower blood glucose levels.

d. Husbands' negative balance of relationship behaviors should have a positive association with blood glucose, so that a higher negative balance of relationship behaviors predicts their own higher blood glucose levels.

6. Are there independent main effects of wives' *balance* of positive to negative *emotional experiences* and *balance* of positive to negative *relationship behaviors* on husbands' blood glucose readings after controlling for husbands' *balance* of positive and negative emotional experiences and *balance* of positive to negative relationship behaviors?

Hypotheses:

a. Wives' positive balance of emotional experience should have a negative association with blood glucose, so that a higher positive balance of emotional experience predicts lower blood glucose levels in their husbands.

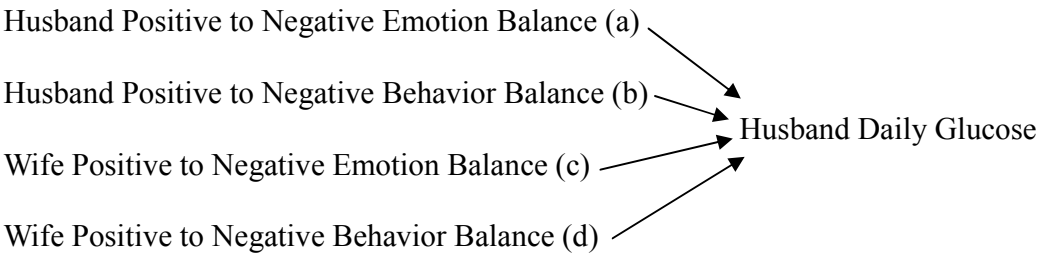
b. Wives' negative balance of emotional experience should have a positive association with blood glucose, so that a higher negative balance of emotional experience predicts higher blood glucose

levels in their husbands.

c. Wives' positive balance of relationship behaviors should have a negative association with blood glucose, so that a higher positive balance of relationship behaviors predicts lower blood glucose levels in their husbands.

d. Wives' negative balance of relationship behaviors should have a positive association with blood glucose, so that a higher negative balance of relationship behaviors predicts higher blood glucose levels in their husbands.

Model 3



Model 4 adds the moderator effects of age, general health and marital satisfaction to each of the paths for all of the previous models. Although moderators will be examined for each pathway in all four models for both husbands and wives, only one example is given in Figure 4 for the sake of simplicity.

Research questions:

7. Are the effects of husbands' or wives' *positive* emotional experience or *negative* emotional experience on husbands' blood glucose readings moderated

by husbands' age, husbands' general health, or husbands' or wives' marital satisfaction?

Hypotheses:

a. The negative association between husbands' positive emotional experience and glucose should be moderated by husbands' age so that the strength of association is stronger for older husbands.
b. The positive association between husbands' negative emotional experience and glucose should be moderated by husbands' age so that the strength of association is weaker for older husbands.
c. The negative association between wives' positive emotional experience and husbands' glucose should be moderated by husbands' age so that the strength of association is stronger for older husbands.
d. The positive association between wives' negative emotional experience and husbands' glucose should be moderated by husbands' age so that the strength of association is weaker for older husbands.
e. The negative association between husbands' positive emotional experience and glucose should be moderated by husbands' health so that the strength of association is weaker for husbands in poorer overall health.
f. The positive association between husbands' negative emotional

experience and glucose should be moderated by husbands' health so that the strength of association is stronger for husbands in poorer overall health.

g. The negative association between wives' positive emotional experience and husbands' glucose should be moderated by husbands' health so that the strength of association is weaker for husbands in poorer overall health.

h. The positive association between wives' negative emotional experience and husbands' glucose should be moderated by husbands' health so that the strength of association is stronger for husbands in poorer overall health.

i. The negative association between husbands' positive emotional experience and glucose should be moderated by husbands' marital satisfaction so that the strength of association is stronger for husbands who are more satisfied with their marriages.

j. The positive association between husbands' negative emotional experience and glucose should be moderated by husbands' marital satisfaction so that the strength of association is weaker for husbands who are more satisfied with their marriages.

k. The negative association between husbands' positive emotional experience and glucose should be moderated by wives' marital satisfaction so that the strength of association is stronger for

husbands whose wives are more satisfied with their marriages.

l. The positive association between husbands' negative emotional experience and glucose should be moderated by wives' marital satisfaction so that the strength of association is weaker for husbands whose wives are more satisfied with their marriages.

m. The negative association between wives' positive emotional experience and husbands' glucose should be moderated by husbands' marital satisfaction so that the strength of association is stronger for husbands who are more satisfied with their marriages.

n. The positive association between wives' negative emotional experience and husbands' glucose should be moderated by husbands' marital satisfaction so that the strength of association is weaker for husbands who are more satisfied with their marriages.

o. The negative association between wives' positive emotional experience and glucose should be moderated by wives' marital satisfaction so that the strength of association is stronger for husbands whose wives are more satisfied with their marriages.

p. The positive association between wives' negative emotional experience and glucose should be moderated by wives' marital satisfaction so that the strength of association is weaker for husbands whose wives are more satisfied with their marriages.

8. Are the effects of husbands' or wives' *positive* relationship behaviors or

negative relationship behaviors on husbands' blood glucose readings moderated by husbands' age, husbands' general health, or husbands' or wives' marital satisfaction?

Hypotheses:

a. The negative association between husbands' positive relationship behaviors and glucose should be moderated by husbands' age so that the strength of association is stronger for older husbands.
b. The positive association between husbands' negative relationship behaviors and glucose should be moderated by husbands' age so that the strength of association is weaker for older husbands.
c. The negative association between wives' positive relationship behaviors and husbands' glucose should be moderated by husbands' age so that the strength of association is stronger for older husbands.
d. The positive association between wives' negative relationship behaviors and husbands' glucose should be moderated by husbands' age so that the strength of association is weaker for older husbands.
e. The negative association between husbands' positive relationship behaviors and glucose should be moderated by husbands' health so that the strength of association is weaker for husbands in poorer overall health.

f. The positive association between husbands' negative relationship behaviors and glucose should be moderated by husbands' health so that the strength of association is stronger for husbands in poorer overall health.
g. The negative association between wives' positive relationship behaviors and husbands' glucose should be moderated by husbands' health so that the strength of association is weaker for husbands in poorer overall health.
h. The positive association between wives' negative relationship behaviors and husbands' glucose should be moderated by husbands' health so that the strength of association is stronger for husbands in poorer overall health.
i. The negative association between husbands' positive relationship behaviors and glucose should be moderated by husbands' marital satisfaction so that the strength of association is stronger for husbands who are more satisfied with their marriages.
j. The positive association between husbands' negative relationship behaviors and glucose should be moderated by husbands' marital satisfaction so that the strength of association is weaker for husbands who are more satisfied with their marriages.
k. The negative association between husbands' positive relationship behaviors and glucose should be moderated by wives' marital

satisfaction so that the strength of association is stronger for husbands whose wives are more satisfied with their marriages.

l. The positive association between husbands' negative relationship behaviors and glucose should be moderated by wives' marital satisfaction so that the strength of association is weaker for husbands whose wives are more satisfied with their marriages.

m. The negative association between wives' positive relationship behaviors and husbands' glucose should be moderated by husbands' marital satisfaction so that the strength of association is stronger for husbands who are more satisfied with their marriages.

n. The positive association between wives' negative relationship behaviors and husbands' glucose should be moderated by husbands' marital satisfaction so that the strength of association is weaker for husbands who are more satisfied with their marriages.

o. The negative association between wives' positive relationship behaviors and glucose should be moderated by wives' marital satisfaction so that the strength of association is stronger for husbands whose wives are more satisfied with their marriages.

p. The positive association between wives' negative relationship behaviors and glucose should be moderated by wives' marital satisfaction so that the strength of association is weaker for husbands whose wives are more satisfied with their marriages.

9. Are the effects of husbands' or wives' *balance* of positive to negative *emotional experiences* on husbands' blood glucose readings moderated by husbands' age, husbands' general health, or husbands' or wives' marital satisfaction?

Hypotheses:

a. The negative association between husbands' positive balance of emotional experiences and glucose should be moderated by husbands' age so that the strength of association is stronger for older husbands.
b. The positive association between husbands' negative balance of emotional experiences and glucose should be moderated by husbands' age so that the strength of association is weaker for older husbands.
c. The negative association between wives' positive balance of emotional experiences and husbands' glucose should be moderated by husbands' age so that the strength of association is stronger for older husbands.
d. The positive association between wives' negative balance of emotional experiences and husbands' glucose should be moderated by husbands' age so that the strength of association is weaker for older husbands.
e. The negative association between husbands' positive balance of

emotional experiences and glucose should be moderated by husbands' health so that the strength of association is weaker for husbands in poorer overall health.

f. The positive association between husbands' negative balance of emotional experiences and glucose should be moderated by husbands' health so that the strength of association is stronger for husbands in poorer overall health.

g. The negative association between wives' positive balance of emotional experiences and husbands' glucose should be moderated by husbands' health so that the strength of association is weaker for husbands in poorer overall health.

h. The positive association between wives' negative balance of emotional experiences and husbands' glucose should be moderated by husbands' health so that the strength of association is stronger for husbands in poorer overall health.

i. The negative association between husbands' positive balance of emotional experiences and glucose should be moderated by husbands' marital satisfaction so that the strength of association is stronger for husbands who are more satisfied with their marriages.

j. The positive association between husbands' negative balance of emotional experiences and glucose should be moderated by husbands' marital satisfaction so that the strength of association is

weaker for husbands who are more satisfied with their marriages.

k. The negative association between husbands' positive balance of emotional experiences and glucose should be moderated by wives' marital satisfaction so that the strength of association is stronger for husbands whose wives are more satisfied with their marriages.

l. The positive association between husbands' negative balance of emotional experiences and glucose should be moderated by wives' marital satisfaction so that the strength of association is weaker for husbands whose wives are more satisfied with their marriages.

m. The negative association between wives' positive balance of emotional experiences and husbands' glucose should be moderated by husbands' marital satisfaction so that the strength of association is stronger for husbands who are more satisfied with their marriages.

n. The positive association between wives' negative balance of emotional experiences and husbands' glucose should be moderated by husbands' marital satisfaction so that the strength of association is weaker for husbands who are more satisfied with their marriages.

o. The negative association between wives' positive balance of emotional experiences and husbands' glucose should be moderated by wives' marital satisfaction so that the strength of association is stronger for husbands whose wives are more satisfied with their

marriages.

p. The positive association between wives' negative balance of emotional experiences and husbands' glucose should be moderated by wives' marital satisfaction so that the strength of association is weaker for husbands whose wives are more satisfied with their marriages.

10. Are the effects of husbands' or wives' *balance* of positive to negative *relationship behaviors* on husbands' blood glucose readings moderated by husbands' age, husbands' general health, or husbands' or wives' marital satisfaction?

Hypotheses:

a. The negative association between husbands' positive balance of relationship behaviors and glucose should be moderated by husbands' age so that the strength of association is stronger for older husbands.

b. The positive association between husbands' negative balance of relationship behaviors and glucose should be moderated by husbands' age so that the strength of association is weaker for older husbands.

c. The negative association between wives' positive balance of relationship behaviors and husbands' glucose should be moderated by husbands' age so that the strength of association is stronger for

older husbands.

d. The positive association between wives' negative balance of relationship behaviors and husbands' glucose should be moderated by husbands' age so that the strength of association is weaker for older husbands.

e. The negative association between husbands' positive balance of relationship behaviors and glucose should be moderated by husbands' health so that the strength of association is weaker for husbands in poorer overall health.

f. The positive association between husbands' negative balance of relationship behaviors and glucose should be moderated by husbands' health so that the strength of association is stronger for husbands in poorer overall health.

g. The negative association between wives' positive balance of relationship behaviors and husbands' glucose should be moderated by husbands' health so that the strength of association is weaker for husbands in poorer overall health.

h. The positive association between wives' negative balance of relationship behaviors and husbands' glucose should be moderated by husbands' health so that the strength of association is stronger for husbands in poorer overall health.

i. The negative association between husbands' positive balance of

relationship behaviors and glucose should be moderated by husbands' marital satisfaction so that the strength of association is stronger for husbands who are more satisfied with their marriages.

j. The positive association between husbands' negative balance of relationship behaviors and glucose should be moderated by husbands' marital satisfaction so that the strength of association is weaker for husbands who are more satisfied with their marriages.

k. The negative association between husbands' positive balance of relationship behaviors and glucose should be moderated by wives' marital satisfaction so that the strength of association is stronger for husbands whose wives are more satisfied with their marriages.

l. The positive association between husbands' negative balance of relationship behaviors and glucose should be moderated by wives' marital satisfaction so that the strength of association is weaker for husbands whose wives are more satisfied with their marriages.

m. The negative association between wives' positive balance of relationship behaviors and husbands' glucose should be moderated by husbands' marital satisfaction so that the strength of association is stronger for husbands who are more satisfied with their marriages.

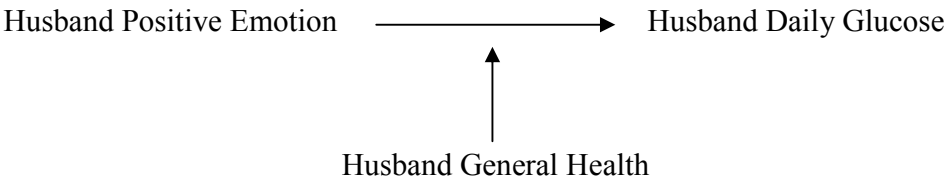
n. The positive association between wives' negative balance of relationship behaviors and husbands' glucose should be moderated

by husbands' marital satisfaction so that the strength of association is weaker for husbands who are more satisfied with their marriages.

o. The negative association between wives' positive balance of relationship behaviors and husbands' glucose should be moderated by wives' marital satisfaction so that the strength of association is stronger for husbands whose wives are more satisfied with their marriages.

p. The positive association between wives' negative balance of relationship behaviors and husbands' glucose should be moderated by wives' marital satisfaction so that the strength of association is weaker for husbands whose wives are more satisfied with their marriages.

Model 4



CHAPTER 4. METHODS

Participants and Design

Data used is from the *Partner Support and Diabetes Management* study conducted at the Southern Arizona VA Health Care System by the author in 2000-2001. The data includes discrete measures of interpersonal behaviors and emotional experience collected daily from both partners and a biological indicator of health, daily blood glucose readings collected from diabetic patients. A total of 35 married couples were recruited for original the study. Three couples dropped out of the study before completion and two couples did not provide daily glucose readings. All remaining participant couples (n = 30) are included in the data set used for the present study. Data was collected using self-report daily diaries over the course of nine days. Additional data collected during daily phone calls are not relevant to the present study and are not reported.

The 60 participants included in the present study are married male patients and their wives (average patient age 58, range 27-70; average length of marriage 26 years, range 6-48). Patients in the study were receiving medical care for Diabetes Mellitus Type 2 at the Southern Arizona VA Health Care System from the same health care provider for at least one year and had been living with their spouse for all of the past year. Both spouses agreed to participate in the study. No age or other selection criteria were used. Participants were identified and recruited with the assistance and approval of their primary health care providers who were treating them for diabetes. Participation was voluntary and both spouses provided informed consent. All patients were informed that they could withdraw from the study at any time without affecting their medical care.

Couples were paid $50.00 for participation when they completed the study. The Institutional Review Board of the University of Arizona approved the study.

Identified patients were sent recruitment letters by mail with basic information about the study and informing them that a phone call would follow within about a week. During follow-up phone calls the author answered questions and offered patients and their spouses the opportunity to participate in the study. Couples who could not be contacted by phone or who declined to participate were dropped from the recruitment pool. Those agreeing to participate were scheduled appointments to meet with the author in person. At that time both partners from each couple provided informed consent and completed a questionnaire to provide basic demographic information including gender, age, race, income, household makeup, time since first diagnosis, medical complications, and general health. After completing the initial questionnaire, a time was agreed upon for each couple to be contacted by phone for nine consecutive evenings. During evening calls, each partner was interviewed separately to gather information about daily glucose, mood, and behavior.

Measures

Health outcome (blood glucose). Hyperglycemia (high blood glucose) is the defining feature of diabetes. Monitoring glycemic control is therefore a cornerstone of diabetes care (Goldstein, Little, Lorenz, Malone, Nathan, Peterson & Sacks, 2004). The primary indicators of glycemic status are glycosylated hemoglobin (HbA1c) and blood glucose. The glycosylated hemoglobin test requires laboratory analysis and must be professionally administered. Blood glucose capillary tests are usually self-administered,

require only a small drop of blood and a small hand-held test meter and/or test strip, and provide patients with instant results. The sensitivity of the test and frequency of testing provides patients with instant feedback about their temporal activities in relation to glucose control (Saudek, Derr & Kalyani, 2006). Although these two methods of glucose testing use different methods and metrics, their relationship to one another and to glucose has been examined and found to be highly correlated so that HbA1c can be expressed as an "average" of blood glucose for most patients (Nathan, Kuenen, Borg, Zheng, Schoenfeld & Heine, 2008; Rohlfing, Wiedmeyer, Little, England, Tennill & Goldstein, 2002). The health outcome measure used in this study is the daily average of three blood glucose readings provided by each patient taken at three specific times over the preceding 24 hours. Blood glucose was taken by each patient using self-administered "finger sticks" or capillary tests. Patients provided this information during telephone interviews each day for nine consecutive days. Blood glucose has been found in prior research to be a useful and reliable indicator of health that is sensitive to environmental events and interpersonal variables and has been used in previous studies as a biological indicator of physiological response to stressful events (Lammers et al., 1984; Alvarez et al., 1989; Gonder-Frederick et al., 1990; Goetsch et al., 1990; Armario et al., 1996; Fairclough & Houston, 2004) and to assess health longitudinally (Gonder-Frederick et al., 1989; Goetsch et al., 1990; Halford et al., 1990; Goetsch et al., 1994; Riazi et al., 2004; Skaff et al., 2009).

Emotional experience. Husbands and wives reported emotional experience daily during each phone call using the Mood Adjective Checklist (MACL; Nowlis, 1965). The original 36-item MACL was designed to assess 12 mood dimensions. Stone (1981)

developed a brief 11-item version of the MACL specifically for daily telephone call use to assess global positive and negative emotional experiences (Stone, 1981; Hedges, Jandorf & Stone, 1985). The 11-item version was used in the present study. This version of the MACL consists of 11 adjectives that have been found to load on two major factors, positive and negative. Positive adjectives are playful, elated, energetic, kindly, self-centered and leisurely. Negative adjectives are sad, concentrating, angry, skeptical and clutched-up. Respondents rate each adjective to indicate how they felt during the past 24 hours using a 3-point scale (1 = definitely does not apply, 2 = slightly applies and 3 = definitely applies). Positive and negative mood scores are calculated by simply summing the unweighted scores for each item. Positive mood scores range from 6 to 18 and negative mood scores range from 5 to 15 with a higher score indicating more of that mood factor. The MACL has been found to be more sensitive to daily changes in emotional experience and more appropriate for use in daily assessments than other measures (Stone, 1981; Hedges et al., 1985; Kennedy-Moore, Greenberg, Newman, & Stone, 1992). However, despite its popularity of use, the psychometric properties of the MACL have been questioned in recent years, and published reliability statistics are impossible to find (Watson & Vaidya, 2003; Gray & Watson, 2007). In accord with this, reliabilities of the full scales were found to be low in the present study (For husbands, alpha = .59 for the positive mood scale and .62 for the negative mood scale; for wives, alpha = .66 for the positive mood scale and .67 for the negative mood scale). Therefore, MACL data was factor analyzed prior to further data analysis in the present study, described in detail in the data reduction section.

Relationship behaviors. Husbands and wives separately reported positive and negative relationship behaviors each day for nine consecutive days during telephone interviews using the Daily Activities Interview (DAI; Huston & Vangelesti, 1991). The DAI is a 16-item assessment tool developed specifically for daily telephone contact studies. The brief questionnaire is can be completed quickly and simply requires respondents to indicate if any of 16 events occurred and how many times within the previous 24 hours during interactions with their spouse. Questions cover three content areas: affectional expression, sexual interest and negativity. For the present study only the affectional expression and negativity items were used; the 3-item sexual interest scale was dropped due to the content of the items not being relevant to the present study. The affectional expression scale is used as the measure of positive relationship behaviors and the negativity scale is used as the measure of negative relationship behaviors. The affectional expression scale contains seven items designed to capture expression of affection. Sample items are “Your partner expressed approval of you or complimented you about something you did” and “Your partner said 'I love you'”. Published reliability alphas range from .78 to .84 for the affectional expression scale (Huston & Vangelisti, 1991). The negativity scale contains six items designed to capture negative interpersonal behaviors. Sample items are “Your partner showed anger or impatience by yelling, snapping, or raising his/her voice” and “Your partner criticized or complained about something you did or didn't do”. The DAI has been used in several previous longitudinal studies (Huston & Vangelesti, 1991; Huston & Chorost, 1994; Caughlin et al., 2000). Published reliability alphas range from .78 to .91 for the negativity scale (Huston &

Vangelisti, 1991). In the present study, reliability alphas for husbands were .81 for the affectional expression scale and .66 for the negativity scale; for wives, alphas were .76 for the affectional expression scale and .54 for the negativity scale. Because reliabilities were lower than expected, DAI data was factor analyzed prior to further data analysis as described in the data reduction section.

Marital satisfaction. The Marital Opinion Questionnaire (Huston & Vangelisti, 1991) is an 11-item instrument designed to measure global relationship satisfaction and was completed by both husbands and wives as part of the initial questionnaire at the beginning of their participation in the study. The instrument includes 10 seven-point semantic differential items consisting of two opposing anchor words and seven check boxes between the words. Respondents are asked to think about their marriage and to place an X in the box that comes closest to describing how the respondent has predominantly felt about their marriage over the past two months. Example items are "enjoyable-miserable" and "rewarding-disappointing". The semantic differential items are scored on a scale from one to seven with a higher score indicating greater satisfaction and summed for a total score. Alpha reliability coefficients for the semantic differential scale ranges from .88 to .94. The final item is a global assessment of respondents' overall satisfaction with their marriage consisting of a single question, "All things considered, how satisfied or dissatisfied have you been with your relationship as a whole?" using a seven-point scale ranging from "completely satisfied" to "completely dissatisfied". The published correlation between the semantic differential scale and the single-item global assessment of marital satisfaction ranges from .63 to .80. The average score of the 10

semantic differential items is added to the global assessment score and divided by two to obtain an index of marital satisfaction (Huston & Vangelisti, 1991). In the present study sample, the reliability alpha for the semantic differential scale is .93 for husbands and .85 for wives, and the correlation between the semantic differential scale and the single-item global assessment of marital satisfaction is .52 for husbands and .71 for wives. Because the correlations between the semantic differential scales and the single-item global assessment item were lower than expected for both husbands and wives, the semantic differential scales were factor analyzed. It was determined that no items could be removed to improve the correlations. Likewise, adding the global item to the 10 semantic differential scale items to form a single 11-item scale did not significantly improve the item-total correlations or internal consistency reliability alphas. Therefore no adjustments were made to the marital satisfaction measure as originally developed by Huston & Vangelisti (1991).

General health. Both husbands and wives completed the Medical Outcomes Study 12-Item Short Form Health Survey (SF-12; Ware, Kosinski & Keller, 1996) as part of the initial questionnaire. The MOS SF-12 is an abbreviated version of the 36-item SF-36, one of the most common brief health surveys used by researchers, and was developed to assess general mental and physical health status and evaluate the outcome of health care services (Stewart, Hays & Ware, 1988; Stewart & Ware, 1992; Ware & Sherbourne, 1992). The SF-12 was developed to provide a briefer health measure that is less burdensome to administer but still maintains adequate psychometric properties and provides results that compare with the original SF-36; most respondents can complete the

SF-12 in two minutes or less (Ware et al., 1996). Both the SF-12 and SF-36 cover eight health domains and include separate composite measures of physical and mental health. Physical Component Summary (PCS) scores for the SF-36 and SF-12 have been found to be correlated .95 to .96; Mental Component Summary (MCS) scores for the SF-36 and SF-12 have also been found to be correlated .95 to .96 (Dempster & Donnelly, 2001; Muller-Nordhorn, Roll & Willich, 2004). Both the SF-36 and SF-12 have demonstrated essentially equivalent validity in discriminating between groups of patients based on medical status (Muller-Nordhorn et al., 2004; Dempster & Donnelly, 2001).

The SF-12 PCS consists of six items, two items each covering the health domains physical functioning and role-physical, and one item each covering the health domains bodily pain and general health. The physical functioning scale asks "Does your health now limit you in any of these activities? If so, how much?" Followed by items such as "Climbing several flights of stairs" rated on a 3-point scale: "Yes, limited a lot", "Yes, limited a little" or "No, not limited at all" (Ware et al., 1996). Scale reliability alphas for the SF-12 PCS range from .77 to .87 (Luo, Lynn George, Kakouras, Edwards, Pietrobon, Richardson & Hey, 2003; Resnick & Parker, 2001; Larson, Schlundt, Patel, Hargreaves & Beard, 2008). The SF-12 MCS also consists of six items, two each covering the health domains role-emotional and mental health, and one item each covering the health domains vitality and social functioning. The mental health scale asks "How much of the time during the past four weeks:" followed by questions such as "Have you felt downhearted and blue?" rated on a 6-point scale ranging from "All of the time" to "None of the time". Scale reliability alphas for the SF-12 MCS range from .72 to .80 (Luo et al.,

2003; Resnick & Parker, 2001; Larson et al., 2008).

The scoring and interpretation algorithm of the SF-12 used for this study are in accordance with the RAND 36-Item Health Survey 1.0 from which the SF-36 was developed. Contents of the RAND and MOS instruments are virtually identical. However, the scoring algorithm is much simpler for the RAND version, resulting in scales with a range of 0 to 100 with a mean of 50 and standard deviation of 10 in the general US population (Hays, Sherbourne & Mazel, 1993; Ware et al., 1996). Although designed to be orthogonal scales, the SF-12 PCS and MCS scales have been found to be correlated .62, indicating potential usefulness as a global measure of overall health when combined (Farivar, Cunningham & Hays, 2007). Reliability alpha for the entire 12-item scale has been found to be .77, comparable to the alphas for the PCS and MCS when analyzed separately (Cernin, Cresci, Jankowski & Lichtenberg, 2010). For the present study, the SF-12 PCS and MCS scores are combined to provide a summary measure of general health. For the study sample, the reliability alpha for the full 12-item SF-12 is .83 for husbands and .75 for wives.

Data Reduction

Predictor variables were person-centered and scales were examined for reliability within the study sample. As described above, both the Mood Adjective Checklist (MACL; Stone, 1981; Hedges et al., 1985) and the Daily Activities Interview (DAI; Huston & Vangelesti, 1991) were found to have low internal reliability alphas. To address this, both measures were factor analyzed using maximum likelihood extraction with varimax rotation prior to further analysis. To test for the possibility of gender effects the

data was analyzed separately for husbands and wives.

For the MACL the analysis revealed that dropping one item included in the original positive mood scale ("self-centered") and adding one item included in the original negative mood scale ("concentrating") resulted in improved internal consistency for the positive mood scale. The resulting MACL 6-item scale provided the most reliable single factor positive mood solution for both husbands and wives. These six items were combined to form the Positive Emotional Experience scale in the present study. The positive items are "elated", "concentrating", "playful", "kindly", "energetic" and "leisurely". The final Positive Emotional Experience scale used in the present study has a reliability alpha of .68 for husbands and .66 for wives, which is still somewhat low but is close to the recommended minimum of .70 (Nunnally, 1978). Removing the single item "concentrating" from the original negative mood scale resulted in a 4-item scale with improved internal consistency for both husbands and wives and was used for the Negative Emotional Experience scale in the present study. These four items yielded the most reliable single factor solution for negative mood for both husbands and wives. The items are "angry", clutched up", "sad" and "skeptical". The final Negative Emotional Experience scale used in the present study has a reliability alpha of .75 for husbands and .78 for wives.

For the DAI, factor analysis revealed that two items could be dropped from the original affectional expression scale and that the same five items provided best single factor solution for both husbands and wives. Sample items from the revised 5-item affectional expression scale are "You expressed physical affection with your partner, such

as kissing, hugging, or cuddling (but not part of sexual intercourse)?" and "Your partner expressed approval of you or complimented you about something you did". The resulting scale was used as the Positive Relationship Behavior scale for the present study. For the Positive Relationship Behavior scale, the final reliability alpha was .84 for husbands and .79 for wives.

Results for the factor analysis of the original DAI negativity scale are more complex. For both husbands and wives, four items provided the most reliable single factor solution for the negativity scale. However, husbands and wives differed in the highest loading items. Two items are the same for both spouses, "Your partner showed anger or impatience by yelling, snapping, or raising his/her voice?" and "Your partner criticized or complained about something you did or didn't do?" The other two highest loading items for husbands are "Your partner failed to do something you asked him/her to do, or that you expected to get done (such as running an errand, coming home late, not doing dishes, or something like that)?" and "Your partner did something knowing it annoyed you (some habit like leaving a light on, not picking up his/her clothes, or something like that)?" The two remaining items for wives are "Your partner seemed bored or uninterested in you while you were talking?" and "Your partner dominated a conversation with you, such as by interrupting you or not giving you a chance to talk?" Due to the discrepancy in the highest loading items, slightly different versions of the scale were created for husbands and wives. The resulting 4-item negativity scales were used for the Negative Relationship Behavior scales in the present study. The final reliability alpha for the present study was .74 for the husbands' version of the scale and

.70 for the wives' version.

CHAPTER 5. DATA ANALYSIS

Prior to analysis, person-centered variables were created for positive emotional experience, negative emotional experience, positive relationship behaviors and negative relationship behaviors (see Table 1). Person-centered variables were then used to create difference scores to index the balance of positive to negative emotional experience and positive to negative relationship behaviors (see Table 2). Although ratio scores would be an alternate way to assess positive-negative balance, difference scores were used due to the nature of the study data. Data that includes "0" as a response can create a mathematical "divide by zero" error issue. In the data used for the present study, "0" is a legitimate response that indicates "non-occurrence" of an event at a specific data collection point. Specifically, some relationship behaviors occurred infrequently or not at all, resulting in a high incidence of "0" responses. When attempting to create ratio scores these zeros cannot be accommodated when they occur in the denominator. As such the present data does not support the use of ratio scores, and so difference scores were used instead.

Repeated measures multilevel modeling with SAS PROC MIXED was used for analysis of the daily diary data. Because the outcome variable (husband's glucose) applies to only one of the partners, the data is not truly "dyadic" and nesting of partner's outcomes within couples is not an issue, however both partners contribute predictors to the model. In this type of data structure (outcomes from only one partner) there is no dyadic dependence in the outcome variable (since it comes from only one partner) and so there is no need to account for lack of independence due to partners being nested in

couples. However, because the outcome variable (husband's glucose) was measured every day there is potential dependence due to time being nested within person. Multilevel modeling addresses this and allows for the simultaneous analysis of variance within and between individuals, as well as interaction effects (Singer & Willett, 2003). Multilevel modeling also allows for predictors to occur at two different levels while maintaining the structural integrity of the daily diary data. For example, moderation may occur on a level 1 variable (e.g., daily emotional experience) from a level 2 variable (e.g., general health).

The analytic strategy allows for the simultaneous comparison of each husband's glucose variability across days (level 1) and comparisons with the average glucose of other husbands (level 2). This provides a means of determining whether the greatest source of variance in glucose is at the daily within-person level (level 1) or the between-person level (level 2). This test of proportional variance accounted for is known as the intraclass correlation coefficient and is a useful for guiding the remainder of the analysis (Singer & Willett, 2003). In the present study the primary interest is in glucose fluctuations within individuals and the predictors that are associated with any differences between days. The repeated measures multilevel modeling used allows for two levels of predictors, level 1 daily events (e.g., emotional experience) and level 2 individual differences (e.g., age), and treats person as the clustering variable so that days are "nested" in persons.

The analysis was completed in three steps. The first step consisted of checking for intercorrelations between the predictor variables. The variables included were positive

emotional experience, negative emotional experience, positive relationship behaviors and negative relationship behaviors (see Table 3). Both daily level (person-centered) and average level (person-mean) correlations were examined due to the possibility of correlations occurring at either of these two levels in the study data. This allowed an examination of the individual predictors to determine if they represented unique constructs. For example, if husbands' positive and negative emotional experience were very highly negatively correlated it would suggest a single underlying continuum, rather than two independent dimensions, and positive emotional experience and positive relationship behaviors should not be so highly correlated as to indicate that they might represent the same construct.

The second step involved determining the best base model for the outcome variable (husband glucose) without predictors. This required examining three possible models for glucose: an unconditional means model that includes only a random intercept in order to determine differences in average glucose levels between individuals and the intraclass correlation coefficient; an unconditional growth model that includes a random intercept and time slope to determine if there is individual change in glucose as a factor of time; and a third model to examine whether the residual variance for glucose for each individual showed signs of autocorrelation. The three models were compared to determine the best fitting base model for glucose.

The third step in the analysis consisted of testing the core models developed for the study by adding predictors to the base model for glucose determined in the second step. Predictors were husband positive and negative emotional experience, and wife

positive and negative emotional experience (Model 1); husband positive and negative relationship behaviors, and wife positive and negative relationship behaviors (Model 2); husband positive-negative emotional experience difference scores, wife positive-negative emotional experience difference scores, husband positive-negative relationship behavior difference scores, and wife positive-negative relationship behaviors difference scores (Model 3). Moderators were then added to each model. The three moderators tested were husband's age, overall health and global marital satisfaction (Model 4).

CHAPTER 6. RESULTS

Step 1: Assessing Correlations Among Predictor Variables.

The first step in the analysis confirmed that for both husbands and wives, correlations between predictor variables of interest were of the expected relative strength and in the predicted direction (see Table 3). For both husbands and wives, positive and negative emotional experience were weakly negatively correlated, indicating contrasting experience and substantial independence. Similarly, positive and negative relationship behaviors were also weakly negatively correlated, indicating that the behaviors examined appear to represent divergent constructs that are largely independent. Positive emotional experience and positive relationship behaviors were only slightly positively correlated, especially at the daily level, which is the focus of the research questions. Similarly, negative emotional experience and negative relationship behaviors were only slightly positively correlated at the daily level for both husbands and wives. This provides evidence for substantial independence of the predictors, as well as the accurate valence and conceptual distinction of the constructs. This also serves as a validity check for the constructs as measured and support for the conceptual integrity of the models used in the study.

Step 2: Establishing the Best Fitting Base Model for Daily Glucose

The next step in the analysis involved finding the best fitting model for husbands' glucose, the outcome variable for the study. Two basic models were examined; an *unconditional means model* and an *unconditional growth model* (Singer & Willett, 2003). The unconditional means model is a model with only a random intercept (average

glucose) for each husband, but no predictors; this provides a means of examining variation between and within persons. The resulting glucose model has only three components: a grand mean of all individuals' glucose means, each person's variance around that grand mean, and remaining within-person residual variance. This is important because it provides a way to estimate whether the majority of the model variance in glucose is at the within-person or between-person level, therefore guiding the focus of further analysis.

In the unconditional means model for glucose, the fixed effect for glucose (the grand mean) was $b = 146.36$, $SE = 3.60$. The variance of husbands' glucose intercepts was significant, $t = 40.63$, $df = 51$, $p < .0001$. The estimated between-person (level 2) variance was 491.09 and the estimated within-person (level 1) variance was 1449.90. The *intraclass correlation coefficient* provides an estimate of the proportion of variance accounted for at each level and is determined by dividing the between-person variance by the sum of the within and between-person variance (Singer & Willett, 2003). The resulting intraclass correlation coefficient for the unconditional glucose means model was .25, indicating that 75% of the variance in the model occurred at the within-person level, warranting further exploration with models predicting glucose variation within individuals from daily events and experiences.

To examine the effect of time on glucose variation, the unconditional growth model adds a time slope to the previous unconditional model but no other predictors, thus growth or change over time is "unconditional". This is similar to a regression model in which each husband has his own intercept (glucose mean) and slope (change over time)

with no other specifiers. In this model, each husband has his own rate of change, so that level 1 residual variance represents each husband's inter-individual variation around his own linear change trajectory for glucose and level 2 residual variances represent variability of parameters (intercept and slopes) between husbands for glucose. For the unconditional growth model to provide a meaningful improvement over the unconditional means model, time must be a significant factor and the growth model should provide a significant improvement in model fit as compared to the means model. The fixed effect of time in the unconditional growth model was non-significant ($F = 2.63$, $df = 1$, $p = .106$). For the unconditional means model the -2 log likelihood fit statistic was 4520.90 and for the unconditional growth model the -2 log likelihood fit statistic was 4518.30. Using the simple goodness of fit formula 4520.90 – 4518.30 = 2.6, the unconditional growth model was not a better fit than the simpler unconditional means model ($\chi^2 = 2.6$, $df = 1$, non-significant), indicating that there was no meaningful association between time and glucose variance for husbands in the study. Therefore, the unconditional means model with only glucose intercepts and residuals was the best fitting model for glucose.

Finally, the unconditional means model was examined for autocorrelation of level 1 glucose residuals. The estimated covariance parameter for autocorrelated (i.e. AR(1)) glucose residuals was not significant, with $b = .01$, $SE = .06$, $z = .19$, $p = .853$. The -2 log likelihood fit statistic was 4520.90, the same as the model without the AR(1) parameter, indicating that autocorrelation did not have a significant effect so that parameter was dropped from the model. The unconditional means model without AR(1) residuals was used for the base model for glucose in all further analysis with predictors.

Step 3: Testing the Study Models

Model 1 tested the association between husbands' and wives' self-reported positive and negative daily emotional experience and husbands' daily blood glucose levels. Research question 1 asked if husbands' positive or negative emotional experience predicted husbands' own blood glucose readings. As shown in Table 4a, the first part of the answer is no; husbands' daily positive emotional experience did not predict daily glucose levels, b = -18.53, t (189) = -1.66, p = .098. However, husbands' daily negative emotional experience did predict glucose levels, b = -17.02, t (189) = -2.09, p = .038. Counter intuitively, it appears that a decrease in husbands' negative emotional experience was associated with an increase in blood glucose levels. Research question 2 asked if wives' daily positive or negative emotional experience predicted husbands' daily blood glucose readings. The answer appears to be no, as neither wives' positive nor negative emotional experience predicted husbands' glucose levels.

Model 2 tested the association between husbands' and wives' reports of his or her spouses' daily positive and negative relationship behaviors and husbands' daily blood glucose levels. Research question 3 asked if husbands' reports of wives' daily positive or negative relationship behaviors predicted husbands' blood glucose levels. As shown in Table 4b, wives' negative relationship behaviors as reported by husbands trended toward significance in predicting husbands' daily blood glucose levels (b = -11.07, t (188) = -.09, p = .059). Once again this is a counter intuitive finding, as it appears that increases in wives' negative relationship behaviors was associated with decreases in husbands' blood glucose levels, although not strongly enough to reach statistical significance. Research

question 4 asked if wives' reports of husbands' daily positive or negative relationship behaviors was associated with husbands' daily blood glucose levels. Again referring to Table 4b, the answer appears to be no, as neither husbands' positive nor negative relationship behaviors predicted husbands' daily blood glucose levels.

Model 3 tested the association between husbands' and wives' daily difference scores of positive to negative emotional experiences and positive to negative relationship behaviors and husbands' daily glucose levels. Research question 5 asked if husbands' difference scores of positive to negative emotional experiences, and difference scores of positive to negative relationship behaviors, predicted husbands' daily blood glucose levels. As shown in Table 4c, the first part of the answer is no, husbands' daily difference scores for positive to negative emotional experience did not predict husbands' daily blood glucose levels. However, husbands' difference scores for positive to negative relationship behaviors did predict husbands' daily blood glucose levels (b = 3.79, t (188) = 2.58, p = .011). Since these scores represent husbands' reports of wives' relative proportion of positive to negative relationship behaviors, it appears that on days when wives exhibited a higher proportion of positive as opposed to negative relationship behaviors, these behaviors were associated with lower blood glucose levels in their husbands. This finding is in accord with the idea that a positive balance of relationship behaviors may have beneficial health effects. Research question 6 asked if wives' difference scores of positive to negative emotional experiences, and difference scores of positive to negative relationship behaviors, were associated with husbands' daily blood glucose levels. The answer to question six appears to be no, as wives' difference scores for neither positive to

negative emotional experience nor positive to negative relationship behaviors predicted husbands' blood glucose levels.

Model 4 tested husbands' age, husbands' general health, and husbands' and wives' marital satisfaction as moderators. Research question 7 asked if husbands' age, husbands' general health, or husbands' or wives' marital satisfaction moderated the association between husbands' or wives' daily positive emotional experience or negative emotional experience and husbands' daily blood glucose levels. There was a significant interaction between husbands' age and husbands' positive emotional experience, F (1, 185) = 5.97, p = .016. As shown in Figure 1, for younger husbands, more positive emotional experience predicted lower glucose levels, b = -39.80, t (185) = -2.96, p = .004. However, for older husbands, positive emotional experience did not predict glucose levels, b = 11.13, t (185) = .65, p = .518. There was also a significant interaction between husbands' general health and husbands' positive emotional experience, F (1, 185) = 5.98, p = .015. As shown in Figure 2, for husbands who were in poorer general health as indicated by scores on the SF-12, more positive emotional experience predicted lower blood glucose, b = -30.15, t (185) = -2.44, p = .016. However, for healthier husbands, positive emotional experience did not predict blood glucose, b = 12.28, t (185) = .78, p = .438. Finally, there was a significant interaction between husbands' positive emotional experience and wives' marital satisfaction, F (1, 173) = 4.48, p = .036. As shown in Figure 3, for husbands whose wives were more satisfied with their marriage, husbands' positive emotional experience predicted lower glucose levels, b = -34.95, t (177) = -2.39, p = .018, but for husbands with less satisfied wives, husbands' positive emotional experience did not

predict glucose levels, b = -5.06, t (177) = -.040, p = .691. There were no other significant interactions in Model 4 associated with the relationship between husbands' or wives' positive or negative emotional experience and husbands' blood glucose. In summary, for husbands who were younger, in poorer general health, and married to wives who were more satisfied with their marriage, positive emotional experience predicted lower blood glucose levels.

Research question 8 asked if husbands' age, husbands' general health, or husbands' or wives' marital satisfaction moderated associations between husbands' or wives' daily positive relationship behaviors or negative relationship behaviors and husbands' daily blood glucose levels. There was a significant interaction between wives' marital satisfaction and husbands' reports of wives' negative relationship behaviors, F (1, 172) = 11.75, p = .001. As shown in Figure 4, wives' marital satisfaction moderated the association between wives' negative relationship behaviors and husbands' blood glucose levels; for wives who were more satisfied, their negative relationship behaviors predicted their husbands' glucose somewhat more strongly (b = -59.79, t (176) = -3.73, p = .000) than in those marriages in which wives were less satisfied (b = -18.69, t (176) = -3.10, p = .002). Counter intuitively, it appears that an increase in wives' negative relationship behaviors is associated with lower blood glucose levels in their husbands. No other interactions in Model 4 significantly interacted with the relationship between husbands' or wives' positive or negative relationship behaviors and husbands' blood glucose. In summary, wives' marital satisfaction interacted with wives' negative relationship behaviors, and counter intuitively, increases in wives' negative relationship behaviors

predicted decreases in husbands' blood glucose levels.

Research question 9 asked if husbands' age, husbands' general health, or husbands' or wives' marital satisfaction moderated the association between daily difference scores of positive to negative emotional experiences and husbands' daily blood glucose levels. There was an interaction between husbands' general health and wives' emotional experience difference scores, F (1, 184) = 12.25, p = .001. As shown in Figure 5, for husbands who were in better general health as indicated by scores on the SF-12, wives' reports of a higher balance of positive as opposed to negative emotional experience predicted lower blood glucose, b = -18.97, t (184) = -2.91, p = .004, but for husbands in poorer general health, wives' reports of a higher balance of positive as opposed to negative emotional experience did not predict husbands' blood glucose levels, b = 8.20, t (184) = 1.37, p = .171. There was also an interaction between wives' marital satisfaction and wives' emotional experience difference scores, F (1, 172) = 8.05, p = .005. However, when the interaction was decomposed, neither slope was statistically significant. Although the slopes were significantly different from one another, neither slope was significantly different than zero. As shown in Figure 6, once again the relationship between wives' marital satisfaction and glucose was counter intuitive: wives' greater satisfaction with their marriage and a higher balance of positive as opposed to negative emotional experience were associated with higher blood glucose in their husbands, b = 7.16, t (176) = 1.12, p = .262. Wives who were less satisfied with their marriage and who reported a higher balance of positive as opposed to negative emotional experience predicted lower blood glucose in their husbands, b = -10.05, t (176) = -1.84, p = .068. To

summarize, for husbands who were in better general health, wives' reports of a higher balance of positive as opposed to negative emotional experience predicted lower blood glucose. Also, although statistically non-significant, among wives who reported a higher balance of positive as opposed to negative emotional experience, being more satisfied with their marriages was associated with higher blood glucose in their husbands, while being less satisfied with their marriage was associated with lower blood glucose in their husbands.

Research question 10 asked if husbands' age, husbands' general health, or husbands' or wives' marital satisfaction moderated the relationship between daily difference scores for positive to negative relationship behaviors and husbands' daily blood glucose levels. The answer here is no across the board; there were no significant interactions in any of the models examined.

CHAPTER 7. DISCUSSION

This study used diary methods to examine the daily emotional experiences and relationship behaviors of married couples coping with the husband's diabetes and how those experiences and behaviors affected his blood glucose levels. The study is relatively unique in that data collected included discrete measures of the interpersonal behaviors and emotional states of both partners over time in a naturalistic setting and a biological indicator of health, the diabetic husband's blood glucose levels. Additionally, the measures used enabled the examination of positive and negative emotional experiences as separate constructs and also allowed the disentangling of emotional experience from interpersonal relationship behaviors, something difficult or impossible to ascertain in previous studies. Repeated measures multilevel models were used to examine whether or not wives' relationship behaviors and emotional experiences influenced husbands' blood glucose beyond the effects of husbands' own relationship behaviors and emotional experiences. Although not truly a "dyadic" study because the health outcome variable (blood glucose) was collected from only one partner, both partners contributed predictors to the models. The multilevel models used addressed the problems of the outcome variable (husband's glucose) being measured every day and therefore creating potential dependence due to time being nested within person, and predictors occurring at two different levels, while allowing for the simultaneous analysis of variance within and between individuals and interaction effects without harming the integrity of the daily diary data (Singer & Willett, 2003). Finally, the study allowed the examination of findings within the framework of two theories. First, the "bad is stronger than good"

theory, which suggests that negative emotional experiences and negative relationship interactions have a greater effect on health outcomes than positive emotional experiences and interactions (Baumeister et al., 2001; Fredrickson & Losada, 2005). Second, "balance" theory, which suggests that positive outcomes depend on a high positive to negative experience ratio rather than absolute levels of either positive or negative experiences (Ryff et al., 2001; Gottman, 1994; Fredrickson & Losada, 2005).

Model 1 examined husbands' and wives' positive and negative daily emotional experience and found that only husbands' negative emotional experience had a significant effect on husbands' blood glucose, but not in the direction anticipated by the "bad is stronger than good" theory (Baumeister et al., 2001; Fredrickson & Losada, 2005). It is unclear why decreases in husbands' negative emotional experience might predict higher blood glucose levels, or why wives' emotional experience appeared to have no effect. In order to attempt to explain this finding, *post hoc* data analysis was performed. A closer examination of the slopes for husbands' positive and negative emotional experience (see Table 4a) revealed that husbands' positive and negative emotional experience slopes were very similar and in the same direction, although only the negative emotional experience beta was statistically significant. This covariance may indicate an emotional experience balancing mechanism, and it may in fact be that the decrease in positive emotional experience was responsible for at least some of the unexpected association between emotional experience and glucose. To further explore the results from Model 1, the four model components (husbands' positive emotional experience, husbands' negative emotional experience, wives' positive emotional experience, and wives' negative

emotional experience) were disassembled and re-run separately. The results did not alter the original findings; in fact, all four paths were statistically non-significant predictors of husbands' glucose using only one predictor at a time.

Model 2 examined husbands' and wives' positive and negative daily relationship behaviors, and although none of the effects were statistically significant, wives' negative relationship behaviors demonstrated a trend toward significance. Again it was the negative that appeared to be the stronger predictor, albeit non-significant, but once again the effect was not in the anticipated direction. Increases in wives' negative relationship behaviors was associated with decreases in husbands' blood glucose level. Additional *post hoc* data analysis was performed in an attempt to better understand the unexpected findings. The four model components (husbands' positive relationship behavior, husbands' negative relationship behavior, wives' positive relationship behavior, and wives' negative relationship behavior) were re-run individually one predictor at a time. All four paths remained statistically non-significant predictors of husbands' glucose when using only one predictor at a time. So, is bad stronger than good when it comes to emotional experience or relationship behaviors and health outcomes? Unfortunately the answer to this question remains unclear from Models 1 and 2; these basic models simply did not capture enough information.

Model 3 examined the effects of husbands' and wives' daily difference scores of positive to negative emotional experiences and positive to negative relationship behaviors on husbands' daily glucose levels. Prior research suggests that the relationships between positive and negative emotional experience and relationship behaviors are complex, and

that a balance of positive to negative emotional experiences and behavioral interactions may be more important to health outcomes than absolute levels of either (e.g., Ryff et al., 2001; Gottman, 1994; Fredrickson & Losada, 2005). Husbands' difference scores for positive to negative relationship behaviors did predict husbands' blood glucose levels. These scores represent husbands' reports of wives' relationship behaviors, so that husbands' blood glucose levels were lower on days when wives' relationship behaviors were evaluated by husbands to be balanced in a more positive manner. This finding is consistent with the "balance" theory of marital relationships and health (Gottman, 1994; Ryff et al., 2001; Fredrickson & Losada, 2005). The actual ratio of positive to negative relationship behaviors cannot be determined due to limitations in the data, but the results provide supporting evidence for the balance theory of the association between marital factors and health, with a more positive balance of wives' relationship behaviors being associated with better health outcomes for husbands. Model 2 demonstrated that the mere presence or absence of higher levels of positive or negative relationship behaviors was not a significant predictor of husbands' blood glucose levels. Model 3 demonstrated that it is the relative balance of wives' positive to negative relationship behaviors rather than the absolute level that had an effect on husbands' blood glucose level on a given day.

To determine if any additional insights could be gained, *post hoc* data analysis was also performed for Model 3. In this analysis, the four paths in Model 3 were decomposed so that each path became its own model. For example, the original Model 3 path consisting of *husband positive to negative emotion balance* was broken down into summary positive emotional experience score, summary negative emotional experience

score, and the difference score. Likewise, the original Model 3 path consisting of *husband positive to negative behavior balance* was broken down into summary positive relationship behavior score, summary negative relationship behavior score, and the difference score. The same method was used for wives' data. Examining each Model 3 path as its own separate model did not alter the original findings. In fact, the model fit was worse. None of the three paths in any of the four individual models were statistically significant predictors of husbands' glucose.

Model 4 examined the moderator effects of husbands' age, husbands' general health, and husbands' and wives' marital satisfaction on each of the previous three models.

Husbands' age. Although it appeared from Model 1 that husbands' positive emotional experience was not associated with glucose, there was a significant interaction between husbands' age and positive emotional experience on glucose. As shown in Figure 5, for younger husbands, more positive emotional experience predicted lower blood glucose levels. This finding is consistent with prior research indicating that positive emotional experiences promote better health outcomes (e.g., Ryff et al., 2001; Ryff & Singer, 1998; 2000; Fredrickson & Losada, 2005). However, some researchers have found a "positivity effect" of aging in which older adults attend more to emotional processes and have better emotion regulation skills resulting in higher positive affect (e.g., Charles & Carstensen, 2009; Mather & Carstensen, 2005). This suggests that older rather than younger husbands would be associated with higher positive emotional experiences. In Model 1, husbands' positive emotional experience alone had no significant association with glucose, but

negative emotional experience had a significant but counter intuitive relationship with glucose. A closer examination of Model 1 shows that both positive and negative emotional experience slopes were negative. The similarity in their slopes may indicate an emotion regulation process. Although older husbands may be better at attending to and regulating emotional processes, younger husbands were better able to reap health benefits from their positive experiences. It may be that younger husbands were more hardy or resilient, had greater coping skills, or perhaps were less impacted by their illness (e.g., fewer years of high allostatic load) in ways not assessed by general health or other measures used in the study.

Husbands' general health. There was a significant interaction between husbands' general health and the relationship between husbands' positive emotional experience and glucose. For husbands who were in poorer general health, more positive emotional experience predicted lower blood glucose, but for healthier husbands, positive emotional experience did not predict blood glucose. Prior research indicates that persons coping with chronic illness and who are in poorer overall health are more impacted by negative emotional experiences due to already strained internal coping mechanisms (Segrin & Flora, 2005; Thompson & Pitts, 1992; Cannon & Cavanaugh, 1998). However, a highly taxed coping system may mean that even a little positive emotion goes a long way in providing health benefits. Once again, this is consistent with research indicating that positive emotion has health benefits (Ryff & Singer, 1998; 2000; Ryff et al., 2001; Fredrickson & Losada, 2005).

There was also a significant interaction between husbands' general health and the

relationship between wives' emotional experience difference score and husbands' blood glucose level. For husbands in better general health, wives who reported a greater balance of positive to negative emotional experience predicted lower blood glucose levels in their husbands. It appears that at least for husbands in better health, there was a positive health benefit from a positive balance in their wives' emotional experience. This finding supports prior research indicating that emotional positivity in close relationships is health promoting (Ryff & Singer, 2002; Ryff et al., 2001; Kiecolt-Glaser & Newton, 2001). It also provides additional evidence for the "balance" theory that a high overall balance of positive to negative emotional experiences provides health benefits (Gottman, 1994; Fredrickson & Losada, 2005). It appears that this association was diminished in husbands who were more ill. Although poorer health was associated with greater health benefits from husbands' positive emotional experience, poorer health may attenuate the beneficial effects of relational positivity through a process not available for examination within the limitations of this study.

Marital satisfaction. Wives' marital satisfaction, but not husbands' also played a significant role. When wives were more satisfied with their marriage, husbands' positive emotional experience predicted lower blood glucose levels. It is unclear if wives are more satisfied with their marriage because their husbands have more positive emotional experiences, or if their husbands have more positive emotional experiences because they are married to more satisfied wives. It seems likely that both are related to the overall emotional climate in which the couple lives and interacts on a daily basis. Marriages in which there is greater positive emotional balance has been found to be predictive of both

marital satisfaction and health outcomes (e.g., Ryff et al., 2001; Gottman, 1994).

Wives' marital satisfaction also interacted with the relationship between wives' negative relationship behaviors and husbands' blood glucose. As in Model 2, the association was counter intuitive: increases in wives' negative relationship behaviors predicted decreases in husbands' blood glucose levels. It may be that husbands attend more to wives' negative relationship behaviors on days when husbands are healthier and less preoccupied by their health concerns, or they may perceive their wives as exhibiting more negative behaviors on days when their wives are more actively engaged in their care. For example, wives' encouragement to follow a diet or to exercise may be perceived by husbands as nagging or complaining even though it helps them to manage their diabetes. In marriages that are relatively satisfying and predominantly balanced toward positive emotional experiences, negative relationship behaviors may be experienced as particularly egregious and salient and therefore may have a greater impact on perceptions of a spouse's behavior on a given day, even though the marital relationship is perceived as satisfying overall.

Conclusions. For husbands who were younger, in poorer general health, and married to wives who were more satisfied with their marriage, positive emotional experience predicted lower blood glucose levels. For husbands in better general health, wives' reports of a higher balance of positive as opposed to negative emotional experience also predicted lower blood glucose. The results indicate that bad is not necessarily stronger than good, and positive emotional experience predicts positive diabetes outcomes as measured by lower blood glucose levels. Support was found for balance theory, in which

a balance of emotional experience that is predominantly positive predicts a positive effect on health outcomes as indicated by lower blood glucose levels.

Limitations. This study has several important limitations. First, the study sample was relatively homogenous, and included all male patients, all with Type 2 diabetes, and all receiving care at the same health care facility. Also, as with all correlation studies, concurrent covariance cannot with certainty imply causality. The study used insufficient data to be a true dyadic study. Including appropriate measures for both partners would have allowed for more sophisticated dyadic multilevel models and data analysis, potentially providing a wealth of information not available in the study. Another serious limitation is with the measures used. Although the study allowed examination of emotional experience and behaviors as independent constructs, a more refined measure of emotional experience such as the Positive and Negative Affect Scales could improve reliability and reduce measurement error (Watson & Vaidya, 2003). Likewise, although the Daily Activities Interview (Huston & Vangelisti, 1991) has established reliability and validity in assessing many relationship behaviors, it includes no specific health-related items. Health-related behaviors as well and close relationship behaviors should be included in order to further refine the understanding of the relative importance of behaviors and emotional experience in health outcomes within close relationships. Another issue is that relationship behavior measurement in the study was based on the perceptions of one partner about the behavior of the other. Behavior measurement could be strengthened considerably if reports included correlated data from both partners reporting on the same behavior. Finally, another potential measurement confound is that

both emotional experience and relationship behaviors were assessed by retrospective self-report, albeit over a brief time interval (e.g., daily summary reports). Although diary studies avoid some of the limitations inherent in laboratory or other observational methods, diary data lacks the inter-rater reliability available through third-party observation and behavior coding.

Future directions. One area for future exploration is the finding that wives' marital satisfaction interacted with wives' negative relationship behaviors so that, counter intuitively, increases in wives' negative relationship behaviors as reported by husbands predicted decreases in husbands' blood glucose levels when wives were more satisfied with their marriage. Healthier husbands may attend more to wives' negative relationship behaviors, they may perceive their wives as exhibiting more negative behaviors on days when their wives are more actively engaged in their care. It is also not clear how wives' relationship behaviors influence husbands' glucose if not through husbands' emotional experience. The specific mechanism of operation should be examined in depth in future studies using more sophisticated mediation or moderation models. Another area to explore is the finding that older husbands did not appear to benefit from positive emotional experience in the same manner as younger husbands. It may be that younger husbands benefited more due to better coping skills, hardiness, resilience or other variables. Future studies should also include greater diversity in the study sample, including at minimum female patients as well as male patients, and including Type 1 and Type 2 diabetes. It is also possible that there were lagged associations that have not been explored. Future studies should examine time lag models to explore possible spillover

relationships between emotional experience and behavior interactions on one day and health outcomes on subsequent days. Finally, in the present study marital satisfaction only had an association with glucose as a partner effect; wives' marital satisfaction was associated with husbands' glucose but husbands' own marital satisfaction was not. Future studies should consider using true dyadic models that include adequate measures for both partners to better differentiate between actor and partner effects on health outcomes.

APPENDIX A. TABLES

Table 1

Variable Descriptives for Emotional Experience and Relationship Behaviors

Variable	*n*	*M*	*SD*	Minimum	Maximum
Husband positive emotional experience	532	0	0.25	-1.09	.72
Husband negative emotional experience	532	0	0.35	-0.94	1.58
Husband positive relationship behaviors	532	0	1.16	-5.01	7.02
Husband negative relationship behaviors	513	0	1.19	-2.78	21.97
Wife positive emotional experience	532	0	0.25	-1.09	.72
Wife negative emotional experience	532	0	0.35	-0.94	1.58
Wife positive relationship behaviors	532	0	1.16	-5.01	7.02
Wife negative relationship behaviors	514	0	0.50	-1.59	3.65

Note: All variables are person-centered

Table 2

Variable Descriptives for Difference Scores

Variable	*n*	*M*	*SD*	Minimum	Maximum
Husband positive to negative emotional experience difference score	532	0.72	0.72	-2.00	2.00
Husband positive to negative relationship behaviors difference score	513	2.25	2.67	-22.75	16.80
Wife positive to negative emotional experience difference score	532	0.72	0.72	-2.00	2.00
Wife positive to negative relationship behaviors difference score	514	2.29	2.43	-2.50	16.80

Table 3

Predictor Variable Intercorrelations

Variable Pairs	Person-centered	Person-mean
Husband		
Positive and negative emotional experience	-.11	-.16
Positive and negative relationship behaviors	-.04	-.07
Positive emotional experience and relationship behaviors	.20	.41
Negative emotional experience and relationship behaviors	.20	.29
Wife		
Positive and negative emotional experience	-.11	-.16
Positive and negative relationship behaviors	-.05	-.20
Positive emotional experience and relationship behaviors	.20	.41
Negative emotional experience and relationship behaviors	.35	.56
Couple		
Husband and wife positive emotional Experience	.13	.44
Husband and wife negative emotional Experience	.20	.50
Husband and wife positive relationship Behaviors	.26	.46
Husband and wife negative relationship Behaviors	.08	.14

Table 4a

Model 1: Emotional Experience Effect on Glucose

Variable	Intercept	*b*	*SE*	*t*	*p*
Glucose	146.26		5.10	28.70	<.0001
Positive emotional experience					
Husband		-18.53	11.14	-1.66	.098
Wife		10.58	9.66	1.10	.275
Negative emotional experience					
Husband		-17.02	8.13	-2.09	.038
Wife		9.02	6.36	1.42	.157
Covariance Parameter Estimates		*b*	*SE*	*z*	*p*
Random intercept		497.02	183.94	2.70	.003
Residual		1399.74	142.09	9.85	<.0001

Table 4b

Model 2: Relationship Behavior Effect on Glucose

Variable	Intercept	*b*	*SE*	*t*	*p*
Glucose	146.23		5.10	28.66	<.0001
Positive relationship behavior					
Husband		1.77	1.95	.91	.365
Wife		1.48	2.54	.58	.562
Negative relationship behavior					
Husband		-11.07	5.82	-1.90	.059
Wife		6.42	4.94	1.30	.196

Covariance Parameter Estimates	*b*	*SE*	*z*	*p*
Random intercept	495.68	184.07	2.69	.0035
Residual	1416.25	144.11	9.83	<.0001

Table 4c

Model 3: Emotional Experience and Relationship Behavior Difference Score Effect on Glucose

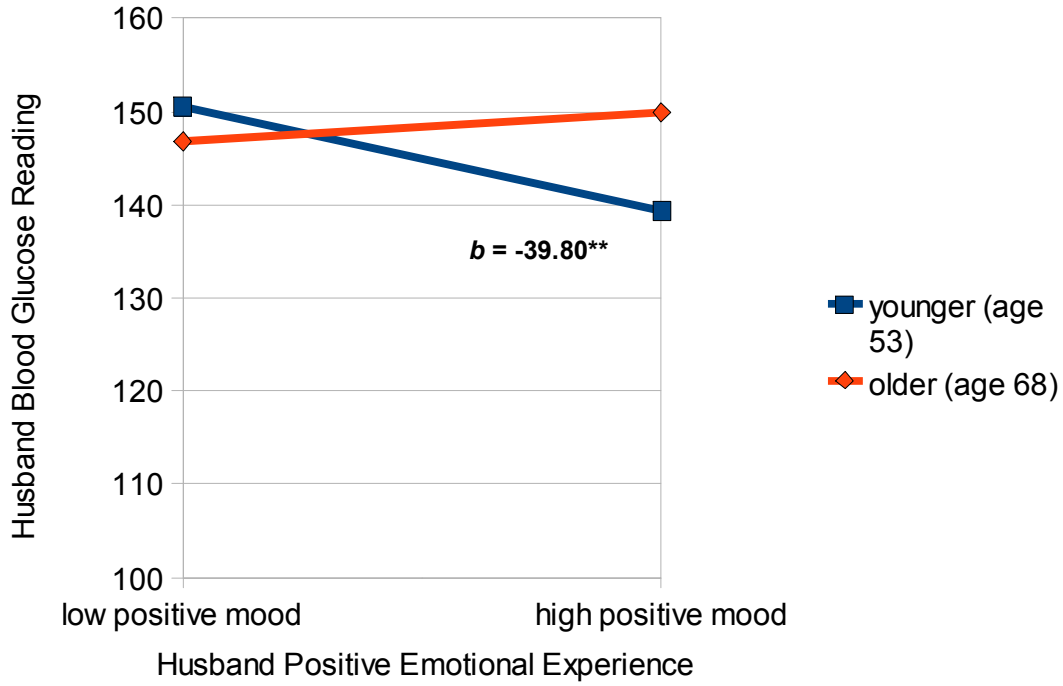
Variable	Intercept	*b*	*SE*	*t*	*p*
Glucose	136.68		6.39	21.37	<.0001
Emotional experience difference					
Husband		3.32	5.00	.67	.506
Wife		-3.90	4.99	-0.78	.439
Relationship behavior difference					
Husband		3.79	1.47	2.58	.011
Wife		.04	1.89	.02	.983

Covariance Parameter Estimates	*b*	*SE*	*z*	*p*
Random intercept	349.07	147.16	2.37	.009
Residual	1443.36	147.16	9.81	<.0001

APPENDIX B. FIGURES

Figure 1

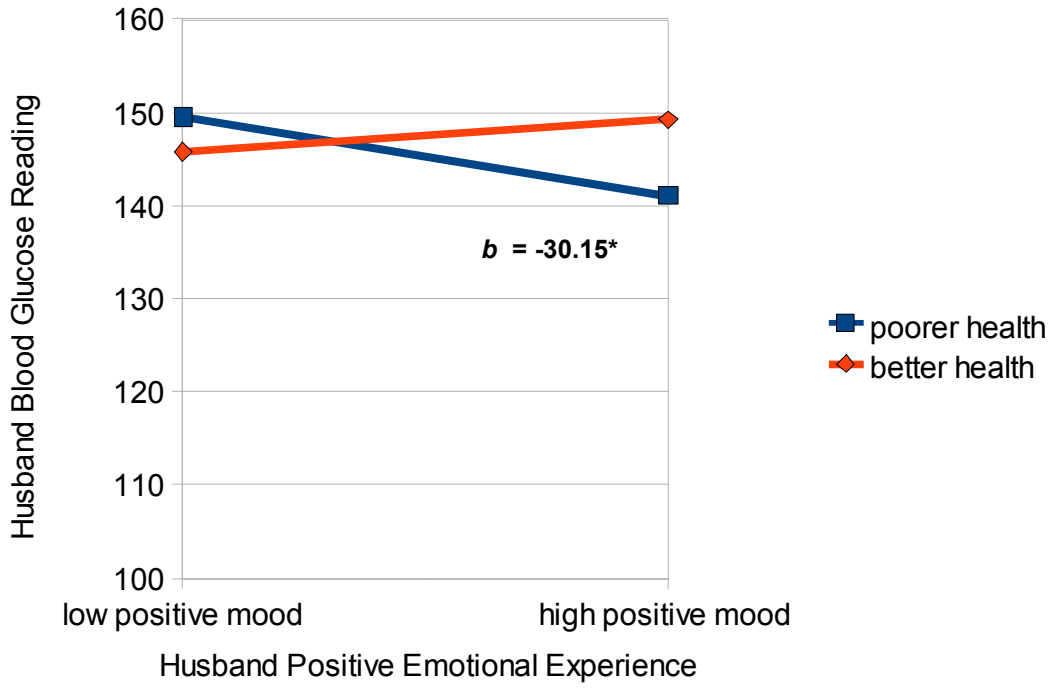
Husband Positive Emotional Experience x Age



**p = .004

Figure 2

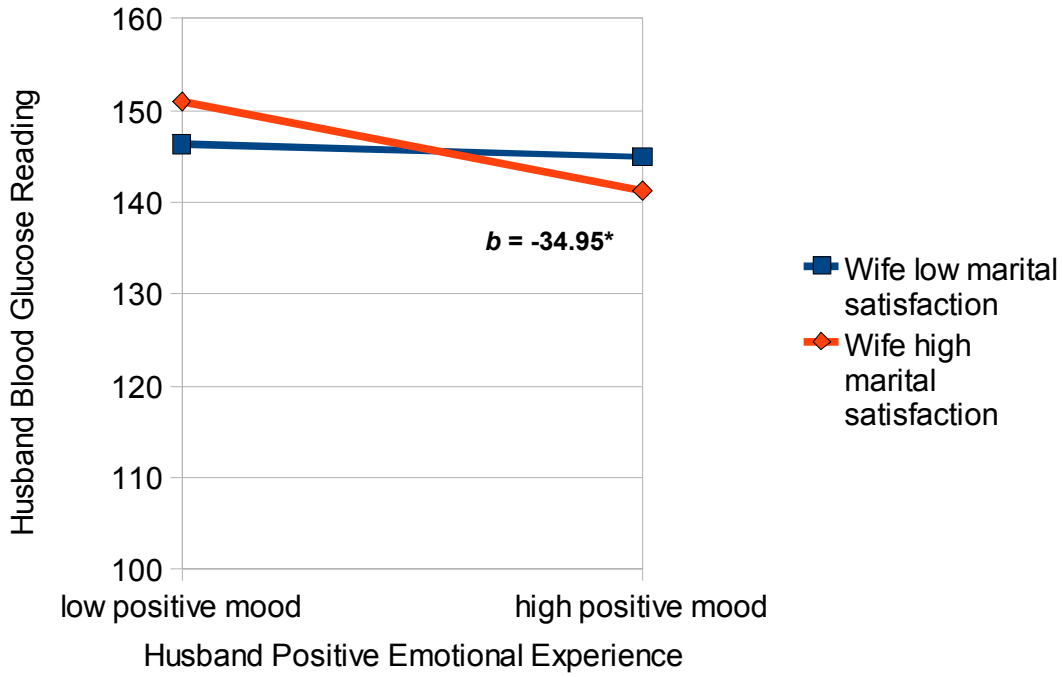
Husband Positive Emotional Experience x General Health



*p = .016

Figure 3

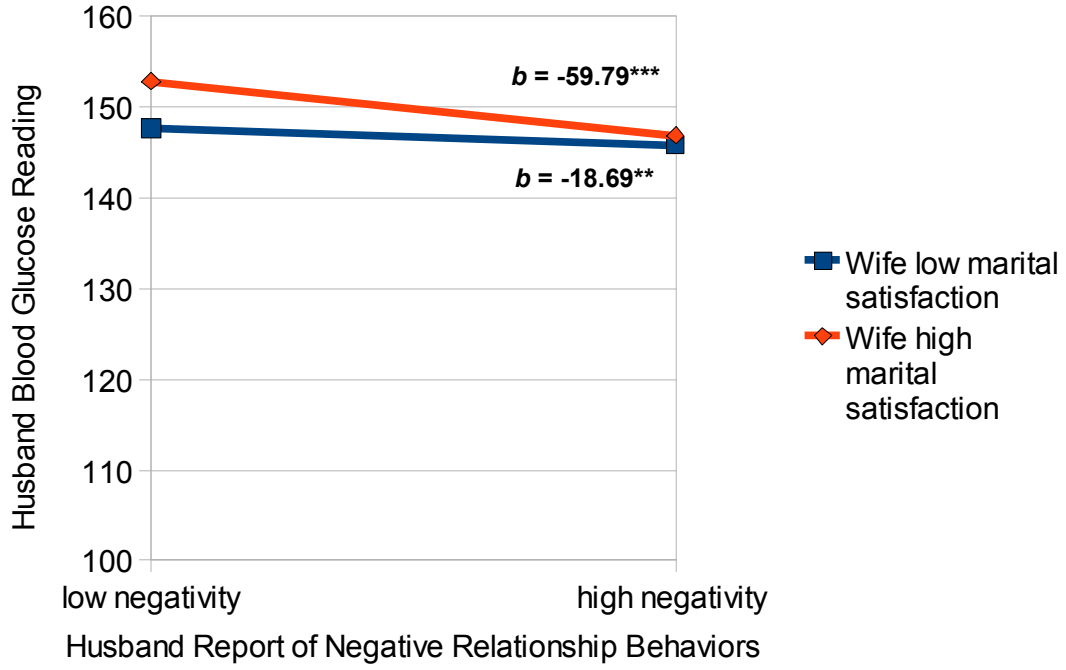
Husband Positive Emotional Experience x Wife Marital Satisfaction



*p = .018

Figure 4

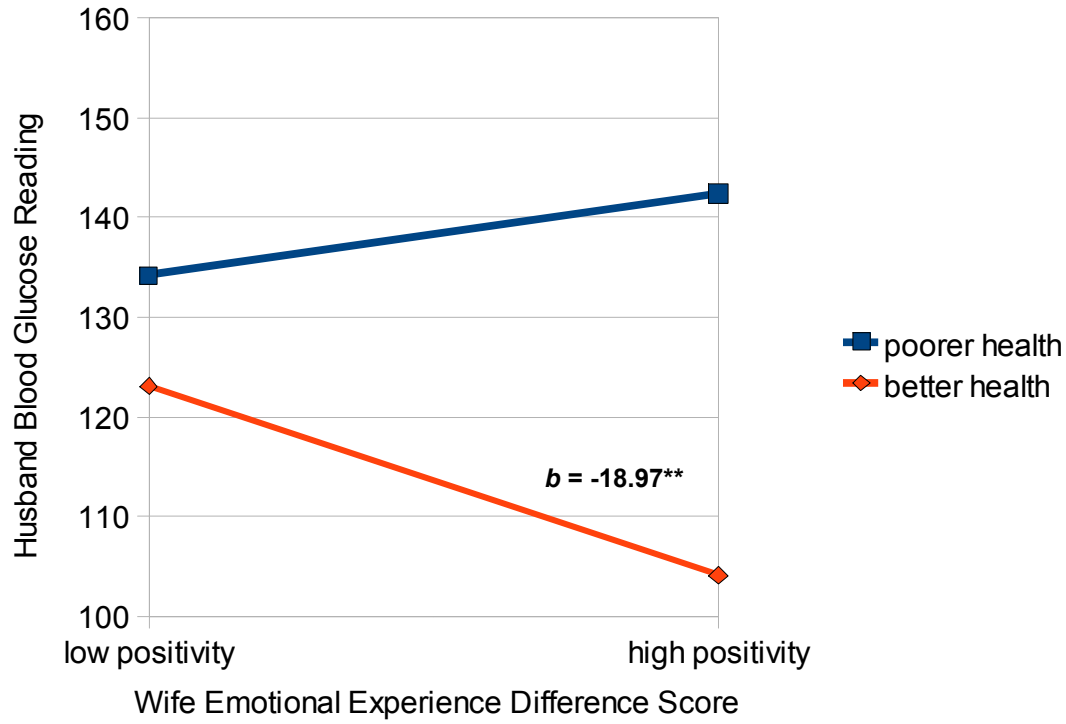
Husband Report of Negative Relationship Behaviors x Wife Marital Satisfaction



***p = .000
**p = .002

Figure 5

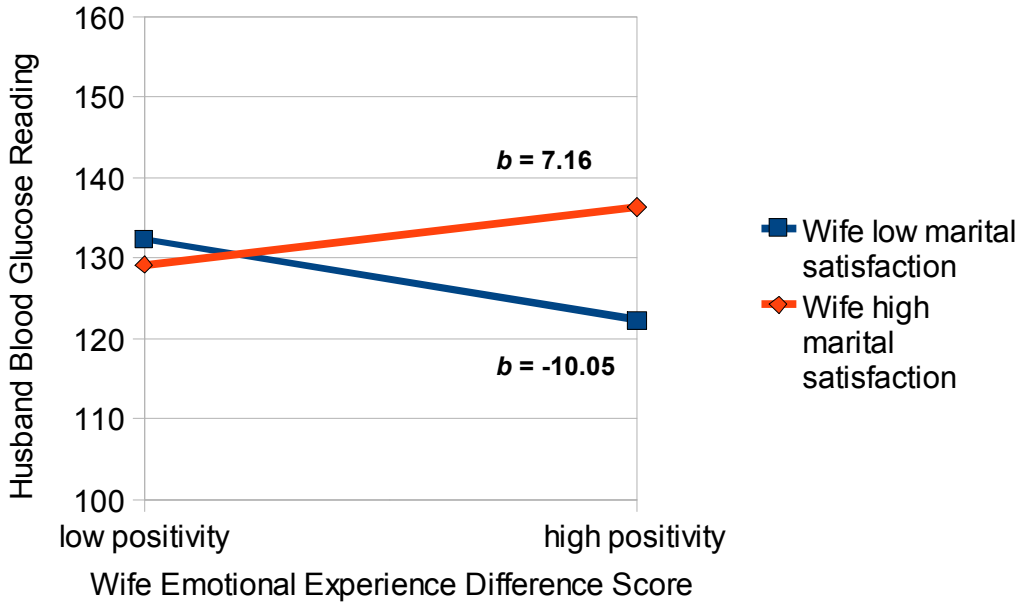
Wife Emotional Experience Difference Score x Husband General Health



**p = .004

Figure 6

Wife Emotional Experience Difference Score x Wife Marital Satisfaction



Note: Although the interaction between wives' emotional experience difference score and wives' marital satisfaction on husbands' blood glucose was significant in the model, F (1, 172) = 8.05, p = .005, when the interaction was decomposed neither slope was statistically significant.

REFERENCES

Alvarez, M.A., Portilla, L., Gonzalez, R. & Ezcurra, E. (1989). Insulin response to a short stress period. *Psychoneuroendocrinology, 14,* 241-244.

American Diabetes Association (2003). Economic costs of diabetes in the U.S. in 2002. *Diabetes Care, 26,* 917-932.

American Diabetes Association (2008). Economic costs of diabetes in the U.S. in 2007. *Diabetes Care, 31,* 596-615.

Armario, A., Marti., O., Molina, T., de Pablo, J. & Valdes, M. (1996). Acute stress markers in humans: Response of plasma glucose, cortisol and prolactin to two examinations differing in the anxiety they provoke. *Psychoneuroendocrinology, 21,* 17-24.

Barzilay, J.I., Kronmal, R.A., Gottdiener, J.S., Smith, N.L., Burke, G.L., Tracy, R., Savage, P.J. & Carlson, M. (2004). The association of fasting glucose levels with Congestive Heart Failure in diabetic adults $\geq$ 65 years: The Cardiovascular Health Study. *Journal of the American College of Cardiology, 43,* 2236-2241.

Baumeister, R.F., Bratslavsky, E., Finkenauer, C. & Vohs, K.D. (2001). Bad is stronger than good. *Review of General Psychology, 5,* 323-370.

Berkman, L.F., Glass, T., Brissette, L. & Seeman, T.E. (2000). From social integration to health: Durkheim in the new millennium. *Social Science and Medicine, 51,* 843-857.

Berscheid, E. (1983). Emotion. In In H.H. Kelley, E. Berscheid, A. Christensen, J.H. Harvey, T.L. Huston, G. Levinger, E. McClintock, L.A. Peplau & D.R. Peterson

(Eds.), *Close relationships*, (pp. 110-168). New York: W.H. Freeman.

Berscheid, E. & Reis, H.T. (1998). Attraction and close relationships. In D.T. Gilbert, S.T. Fiske & Gardner, L. (Eds.), *Handbook of social psychology, 4th ed., vol. 2,* 193-281.

Bertoni, A.G., Krop, J.S., Anderson, G.F. & Brancati, G.F. (2002). Diabetes-related morbidity and mortality in a national sample of U.S. elders. *Diabetes Care, 25,* 471-475.

Bolger, N., Davis, A. & Rafaeli, E. (2003). Diary methods: Capturing life as it is lived. *Annual Review of Psychology, 54,* 579-616.

Bolger, N., DeLongis, A., Kessler, R.C. & Schilling, E.A. (1989). Effects of daily stress on negative mood. *Journal of Personality and Social Psychology, 57,* 808-818.

Bolger, N. & Eckenrode, J. (1991). Social relationships, personality, and anxiety during a major stressful event. *Journal of Personality and Social Psychology, 61,* 440-449.

Bolger, N., Zuckerman, A. & Kessler, R.C. (2000). Invisible support and adjustment to stress. *Journal of Personality and Social Psychology, 79,* 953-961.

Bradbury, T.N., Fincham, F.D & Beach, S.R.H. (2000). Research on the nature and determinants of marital satisfaction: A decade in review. *Journal of Marriage and the Family, 62,* 964-980.

Burman, B. & Margolin, G. (1992). Analysis of the association between marital relationships and health problems: An interactional perspective. *Psychological Bulletin, 112,* 39-63.

Campbell, L. & Kashy, D.A. (2002). Estimating actor, partner, and interaction

effects for dyadic data using PROC MIXED and HLM: a user-friendly guide. *Personal Relationships, 9,* 327-342.

Cannon, C.A. & Cavanaugh, J.C. (1998). Chronic illness in the context of marriage: A sysems perspective of stress and coping in Chronic Obstructive Pulmonary Disease. *Families, Systems and Health, 16,* 401-418.

Carstensen, L.L., Fung, H.H. & Charles, S.T. (2003). Socioemotional selectivity theory and the regulation of emotion in the second half of life. *Motivation and Emotion, 27,* 103-123.

Carter, R.E. & Carter, C.A. (1994). Marital adjustment and effects of illness in married pairs with one or both spouses chronically ill. *The American Journal of Family Therapy, 22,* 315-326.

Caughlin, J.P., Huston, T.L. & Houts, R.M. (2000). How does personality matter in marriage? An examination of trait anxiety, interpersonal negativity, and marital satisfaction. *Journal of Personality and Social Psychology, 78,* 326-336.

Cernin, P.A., Cresci. K., Jankowski, T.B. & Lichtenberg, P.A. (2010). Reliability and validity testing of the short-form health survey in a sample of community-dwelling African American older adults. *Journal of Nursing Measurement, 18,* 49-59.

Charles, S. & Carstensen, L.L (2009). Social and emotional aging. *Annual Review of Psychology, 61,* 383-409.

Cohen, C. & Wills, T.A. (1985). Stress, social support and the buffering hypothesis. *Psychological Bulletin, 98,* 310-357.

Cohen, S. (1988). Psychosocial models of the role of social support in the etiology

of physical disease. *Health Psychology, 7,* 269-297.

Coyne, J.C. (1976a). Toward an interactional description of depression. *Psychiatry, 39,* 29-40.

Coyne, J.C. (1976b). Depression and the response of others. *Journal of Abnormal Psychology, 85,* 186-193.

Coyne, J.C., Rohrbaugh, M.J., Shoham, V., Sonnega, J.S., Nicklas, J.M. & Cranford, J.A. (2001). Prognostic importance of marital quality for survival of congestive heart failure. *The American Journal of Cardiology, 88,* 526-529.

De Vogli, R., Chandola, T. & Marmot, M.G. (2007). Negative aspects of close relationships and heart disease. *Archives of Internal Medicine, 167,* 1951-1957.

Dempster, M. & Donnelly, M. (2001). A comparative analysis of the SF-12 and the SF-36 among Ischaemic Heart Disease patients. *Journal of Health Psychology, 6,* 707-711.

DesRosier, M.B., Catanzaro, M. & Piller, J. (1992). Living with chronic illness: Social support and the well spouse perspective. *Rehabilitation Nursing, 17,* 87-91.

Dunbar, M., Ford, G. & Hunt, K. (1998). Why is the receipt of social support associated with increased psychological distress? An examination of three hypotheses. *Psychology and Health, 13,* 527-544.

Eaker, E.D., Sullivan, L.M., Kelly-Hayes, M., D'Agostino, R.B. & Benjamin, E.J. (2007). Marital status, marital strain, and risk of coronary heart disease or total mortality: The Framington Offspring Study. *Psychosomatic Medicine, 69,* 509-513.

Farivar, S.S., Cunningham, W.E. & Hays, R.D. (2007). Correlated physical and

mental health summary scores for the SF-36 and SF-12 Health Survey, V.I. *Health and Quality of Life Outcomes, 5,* 54-61.

Fairclough, S.H. & Houston, K. (2003). A metabolic measure of mental effort. *Biological Psychology, 66,* 177-190.

Frazier, P.A., Tix, A.P. & Barnett, C.L. (2003). The relational context of social support: Relationship satisfaction moderates the relations between enacted support and distress. *Personality and Social Psychology Bulletin, 29,* 1133-1146.

Fredrickson, B.L. (1998). What good are positive emotions? *Review of General Psychology, 2,* 300-319.

Fredrickson, B.L. (2001). The role of positive emotions in positive psychology: The broaden-and-build theory of positive emotions. *American Psychologist, 56,* 218-226.

Fredrickson, B.L. & Joiner, T. (2002). Positive emotions trigger upward spirals toward emotional well-being. *Psychological Science*, *13*, 172-175.

Fredrickson, B.L. & Losada, M.F. (2005). Positive affect and the complex dynamics of human flourishing. *American Psychologist, 60,* 678-686.

Gable, S.L., Reis, H.T., Impett, E.A. & Asher, E.R. (2004). What do you do when things go right? The intrapersonal and interpersonal benefits of sharing positive events. *Journal of Personality and Social Psychology, 87*, 228-245.

Gable, S.L. & Haidt, J. (2005). What (and why) is positive psychology? *Review of General Psychology, 9,* 103-110.

Gleason, M.E.J., Iida, M., Bolger, N. & Shrout, P.E. (2003). Daily supportive equity in close relationships. *Personality and Social Psychology Bulletin, 29,* 1036-1045.

Goetsch, V.L., Abel, J.L. & Pope, M.K. (1994). The effects of stress, mood, and coping on blood glucose in NIDDM: A prospective pilot evaluation. *Behaviour Research and Therapy, 32,* 503-510.

Goetsch, V.L., Weibe, D.J., Veltum, L.G. & van Dorsten, B. (1990). Stress and blood glucose in type II diabetes Mellitus. *Behaviour Research and Therapy, 28*, 531-537.

Goldstein, D.E., Little, R.R., Lorenz, R.A., Malone, J.I., Nathan, D., Peterson, C.M. & Sacks, D.B. (2004). Tests of glycemia in diabetes. *Diabetes Care, 27*, 1761-1773.

Gonder-Frederick, L.A., Carter, W.R., Cox, D.J. & Clarke, W.L. (1990). Environmental stress and blood glucose change in insulin-dependent diabetes Mellitus. *Health Psychology, 9*, 503-515.

Gonder-Frederick, L.A., Cox, D.J., Bobbitt, S.A. & Pennebaker, J.W. (1989). Mood changes associated with blood glucose fluctuations in insulin-dependent diabetes Mellitus. *Health Psychology, 8,* 45-59.

Gottman, J.M. (1979). *Marital interaction: Experimental investigations*. New York: Academic Press.

Gottman, J.M. (1980). Consistency of nonverbal affect and affect reciprocity in marital interaction. *Journal of Consulting and Clinical Psychology, 48,* 711-717.

Gottman, J.M. (1993a). A theory of marital dissolution and stability. *Journal of Family Psychology, 7,* 57-75.

Gottman, J.M. (1993b). The roles of conflict engagement, escalation, and avoidance in marital interaction: A longitudinal view of five types of couples. *Journal of*

Consulting and Clinical Psychology, 61, 6-15.

Gottman, J.M. (1994). *What predicts divorce?* Hillsdale, NJ: Lawrence Erlbaum Associates.

Gottman, J.M. (1998). Psychology and the study of marital processes. *Annual Review of Psychology, 49*, 169-197.

Gottman, J.M., Coan, J., Carrere, S. & Swanson, C. (1998). Predicting marital happiness and stability from newlywed interactions. *Journal of Marriage and the Family, 60*, 5-22.

Gottman, J.M. & Levenson, R.W. (1988). The social psychophysiology of marriage. In P. Noller & M.A. Fitzpatrick (Eds.), *Perspectives on marital interaction* (pp. 183-200). Clevedon, Avon, England: Multilingual Matters Ltd.

Gottman, J.M. & Levenson, R.W. (1992). Marital processes predictive of later dissolution: Behavior, physiology, and health. *Journal of Personality and Social Psychology, 63*, 221-233.

Gray, E.K. & Watson, D. (2007). Assessing positive and negative affect via self-report. In J.A. Coan & J.J.B. Allen (Eds.), *Handbook of emotion elicitation and assessment (series in affective science)*(p. 174). Oxford University Press.

Halford, W.K., Cuddihy, S. & Mortimer, R.H. (1990). Psychological stress and blood glucose regulation in Type I diabetic patients. *Health Psychology, 9*, 516-528.

Hays, R.D., Sherbourne, C.D., & Mazel, R.M. (1993). The RAND 36-Item Health Survey 1.0. *Health Economics, 2*, 217-227.

Hedges, S.M., Jandorf, L., & Stone, A.A. (1985). Meaning of daily mood

assessments. *Journal of Personality and Social Psychology, 48,* 428-434.

Heffner, K.L., Loving, T.J., Kiecolt-Glaser, J.K., Himawan, L.K., Glaser, R. & Malarkey, W.B. (2006). Older spouses' cortisol responses to marital conflict: Associations with demand/withdraw communication patterns. *Journal of Behavioral Medicine, 29,* 317-325.

House, J.S., Landis, K.R. & Umberson, D. (1988). Social relationships and health. *Science, 241*, 540-545.

Huston, T.L. & Chorost, A.F. (1994). Behavioral buffers on the effect of negativity on marital satisfaction: A longitudinal study. *Personal Relationships, 1*, 223-239.

Huston, T.L. & Robins, E. (1982). Conceptual and methodological issues in studying close relationships. *Journal of Marriage and the Family, 44*, 901-925.

Huston, T.L. & Vangelisti, A.L. (1991). Socioemotional behavior and satisfaction in marital relationships: A longitudinal study. *Journal of Personality and Social Psychology, 61*, 721-733.

Joiner, T.E. & Katz, J. (1999). Contagion of depressive symptoms and mood: Meta-analytic review and explanations from cognitive, behavioral, and interpersonal viewpoints. *Clinical Psychology: Science and Practice, 6*, 149-164.

Kashy, D.A. & Kennedy, D.A. (2000). The analysis of data from dyads and groups. In H.T. Reis & C.M. Judd (Eds.), *Handbook of research methods in social and personality psychology* (pp. 451-477). New York: Cambridge University Press.

Kelley, H.H., Berscheid, E., Christensen, A., Harvey, J.H., Huston, T.L., Levinger, G., McClintock, E., Peplau, L.A. & Peterson, D.R. (1983). Analyzing close relationships.

In H.H. Kelley, E. Berscheid, A. Christensen, J.H. Harvey, T.L. Huston, G. Levinger, E. McClintock, L.A. Peplau & D.R. Peterson (Eds.), *Close relationships,* (pp. 20-67). New York: W.H. Freeman.

Kennedy-Moore, E., Greenberg, M.A., Newman, M.G., & Stone, A.A. (1992). The relationship between daily events and mood: The mood measure may matter. *Motivation and Emotion, 16*, 143-155.

Kiecolt-Glaser, J.K., Glaser, R., Cacioppo, J.T., MacCallum, R.C., Snydersmyth, M., Cheongtag, K. & Malarkey, W.B. (1997). Marital conflict in older adults: Endocrinological and immunological correlates. *Psychosomatic Medicine, 59*, 339-349.

Kiecolt-Glaser, J.K., Malarkey, W.B., Chee, M., Newton, T., Cacioppo, J.T., Hsiao-Yin Mao & Glaser, R. (1993). Negative behavior during marital conflict is associated with immunological down-regulation. *Psychosomatic Medicine, 55*, 395-409.

Kiecolt-Glaser, J.K., McGuire, L., Robles, T.F. & Glaser, R. (2002). Psychoneuroimmunology: Psychological influences on immune function and health. *Journal of Consulting and Clinical Psychology, 70*, 537-547.

Kiecolt-Glaser, J.K. & Newton, T.L. (2001). Marriage and health: His and hers. *Psychological Bulletin, 127*, 472-503.

Kiecolt-Glaser, J.K., Newton, T., Cacioppo, J.T., MacCallum, R.C., Glaser, R. & Malarkey, W.B. (1996). Marital conflict and endocrine function: Are men really more physiologically affected than women? *Journal of Consulting and Clinical Psychology, 64*, 324-332.

King, H., Aubert, R.E. & Herman, W.H. (1998). Global burden of diabetes, 1995-

2025: Prevalence, numerical esimates, and projections. *Diabetes Care, 21*, 1414-1431.

Kleiboer, A.M., Kuijer, R.G., Hox, J.J., Schreurs, K.M.G. & Bensing, J.M. (2006). Receiving and providing support in couples dealing with multiple sclerosis: A diary study using an equity perspective. *Personal Relationships, 13*, 485-501.

Lammers, C.A., Naliboff, B.D. & Straatmeyer, A.J. (1984). The effects of progressive relaxation on stress and diabetic control. *Behaviour Research and Therapy, 22*, 641-650.

Larson, C.O., Schlundt, D., Patel, K., Hargreaves, M. & Beard, K. (2008). Validity of the SF-12 for use in a low-income African American community-based research initiative (REACH 2010). *Preventing Chronic Disease, 5,* 1-14.

Larson, R.W. & Almeida, D.M. (1999). Emotional transmission in the daily lives of families: A new paradigm for studying family processes. *Journal of Marriage and the Family, 61*, 5-20.

Laurenceau, J. & Bolger, N. (2005). Using diary methods to study marital and family processes. *Journal of Family Psychology, 19*, 86-97.

Laurent, H. & Powers, S. (2007). Emotion regulation in emerging adult couples: Temperament, attachment, and HPA response to conflict. *Biological Psychology, 76*, 61-71.

Levenson, R.W & Gottman, J.M. (1983). Marital interaction: Physiological linkage and affective exchange. *Journal of Personality and Social Psychology 45*, 587-597.

Levenson, R.W & Gottman, J.M. (1985). Physiological and affective predictors of

change in relationship satisfaction. *Journal of Personality and Social Psychology 49*, 85-94.

Luo, X., Lynn George, M., Kakouras, I., Edwards, C., Pietrobon, R., Richardson, W. & Hey, L. (2003). Reliability, validity, and responsiveness of the short form 12-item survey (SF-12) in patients with back pain. *Spine, 15*, 1739-1745.

Lyubomirsky, S., King, L. & Diener, E. (2005). The benefits of frequent positive affect: Does happiness lead to success? *Psychological Bulletin, 131*, 803-855.

Maisel, N.C. & Gable, S.L. (2009). The paradox of received social support: The importance of responsiveness. *Psychological Science, 20*, 928-932.

Malarkey, W.B., Kiecolt-Glaser, J.K., Pearl, D. & Glaser, R. (1994). Hostile behavior during marital conflict alters pituitary and adrenal hormones. *Psychosomatic Medicine, 56*, 41-51.

Mather, M. & Carstensen, L.L. (2005). Aging and motivated cognition: The positivity effect in attention and memory. *TRENDS in Cognitive Sciences, 9*, 496-502.

McMahon, J.M., Pouget, E.R. & Tortu, S. (2006). A guide for multilevel modeling of dyadic data with binary outcomes using SAS PROC NLMIXED. *Computational Statistics and Data Analysis, 50*, 3663-3680.

Muller-Nordhorn, J., Roll, S. & Willich, S.N. (2004). Comparison of the short form (SF)-12 health status instrument with the SF-36 in patients with coronary heart disease. *Heart, 90,* 523-527.

Myers, D.G. (2000). The funds, friends, and faith of happy people. *American Psychologist, 55*, 56-67.

Nathan, D.M., Kuenen, J., Borg, R., Zheng, H., Schoenfeld, D. & Heine, R.J. (2008). Translating the A1c assay into estimated average glucose values. *Diabetes Care, 31*, 1473-1478.

Newsome, J.T., Mahan, T.L., Rook, K.S. & Krause, N. (2008). Stable negative social exchanges and health. *Health Psychology, 27*, 78-86.

Nowlis, V. (1965). Research with the Mood Adjective Checklist. In S.S. Tomkins & C.E. Izard (Eds.), *Affect, cognition, and personality* (pp. 352-389). New York: Springer Publishing Company.

Nunnally, J.C. (1978). *Psychometric theory, 2nd ed.* New York: McGraw-Hill.

Reblin, M. & Uchino, B. (2008). Social and emotional support and its implications for health. *Current Opinion in Psychiatry, 21*, 201-205.

Resnick, B. & Parker, R. (2001). Simplified scoring and psychometrics of the revised 12-item Short-Form Health Survey. *Outcomes Management for Nursing Practice, 5,* 161-166.

Revenson, T.A. (1994). Social support and marital coping with chronic illness. *Annals of Behavioral Medicine, 16*, 122-130.

Revenson, T.A. & Majerovitz, S.D. (1991). The effects of chronic illness on the spouse: Social resources as stress buffers. *Arthritis Care and Research, 4*, 63-72.

Revenson, T.A., Schiaffino, K.M., Majerovitz, S.D. & Gibofsky, A. (1991). Social support as a double-edged sword: The relation of positive and problematic support to depression among rheumatoid arthritis patients. *Social Science and Medicine, 33*, 807-813.

Riazi, A., Pickup, J. & Bradley, C. (2004). Daily stress and glycaemic control in Type 1 diabetes: Individual differences in magnitude, direction, and timing of stress-reactivity. *Diabetes Research and Clinical Practice, 66*, 237-244.

Robles, T.F. & Kiecolt-Glaser, J.K. (2003). The physiology of marriage: Pathways to health. *Physiology and Behavior, 79*, 409-416.

Rohrbaugh, M.J., Shoham, V. & Coyne, J.C. (2006). Effect of marital quality on eight-year survival of patients with heart failure. *The American Journal of Cardiology, 98,* 1069-1072.

Rohrbaugh, M.J., Shoham, V., Coyne, J.C., Cranford, J.A., Sonnega, J.S. & Nicklas, J.M. (2004). Beyond the "self" in self-efficacy: Spouse confidence predicts patient survival following heart failure. *Journal of Family Psychology, 18*, 184-193.

Rohlfing, C.L., Wiedmeyer, H., Little, R.R., England, J.D., Tennill, A. & Goldstein, D.E. (2002). Defining the relationship between plasma glucose and HbA1c. *Diabetes Care, 25*, 275-278.

Ross, C.E., Mirowsky, J. & Goldsteen, K. (1990). The impact of the family on health: The decade in review. *Journal of Marriage and the Family, 52*, 1059-1078.

Ryff, C.D., & Singer, B. (1998). The contours of positive human health. *Psychological Inquiry, 9*, 1-28.

Ryff, C.D., & Singer, B. (2000). Interpersonal flourishing: A positive health agenda for the new millennium. *Personality and Social Psychology Review, 4*, 30-44.

Ryff, C.D. & Singer, B. (2002). From social structure to biology. Inegrative science in pursuit of human health and well-being. In C.R. Snyder & S.J. Lopez (Eds.).

Handbook of positive psychology (pp. 541-555). New York: Oxford.

Ryff, C.D., Singer, B.H., Wing, E. & Love, G.D. (2001). Elective affinities and uninvited agonies. Mapping emotion with significant others onto health. In C.D. Ryff & B.H. Singer (Eds.). *Emotion, social relationships, and health* (pp. 133-188). New York: Oxford.

Salovey, P., Rothman, A.J., Detweiler, J.B. & Steward, W.T. (2000). Emotional states and physical health. *American Psychologist, 55*, 110-121.

Saudek, C.D., Derr, R.L. & Kalyani, R.R. (2006). Assessing glycemia in diabetes using self-monitoring blood glucose and hemoglobin A1c. *Journal of the American Medical Association, 295*, 1688-1697.

Scholz, U., Knoll, N., Roigas, J. & Gralla, O. (2008). Effects of provision and receipt of social support on adjustment to laparoscopic radical prostatectomy. A*nxiety, Stress, and Coping, 21*, 227-241.

Seeman, T.E. (1996). Social ties and health: The benefits of social integration. *Annals of Epidemiology, 6*, 442-451.

Segrin, C. & Dillard, J.P. (1992). The interactional theory of depression: A meta-analysis of the research literature. *Journal of Social and Clinical Psychology, 11*, 43-70.

Segrin, C. & Flora, J. (2005). Family interaction and physical health. In *Family communication* (pp.324-345). Mahwah, NJ: Lawrence Erlbaum Associates.

Seidman, G., Shrout, P.E. & Bolger, N. (2006). Why is enacted social support associated with increased distress? Using simulation to test two possible sources of spuriousness. *Personality and Social Psychology Bulletin, 32*, 52-65.

Seligman, M.E.P. & Csikszentmihalyi, M. (2000). Positive psychology: An introduction. *American Psychologist, 55*, 5-14.

Selvin, E., Coresh, J., Golden, S.H., Brancati, F.L., Folsom, A.R. & Steffes, M.W. (2005). Glycemic control and Coronary Heart Disease risk in persons with and without diabetes. *Archives of Internal Medicine, 165*, 1910-1916.

Selvin, E., Coresh, J., Golden, S.H., Boland, L.L., Brancati, F.L. & Steffes, M.W. (2005). Glycemic control, atherosclerosis, and risk factors for cardiovascular disease in individuals with diabetes. *Diabetes Care, 28*, 1965-1973.

Selvin, E., Wattankit, K., Steffes, M.W., Coresh, J. & Sharrett, A.R. (2006). HbA1c and Peripheral Arterial Disease in diabetes. *Diabetes Care, 29*, 877-882.

Sherbourne, C.D. & Hays, R.D. (1990). Marital status, social support, and health transitions in chronic disease patients. *Journal of Health and Social Behavior, 31*, 328-343.

Sherbourne, C.D., Hays, R.D., Ordway, L., DiMateo, M.R. & Kravitz, R.L. (1992). Antecedents of adherence to medical recommendations: Results from the Medical Outcomes Study. *Journal of Behavioral Medicine, 15*, 447-468.

Shrout, P.E., Herman, C.M. & Bolger, N. (2006). The costs and benefits of practical and emotional support on adjustment: A daily diary study of couples experiencing acute stress. *Personal Relationships, 13*, 115-134.

Singer, J. D. & Willett, J. B.(2003). *Applied longitudinal data analysis: Modeling change and event occurrence.* Oxford University Press.

Skaff, M.M., Mullan, J.T., Almeida, D.M., Hoffman, L., Masharani, U., Moher, D. & Fischer, L. (2009). Daily negative mood affects fasting glucose in Type 2 diabetes. *Health Psychology, 28*, 265-272.

Smith, T.W. & Gallo, L.C. (1999). Hostility and cardiovascular reactivity during marital interaction. *Psychosomatic Medicine, 61*, 436-445.

Stewart, A.L., Hays, R.D., & Ware, J.E. (1988). The MOS 36-Item Short-form General Health Survey: Reliability and validity in a patient population. *Medical Care, 26*, 724-735.

Stewart, A.L. & Ware, J.E. (1992). *Measuring functioning and well-being: The Medical Outcomes Study approach*. London: Duke University Press.

Stone, A.A. (1981). The association between perceptions of daily experiences and self- and spouse-rated mood. *Journal of Research in Personality, 15*, 510-522.

Taylor, S.E., Repetti, R.L. & Seeman, T. (1997). Health psychology: What is an unhealthy environment and how does it get under the skin? *Annual Review of Psychology, 48*, 411-447.

Thompson, S.C. & Pitts, J.S. (1992). In sickness and in health: Chronic illness, marriage, and spousal caregiving. In S. Spacapan & S. Oskamp (Eds.), *Helping and being helped: Naturalistic studies* (pp. 115-151). Thousand Oaks, CA: Sage Publications, Inc.

Trief, P.M., Orendorff, R., Himes, C.L. & Weinstock, R.S. (2001). The marital relationship and psychosocial adaptation and glycemic control of individuals with diabetes. *Diabetes Care, 24*, 1384-1389.

Uchino, B.N. (2006). Social support and health: A review of physiological

processes potentially underlying links to disease outcomes. *Journal of Behavioral Medicine, 29*, 377-387.

Uchino, B.N., Cacioppo, J.T. & Kiecolt-Glaser, J.K. (1996). The relationship between social support and physiological processes: A review with emphasis on underlying mechanisms and implications for health. *Psychological Bulletin, 119*, 488-531.

Vella, E.J., Kamarck, T.W. & Shiffman, S. (2008). Hostility moderates the effects of social support and intimacy on blood pressure in daily social interactions. *Health Psychology, 27*, S155-S162.

Ware, J.E., Kosinski, M.A., & Keller, S.D. (1996). A 12-item short-form health survey: Construction of scales and preliminary tests of reliability and validity. *Medical Care, 34*, 220-233.

Ware, J.E. & Sherbourne, C.D. (1992). The MOS 36-Item Short-Form Health Survey (SF-36): Conceptual framework and item selection. *Medical Care, 30*, 473-483.

Watson, D. & Vaidya, J. (2003). Mood measurement: Current status and future directions. In J. A. Schinka, W.F. Velicer & I.B. Weiner (Eds.), *Handbook of psychology, research methods in psychology (volume 2)*(pp. 351 – 376). John Wiley & Sons, Inc.

Wild, S., Roglic, G., Green, A., Sicree, R. & King, H. (2004). Global prevalence of diabetes: Estimates for the year 2000 and projections for 2030. *Diabetes Care, 27*, 1047-1053.

Wills, T.A., Weiss, R.L., & Patterson, G.R. (1974). A behavioral analysis of the determinants of marital satisfaction. *Journal of Consulting and Clinical Psychology, 42*,

802-811.