TESTING NESTED ASSOCIATIONS BETWEEN
MICRODIMENSIONAL AND GLOBAL INDICATORS
OF RELATIONSHIP OUTCOMES

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CHAPTER I

INTRODUCTION

For decades researchers have sought to understand couples and the systemic outputs associated with the interactions of romantic partners (e.g., Gottman & Notarius, 2000). For better or worse, romantic relationships are linked to various healthy and unhealthy outcomes for both partners in the relationship, as well as the family members, including the couples' parents (e.g., Ahrons, 2007; Wood, Goesling, & Avellar, 2007) and children (Ahrons, 2007; Lansford, 2009). These interdependent outcomes can be psychological, social, and even physiological in nature (e.g., Kiecolt-Glaser & Newton, 2001; Wood et al., 2007). This justifies a strong rationale to study these relationships and their underlying day-to-day processes, patterns, feedback loops, and systemic associations (Bertalanffy, 1950). Furthermore an understanding of relationship processes helps efforts to prevent and reduce the emotional and social challenges such as those faced when there is conflict within these relationships (Kiecolt-Glaser & Newton, 2001; Kiecolt-Glaser et al., 2005) or when relationships end (Amato, 2000; Amato & Hohmann-Marriott, 2007; Jalovaara, 2003).

Emotions play a powerful role in the multiple domains of romantic relationships. For example, one partner's emotional support has shown to predict the other partner's reports of higher relationship satisfaction (Cramer, 2004). With research showing how chronic exposure to certain intimate interactions may predict poor physiological health for family members (e.g., Kiecolt-Glaser et al., 2005), there is a need to address emotional and physiological challenges such as those faced when a romantic couple's interactions are routinely low in warmth, low in social support, and high in hostility (Conger et al., 1990; Pasch, Bradbury, & Davila, 1997). Furthermore, across multiple cultures, a unique measure known as *affect* has emerged from the literature (Watson, Clark, & Tellegen, 1988). Affect is defined as the general mood or feelings felt or expressed by an individual (Davidson, 2000). There can be many dimensions of affect (e.g., Johnson, 2002), but the measuring of affect for this particular research focuses on the valence based perspective of negativity versus positivity (Gottman & Levenson, 1985). Specifically, this study explores self-reported continuous affect measures that are rated on a 9-point scale. The top 4 points are considered in the positive rating domain, the bottom 4 points are considered in the negative rating domain, and the lone middle point in the scale is considered a neutral rating. In essence *affect* is measured by assessing from a range how positive ("good") or negative ("bad") someone feels emotionally (Gottman & Levenson, 1985). Understanding the associations of affect to many aspects of romantic relationship interactions can provide an even greater understanding of relationship processes and relationship outcomes (e.g., Gottman, 1993; 1998). For instance, affect ratings have been used as tools to identify satisfied from unsatisfied romantic couples (Griffin, 1993; Johnson et al., 2005), and it has been shown to predict the varying probabilities of divorce (Gottman & Levenson, 2000).

The current study was designed to further explore how negative and positive affect experienced by romantic partners during interactions are linked via multiple interdependent associations to later emotions and partner physiological responses, specifically responses in mean heart-rate variability. The literature suggests that individuals often have a physiological reaction to their affective states (i.e., how positive or negative they feel)(Gross & John, 2003). When romantic partners regularly find themselves in elevated physiological states, they are more likely to incur a large list of health problems later in life such as heart disease or even premature death (Kiecolt-Glaser, McGuire, Robles, & Glaser, 2002). The current study was an exploration of how some of these associations between affect and physiology vary when nested within couple systems that vary in their reports of relationship satisfaction, emotion regulation, and partner reports of global stress. If there are means to improve romantic relationships and skills for managing partners' emotions and stress, perhaps clinicians and educators can work to reduce some of these associations that may lead to poorer health outcomes (Kiecolt-Glaser et al., 2002).

Marriage and Outcomes

A large amount of research has explored how day-to-day interactions within a marriage may lead to future challenges such as divorce. The social and emotional implications of marital processes, including inter-partner discussions (i.e., visits between husbands and wives where they communication with each other), have been researched for decades, and they often include reported links between these processes and various outcomes including divorce, levels of marital satisfaction, and many other systemic processes that are tied to the interactions between partners (e.g., Gottman, Coan, Carrere, & Swanson, 1998). It is no mystery that marital interactions can contribute to global reports of relational outcomes such as satisfaction and stability (Gottman et al., 1998). However, it is also important for researchers, clinicians, and educators to understand how contextual and global factors can then feedback onto these interactions (Bertalanffy, 1950; 1972). Day-to-day interactions between romantic partners often color cognitive and emotional lens through which they ultimately see one another, and then partners wear those same "lenses" when getting into future interactions (Hawkins, Carrere, & Gottman, 2002). The research suggests that this feedback occurs when global levels (or "lenses") of satisfaction or stress reflect unique perceptual lenses for each partner through which the romantic relationship (including day-to-day interactions) is observed (Hawkins et al., 2002). This may happen when a partner's perceived level of marital distress may have such a powerful impact on a couple's relationship satisfaction that the level of communication skills used in one couple's interaction may become irrelevant (Burleson & Denton, 1997). The levels of distress may be so high that communication skills will not resolve problems between partners, indicating the powerful role that affect plays in romantic partner's interactions (e.g., Johnson et al., 2005). These partner's perceptions may be a key tool in paving the pathway to divorce, as suggested by Gottman (1993) in his proposed model of a cascade toward marital dissolution.

Partner affect shaping perceptions. The shaping of each partner's lens within a current interaction is quite often a product of multiple past interactions that have occurred between partners (Hawkins et al., 2002), and the levels of affect negativity or positivity felt during these interactions appear to be quite salient in shaping these perceptions regarding the romantic relationship (Gottman, 1993). For instance, according to a theory of balance between negativity and positivity proposed by Gottman and Levenson (2000), the prediction of marital outcomes such as divorce can be highly dependent upon the levels of positive and/or negative emotion felt during a couple's interpersonal interactions. In their research, evidence was found indicating that as negative affect increased during conflicts the probability of these partners having divorces increased 7 years into the marriage (Gottman & Levenson). Also, as positive affect decreased during partner interactions the probability for these partners having divorces increased 14 years into the marriage (Gottman & Levenson, 2000). Further research confirms the powerful influence of emotions during interactions, by showing how observed positive affect during couple interactions may serve as a softening agent that compensates for deficits in partners' communication and problem solving skills (Johnson et al., 2005). These findings suggest that simple observation of interactions without accounting for underlying emotions may not be sufficient in predicting a couple's marital outcomes (Griffin, 1993).

During interactions there may be instances were couples become emotionally "stuck" in a process where they are unable to leave a negative state as quickly as other couples, and again this is quite often dependent on contextual factors such as how satisfied partners feel about the relationship (Griffin, 1993). Research conducted by Griffin (1993) took a closer look at each partner's reports of the continuous moment-to-moment flow between negative and positive internal affect states. His findings indicated that partners in some relationships may have difficulty leaving negative states during interactive processes. This difficulty was found to be dependent on a number of global covariates including reports of marital satisfaction, differences based on gender, and varying education levels. Regarding marital satisfaction, when wives reported higher satisfaction, they left negativity much quicker than wives who reported lower levels of relationship satisfaction. Husbands, on the other hand were more sensitive to the time spent in negativity and this sensitivity appeared to increase as the husband's education level increased. This may indicate that there are differences based on gender in how partners process negative and positive emotional states during couple interactions. For instance, Laurenceau and Bolger (2005) posited that there may be some type of asynchronous way that partners process their emotions.

Marriage and health. In general, married individuals are found to be healthier physically than those who have identified themselves as widowed, divorced, separated, never-married, or cohabiting (Schoenborn, 2004; Wood, Goesling, & Avellar, 2007). For instance, CDC reports suggest that married folks experience less physical limitations, lower back pain, and headaches than their unmarried counter-parts (Schoenborn, 2004). However one must look deeper than the mere absence or presence of marriage when exploring how relationship status impacts each partner's health. There is an ongoing discussion about how this link is broken down into specific causal models based on various health outcomes (psychological vs. physical) and contextual factors such as race and/or ethnicity (for a review see Koball et al., 2010), or prior health conditions and individual age (Umberson, Williams, Powers, Liu, & Needham, 2006). Other researchers have found evidence that marital quality significantly predicts health trajectories in the general population. More specifically, findings have shown that marital strain accelerates already existing declines in the physical health of partners (Umberson et al., 2006).

Burman and Margolin (1992) developed a model outlining the various ways that aspects of a relationship may be linked to physical health outcomes. Important to their model are the various categories in which they organized the relational factors, beginning first with identifying the possible link between marital status and physical health outcomes, then secondly looking for links between marital quality and physical health, and finally testing for a link between marital interactions and physical health (Burman & Margolin, 1992). They continued by identifying how physical health conditions could, in turn, also have an impact on marital factors, citing evidence for bidirectional (interdependent) influences between marriage and physical health.

Burman and Margolin's (1992) model identified various mediating factors that explain the relationship between marital factors and health status such as stress, social support, emotions, and health-related behaviors, and the model suggests that marital factors are at least partially predictive of many of these other factors that lead to health outcomes. Kiecolt-Glaser and colleagues have developed a similar model that focused primarily on behaviors, emotions, and pathways within the body that mediated the link between marriage and health (Kiecolt-Glaser & Newton, 2001; Robles & Kiecolt-Glaser, 2003).

However, until recently, only small amounts of research have identified the microdimensional patterns and processes of affect during couple interactions (e.g., Griffin, 1993; Gardner & Wampler, 2008). Even fewer studies have observed how these interactions occur both within and between relationship partners while explaining some of the global links between marital satisfaction and the partners' physiological processes. Additionally, with new statistical tests, it becomes possible to test associations between microdimensional factors in a model that nests them within persons (Bryk & Raudenbush, 1992) as well as to assess how these factors are related within various interdependent contexts (Kenny, Kashy, Cook, 2006). The current research project was an explorations of these various listed processes.

The Rationale for the Current Research

Larson and Almeida (1999) expressed the need to use intense longitudinal data to explore the processes of emotions moving through the various parts of the family system. In fact, they have suggested the need to explore various temporal patterns on intra-individual as well as inter-individual levels (Almeida, McDonald, Havens, Schervish, 2001). An intra-individual variation is defined as "short-term reversible changes from occasion to occasion in a given phenomenon, such as fluctuating moods or emotions" (Almeida et al., 2001., p. 135). Inter-individual variations refer to the variations in certain measures such as affect that are associated in some way with another individual's variations in those measures (e.g., Diamond & Hicks, 2005).

The current study was an expansion on the idea of identifying associations and temporal patterns as it was designed to further explore micro-level processes and feedback loops by measuring how both intra- and inter-individual moment-to-moment measures of experienced negative and positive affect during interactions are linked to each other over short occasions of time. It was also an exploration of how each partner's moment-to-moment measures of physiology (specifically heart-rate variability) are associated over time. Furthermore, this was a closer investigation as to how the associations between these emotional and physiological measures are different based on variations in certain contextual factors including partner reports of marital satisfaction and global stress. The foci of this research fall into social, emotional, and physiological domains of health for romantic couples within the context of interactions between partners. Specifically, this research was an exploration of the links between a number of mean affect ratings and mean heart-rate variability measures taken both between and within each romantic partner over time. As proposed in systems theory, the social, emotional and physiological domains of marital interactions are interdependent and quite often nested within higher order suprasystems (White & Klein, 2008). Jackson (1965) suggested that in order to gain a clearer understanding of family systems as a whole, that there was a need to explore the transactions that occur between individuals. The current research was an exploratory look at transactions between various affective and physiological domains, how these transactions are nested within various global moderators, and a description of the various feedback loops that characterize them.

CHAPTER II

REVIEW OF LITERATURE

Overview of General Systems Perspective

According to General Systems Perspective (Bertalanffy, 1972) an open system's (e.g., families & couples) present state is a product of various components that are interdependently linked to one another via negentropic processes regulated through positive and negative feedback loops (White & Klein, 2008). These feedback loops are an illustration of the circular nature that describes how self-regulating interactions take place within a family system (Jackson, 1965). A positive feedback loop is often called a deviation amplifying feedback loop which means there are increases in the deviation from a system's original stable state. On the other hand, a negative feedback loop, which is also known as a deviation dampening feedback loop, is characterized by processes that decrease the deviation from a system's steady state.

Many of these feedback loops are established and perpetuated as communication patterns within couples, and these communication processes contribute to the establishment of what may be considered stable and organized patterns between partners (Becvar & Becvar, 2008). For example, a couple in the middle of a conflict conversation may get into a heated discussion that increases in intensity. These increases of intensity back and forth between partners are examples of deviation amplifying (positive) feedback loops (Schultz, 1984). When the couple works to calm down or recover from the emotionally intense interaction, these processes are considered parts of the deviation dampening or negative feedback loop (White & Klein, 2008).

Family systems also tend to emerge toward steady states of balance regarding social, emotional, and physiological inputs (White & Klein, 2008). This tendency toward stability is called homeostasis (White & Klein, 2008), and the mechanisms within the system that facilitate adaptations are parts of a process called morphostasis (Speer, 1970). Similar to a thermostat calibrated to maintain a certain temperature (e.g., Jackson, 1984), Bertalanffy (1950) suggests that families establish their own consistent levels of emotional, social, and physiological “temperatures” through their day-to-day interactions and through the establishment of higher order (Bertalanffy, 1950) patterns and rules of interaction (White & Klein, 2008).

Interactions and Physiology. When two partners find themselves in intense and hostile interactions regularly, they may be calibrating their communication intensity via positive feedback loops to unhealthy morphostatic levels within many subsystems including the physiological (Kiecolt-Glaser et al., 1997; Kiecolt-Glaser et al., 2005), social, and emotional systems (Gottman & Levenson, 1992). For instance, if a family is characterized by high levels of hostility between partners in a marital subsystem, those high levels of hostility can then feedback onto a partner's physiological system by increasing his or her blood pressure (Ewart, Taylor, Kraemer, & Agras, 1991).

If feedback loops continue to be part of the family system, there are pathological consequences for members of the system on various social, emotional, and physiological levels. These consequences are particularly salient to the romantic relationship (Kiecolt-Glaser et al., 2005). If couple interactions that are typically elevated and hostile become a normal part of a couple's day-to-day routine this can lead to decreases in physiological health (e.g., Ewart et al., 1991; Kiecolt-Glaser et al., 2005) and relational health (e.g., Gottman, Coan, Carrere, & Swanson, 1998). For instance, Repetti, Taylor and Seeman (2002) have explored how long term exposure to conflict and aggression within families often contributes to disruptions in a partner's immune response system over time.

According to systems perspective, all systems have hierarchical levels that are used to conceptualize rules, boundaries, and patterns of interaction (White & Klein, 2008). For instance, a couple in which both partners are capable of experiencing a higher order level of thinking are able to see the long-view with regards to consequences from their interactions on a day-to-day level (Bertalanffy, 1950). The ability to observe and process daily conflicts while using higher order thinking, allows a partner to stand back and apply previously discussed boundaries and rules. It also allows a partner to recognize when patterns of interaction may be unhealthy for a family relationship. This type of thinking on a higher level is extremely difficult and improbable when individuals are regularly experiencing emotional flooding or high levels of negative affect (Skowron, Holmes, & Sabatelli, 2003; Gottman, 1993).

When couples are consistently in elevated and hostile patterns of conflict from day-to-day, in theory they may get “stuck” in a lower order level of pattern formation (Griffin, 1993). If they develop these patterns without using higher order thinking, they often unknowingly decrease the health of their relationships through patterns of negative interaction (Griffin, 1993) and reciprocity (Gottman, 1998). An exploration of each partner’s capacity to recover from emotional arousal would therefore have implications for how partners are able to stand back, recognize, and correct unhealthy patterns before further long-term consequences emerge (Johnson et al., 2005).

The systemic perspective also includes recognizing the intensity of each partner’s interdependent associations of social, emotional and psychological processes (Bertalanffy, 1972). For example, the level of positive affect one romantic partner feels and expresses may be highly dependent on the levels of positive affect felt and expressed by the other partner (Levenson & Gottman, 1983). There is also evidence of an interdependent relationship between the affect an individual feels and the levels of physiological response an individual experiences (Gross & John, 2003). For example, when examining undergraduate students who were asked to suppress their feelings after watching a “disgust-eliciting” (p. 970) film clip, Gross and John (2003) found that those who suppressed their behavioral reactions had more physiological reactions to the film. Furthermore, these physiological responses coupled with emotionality tend to feedback on to each partner’s social interactions as they impact an individual’s capacity for interpersonal competence (Gross & John, 2003).

When studying the transformative processes that are part of a couple’s relationship development, one must recognize the circular processes of mutual influence between partners (Fincham, Stanley, & Beach, 2007). When couples are in conflict, decreases in a partner's interpersonal competence could increase the opportunity for a partner to reciprocate negativity, thus multiple positive feedback loops contribute to further experiences and expressions of negative affect between partners (Gottman, 1980). During most of these interactions an individual's level of emotional arousal is quite often highly dependent on his or her partner's (Gottman, 1980; Griffin, 1993). There are also physiological correlates to these types of interactions, (Ewart et al., 1991) and the systemic links between interactions and physiology may vary depending on the system's (or couple's) context.

The current study was an exploration of how these various affective and physiological components may be linked via feedback loops, and how there may be changes in these associations depending on various global indicators such as relationship satisfaction, reports of global stress, and measures of emotion regulation. Kenny, Kashy, and Cook (2006) developed a unique way of capturing the interdependence between partners in their Actor-Partner Interdependence Model (APIM). The APIM acknowledges the idea that within dyadic relationships and interactions, partners often share mutual cognitive, emotional, and behavioral influences (Kenny et al., 2006), and that these influences are particularly strong with partners in romantic relationships. As systems theory posits that parts of a system are interdependent, the APIM is ideal in taking into account the levels of this interdependence while also measuring within and between-partner associations over time (Kenny et al., 2006). Kenny et al. describe two types of effects: actor (also known as intra-individual effects or stability effects) and partner effects (also known as inter-individual effects) (Kenny et al.). For example, the effect of a husband's anxiety on his relationship satisfaction would be considered an *actor effect.* The impact that his anxiety levels have on his wife's relationship satisfaction is considered a *partner effect* (Kenny et al., 2006). Thus this model account for the interdependence of dyadic systems by accounting for these partner effects while also consider actor effects.

The Interdependence of Family Systems

As some family systems develop over the years a transition emerges from a marriage relationship into the various processes of parenthood (McGoldrick & Carter, 2003). With these processes, many patterns of interaction develop with the formation of new parent-child and sibling relational subsystems (White & Klein, 2008). Quite often the patterns of interaction between romantic partners will then spill over onto how these parents interact with their children (e.g., Simons, Whitbeck, Melby, & Wu, 1994), and these interactions with the children will also feedback and spill over onto the interactions between parents (Cox & Paley, 1997). In essence, the subsystems within the household's primary systems are interdependently linked (White & Klein, 2008). This cycle continues as many of the interaction patterns developed as children are carried into children's later adult romantic relationships (e.g., Kim, Pears, Capaldi, & Owen, 2009; Willoughby, Carroll, Vitas, & Hill, 2012; Wolfinger, 2011).

There remains the challenge picking the most appropriate means of testing these interdependent associations within family processes. In an exploration of romantic development, Theiss and Nagy (2010) used the APIM to test how coupled factors were associated with negative sexual outcomes. Their research showed significant partner effects as one partner's sexual satisfaction was negatively linked to the other partner's perceived doubts about the couple's relationship and the perception of partner interference during day-to-day processes (Theiss & Nagy, 2010). Also, negative thoughts and emotions felt by one partner were positively related to the other partner's relational uncertainty and perception of partner interference (the degree to which one felt his or her partner was undermining his her or her personal actions). This study highlights how the APIM can be used to explore how a partner's perceptions predict his or her own outcomes, as well as the outcomes of his or her partner. The APIM is also helpful in identifying how there are differences in actor and partner effects based on gender (e.g., Peterson & Smith, 2010) while controlling for the interdepent relationships tied to coupled data. Using the APIM, Peterson and Smith (2010) found evidence that female partners process criticism from male partners in a different way than male partners.

Exploring Relationship Research

Global factors. When describing research that addresses the many factors that associate with marriage and its many outcomes and predictors, the range of methods used can be divided into two distinct levels. One level of research takes a look at global-level factors or variables, such as overall reports of marital adjustment (Locke & Wallace, 1959), and quite often they are captured using surveys that may be conducted with large populations over long periods of time (e.g., Shapiro, Gottman & Carrere, 2000).

Historically, there have been many surveys used to assess more global measures of dyadic adjustment for romantic couples, and these instruments usually capture the partners' current perceptions of the state of their relationship, and how satisfied they are within these relationships. These measures include the Marital Adjustment Test (Locke & Wallace, 1959), the Dyadic Adjustment Scale (Spanier, 1976), and the Revised Dyadic

Adjustment Scale (Busby, Christensen, Crane, & Larson, 1995). Many scholars have tested and compared the validity and reliability of these global measures, as they have tested how relationship outcomes are linked to couple distress levels (e.g., Crane, Allgood, Larson, & Griffin, 1990; Graham, Liu, & Jeziorski, 2006). Crane and colleagues (1990) developed methods to create equivalent measures of marital and relationship adjustment across various indices. Also, Graham et al. (2006) conducted a systemic literature review assessing the reliability of the dyadic adjustment scale across 91 published studies. Other studies have examined global predictors longitudinally using various survey data. Waite and Das (2010) conducted a longitudinal exploration on the many predictors (including romantic relational factors) of physiological health outcomes for men and women aged 75-85 years (N = 3005). The findings support the proposition that healthy relationships foster emotional health later in life (Waite & Das, 2010).

Child outcomes. To enhance the validity of measures, global research on marital dynamics has also gone beyond self-report surveys and taken into account the children's perception of their parents' marriages (Grych, Seid, & Fincham, 1992). Children certainly play a powerful role in reporting on the levels of their parents' marital adjustment. This holds particularly true when it comes to observing the impact of parents' marital adjustment on the children's own developmental outcomes (Grych et al., 1992).

There are numerous angles that can be taken when observing how parents' marital processes impact their children. Survey research has shown that the children of divorce, particularly those involving high conflict between partners, usually have on average poorer emotional adjustment as well as poorer physical health outcomes (Fabricius &

Luecken, 2007). However, divorce is only one process among parents and their relationship processes. For instance, Jekielek (1998) conducted research using the National Longitudinal Survey of Youth, and found that, on average, children who remain in high-conflict homes reported lower levels of well-being when compared to children whose high-conflict parents had divorced or separated. This certainly supports the idea that many of the processes leading to divorces may be crucial to predicting a number of other negative child outcomes. Perhaps a closer exploration of how these conflicts between spouses impact their own emotional and physiological processes can shed light on how their interactions could potentially spill over onto the children.

Further research using global measures has explored how communication is predictive of later relationship outcomes. Markman, Rhoades, Stanley, Ragan, and Whitton (2010) provide an example of using global measures of relationship communication as predictors of later marital adjustment. This study is unique in that it used both observed indicators of communication type as well as self-report, but the observed variables failed to significantly predict divorce (Markman et al., 2010). However, they did find that self-report measures (survey measures reporting their overall communication experiences outside of the laboratory) of negative communication between partners were significantly associated with relationship instability, indicating that as negative communication increased, so did the probability of divorce in the future (Markman et al., 2010). Another type of research involves the observation of intense micro-level data such as self-reported continuous affect measures (Gardner & Wampler, 2008). These type of measures are taken when each partner rates in real time how positive or negative he or she was feeling during a brief conversation with his or her partner (Gardner & Wampler, 2008). Quite often these global and micro-level forms of research provide unique and important information regarding the marital processes. However, there remains a paucity of information that may be filled when combining micro-level and global level data, and this can be accomplished by nesting micro-level data within various global contexts (DiPrete & Forristal, 1994).

Microdimensional factors. To gain more insight into the processes that lead to a variety of outcomes for romantic relationships, researchers over the past few decades have taken a closer look seeking to explore what predicts marital satisfaction and stability. Marital and relationship researchers began to look at processes that took place between partners while they were interacting, and quite often the data consisted of smaller measures such as brief facial expressions and observed ratings and coding of each partner's affect (e.g., Gottman, 1980). The systematic coding of interactions between partners was pioneered by Weiss and colleagues in the late 1970s as they explored the idea of teaching partners interpersonal skills to use during conflict conversations (Weiss & Aved, 1978; Weiss, Hops, & Patterson, 1973). With these pioneering studies emerged the advent of various measures, such as the Marital Interaction Coding System (Hops, Mills, Patterson, & Weiss, 1972), that was designed to record and objectively code both verbal and nonverbal behaviors between couples. Although, there were specific explanations made describing how marital processes lead to various relationship outcomes, there was still a need to explore further how the interactions between romantic partners would associate with later relationship outcomes such as marital stability or dyadic adjustment (Gottman, 1980).

Beginning in the 1980s, other research linking marital interactions to various outcomes such as marital satisfaction and divorce was conducted (e.g., Gottman, 1980; Levenson & Gottman, 1983). Much of this continued research included the microanalyses of various factors included within couple interactions such as affect (Levenson & Gottman, 1985), verbal cues, and nonverbal cues (Gottman, 1993; Gottman, Coan, Carrere, & Swanson, 1998). Other research such as that conducted by Revenstorf and colleagues (1980) explored how contingency patterns (i.e., how reactive one partner was to the other partner's negativity, and vice versa) of negativity or positivity differed based on whether or not couples were considered distressed. Also there have emerged studies identifying how physiological variables (Levenson & Gottman, 1985) or even how the synchrony of physiological patterns between partners (Thomsen & Gilbert, 1998) may indicate different levels of couple relationship adjustment.

Using the Marital Interaction Coding System (MICS; Hops et al., 1972) the Rapid Couples Interaction Scoring System (RCISS; Krokoff, Gottman, & Hass, 1989), and the Specific Affect Coding System (SPAFF), Gottman and Krokoff (1989) found that higher levels of partner defensiveness, stubbornness, or withdrawing from the conversation during a couple's interaction were found to significantly associate with reports of lower marital adjustments on the Marital Adjustment Test (Locke & Wallace, 1959). Further explorations of marital processes began to take into account how factors such as personality may impact marital outcomes. Karney and Bradbury (1997) took various individual and couple measures including an assessment of neuroticism and a recording of each couple's dyadic interaction tasks to explore how marital processes may be predictive of the downward trajectory in marital satisfaction. When male and female partners reported higher levels of neuroticism husbands' initial marital adjustment decreased, but this association disappeared over the space of four years. However, spouses' behaviors during the couple interaction were highly predictive of declines in marital adjustment over this same time period. This indicates that personality may play a role in relationship satisfaction. However, each partner's behavior during interactions tends to play a more powerful role in predicting the probability of relationship satisfaction.

Another goal of researchers who observe couple interactions has been to identify if certain types of interactions lead to relationship instability (divorce). As was reported previously, Markman and colleagues (2010) found that observed interactions were not predictive of divorce in their sample of married couples. However, Gottman and colleagues had found a link between the observational coding of couple interactions and the likelihood of divorce (Gottman, 1993; Gottman & Levenson, 1992). The general idea behind Gottman's proposed model was that there were specific partner behaviors that when found frequently within a couple's interactions would eventually lead to various problems including emotional and cognitive processes that were highly predictive of divorce (Gottman, 1993; Gottman et al., 1998; Gottman & Levenson, 1992). However, in a similar study using a different sample, Kim, Capaldi, and Crosby (2007) failed to replicate Gottman's earlier findings and models (Gottman et al., 1998). It has been suggested that this failure to replicate could be a product of multiple research artifacts including different sampling techniques and different types of conflict tasks (Heyman & Hunt, 2007). Although there are many complexities, there are still many answers that may be provided by the exploration of micro-dimensional data such as the observations of couple interactions and their underlying affective processes (e.g., Griffin, 1993, 2003).

For instance, Gottman and Levenson (1985) developed, tested, and validated a self-reported continuous affect measure (rating how positive or negative each person felt) that included partners independently watching video recordings of their own interaction and by moving a dial, each partner provided a continuous rating his or her affect felt during the couple interaction. By assessing the interactions of 30 married couples, the authors found a relationship between these self-reported continuous affect measures and reports of marital satisfaction, with more negative affect ratings associating with decreases in marital satisfaction (Gottman & Levenson, 1985). This shows how the positivity and negativity of affect felt during couple interactions may reflect each partner's global perception of the relationship. They also found that these measures were consistent with the observers' coding of the couples' affect, indicating that these measures were reliable when compared to similar measures of affect (Gottman & Levenson, 1985). This measure was also used elsewhere to explore and identify affect patterns that may be associated with global measures such as relationship satisfaction or communication styles (Griffin, 1993). Griffin further used these types of measures to search for Markovian patterns that distinguish distressed from nondistressed marital relationships (Griffin, 2002).

Gottman and colleagues (e.g., Gottman & Levenson, 1992) have suggested that there are certain couple interactional indicators that serve to predict divorce and low relationship satisfaction with some couples, but these researchers have also recognized that there is a justifiable argument that low marital satisfaction may predict more unhealthy couple interactions. Quite often if a partner is unsatisfied with his or her relationship, this person will begin to see their person in a more negative light (Hawkins et al., 2002). Furthermore as couple stress increases, their interactions will continue in patterns of negative reciprocity (Revenstorf et al., 1980). Hence the relationships between microdimensional and global relationship factors are often circular in their systemic nature. More recently, studies have used microdimensional types of data in conjunction with State Space Grids (SSGs; Lewis, Lamey, & Douglas, 1999) to identify patterns of affect and then to test if these patterns were associated with other global outcomes such as relationship satisfaction (Gardner & Wampler, 2008).

Marriage and Physical Health

Various interactional processes within couple relationships lead to a number of positive and negative social, psychological, and physiological outcomes for partners and their children. A number of studies by Glaser and colleagues have produced a strong research line providing links between family interactions and physical health outcomes (e.g., Glaser et al., 1999). Also, in the past decade, others have explored how the links between the family relationships and physical health go well beyond structure to include processes within various family contexts (For a review see Carr & Springer, 2010) with some research identifying multiple domains of physiological outcomes (Wood et al., 2007) observed within the marital context such as health behaviors, mental health, and physical health. Another study where Hicks and Diamond (2011) observed how day-to-day interactions between partners impacted partner’s health found that if couples went to bed after a conflict considered heightened, there was evidence that female partners’ had elevated cortisol levels the next morning.

Gender is another factor to consider when observing how interactions impact the physical health of family members. For instance, Ewart and colleagues (1991) observed how 24 women and 19 men diagnosed with hypertension responded physiologically to a conversation with their partners about a shared disagreement. During these negative conversations hostile interactions and lower marital satisfaction were associated with increases (relative to baseline measures) in the female partner's blood pressure. However, there were no significant associations found for the male partners in this study, indicating a potential difference in how partners process emotions based on gender.

However, the relationship between family processes and biology is not a unidirectional phenomenon. There are numerous strengths to studying the various bidirectional, or circular (Jackson, 1965) associations that exist between family interactions and biological processes (e.g., Cacioppo, Berntson, Sheridan, & McClintock, 2000). A large body of the research showing how social, biological, and contextual factors operate as transactional components of system in relation to increases of risks for problematic behaviors for individuals during their adolescent years and beyond has been documented (Calkins, 2010; Dodge & McCourt, 2010; Graber, Nichols, & Brooks-Gunn, 2010; Jackson-Newsom & Shelton, 2010; Romer, 2010; Steinberg, 2010).

Other research has shown that various physiological factors can serve as at least partial indicators of relationship outcomes. For instance, recent research has indicated that the activated regions of certain parts of the brain are associated with various levels of attachment between long-term married partners (Acevedo, Aron, Fisher, & Brown, 2012).

Cardiovascular reactivity indicators such as heart-rate and blood pressure may be physiological phenomena that may be associated with measures of marital interaction (Ewart, Taylor, Kraemer, & Agras, 1984; 1991). For instance, observational research has indicated that when human emotions are suppressed, communication is disrupted, and indices of physiological arousal such as blood pressure reactivity increase (Butler et al., 2003). These types of associations regarding emotional suppression and physical reaction occur both within family relationships as well as outside of relationships (Butler et al., 2003).

Other physiological indicators of varying partner functioning during couple interactions include immune system reactivity (Kiecolt-Glaser, Glaser, Cacioppo, & Malarkey, 1998) and hormonal secretion and functionality (For a more complete review see Robles & Kiecolt-Glaser, 2003). Other research has shown that certain persistent relational patterns of interaction may be predictive of various long-term health outcomes such as high blood pressure (Ewart et al., 1991), increased mortality risk (Kimmel et al., 2000), and various types of heart conditions (Coyne et al., 2001; Orth-Gomér et al., 2000). With heart disease being the leading cause of death in the United States (Heron et al., 2008) and with the costs of this disease reaching over $300 billion annually (Centers for Disease Control & Prevention, 2010), there is a need in the relationship sciences field to continue the line of research identifying and testing models that explore how sociological and family relational factors may contribute to the onset, enhancement, and attenuation of various sicknesses including heart-related illnesses. There are also means in which a person's biological functioning impacts his or her social competence. One of the more powerful mechanisms researched is emotion regulation via one's vagal tone.

Emotion Regulation and Romantic Relationships

Emotions. A person's level of affect positivity or negativity is a powerful part of his or her interactive (Gardner & Wampler, 2008) and cognitive (e.g., Murray, Sujan, Hirt, & Sujan, 1990) processes. For instance, research has suggested that when people report higher levels of anger, they are less able to process certain tasks that require more cognition (Murray et al., 1990). Regardless of the topic, those who tend to be "angry" in one domain of their life, such as angry driving, are often found to experience anger in other domains (Deffenbacher, Deffenbacher, Lynch, & Richards, 2003). Also, emotional flexibility is crucial in helping those who experience anger recover and move to another state of affect (Rozanski & Kubzansky, 2005). This is vital for an individual, because if one is likely to stay in a negative state over long periods of time, there is a greater risk for illnesses such as coronary artery disease (Rozanski & Kubzansky, 2005).

When measuring links between interpersonal functioning and affect negativity, there is a need to also consider the salience of the physiological indicators of individual emotion regulation. One physiological indicator of emotion regulation is a person's vagal tone (Diamond, Hicks, & Otter-Henderson, 2011). A measure of autonomic response, one's vagal tone is the level of his or her capacity to recover from high emotion stimulation by assessing indices such as changes in heart-rate and respiratory rate (Diamond et al., 2011). The links between an individual's emotions and his or her physiology are often bidirectional (Porges, Doussard-Roosevelt, & Maiti, 1994), and this holds true when looking at how a human individual's autonomic and nervous systems are associated with emotional regulation and expression. For example Diamond et al. (2011) suggest the need to consider one's vagal regulation as it impacts various dimensions of emotional functioning including “perceptions, appraisals, and reactions to emotionally charged experiences” (p. 731). Vagal regulation, also known as respiratory sinus arrhythmia, is a measure of the body’s speed and capacity to recover from various stress responses such as increases in heart-rate. The greater the vagal regulation the quicker and more flexible the body’s capacity is to recover from stress responses. The measure of vagal regulation is also a key underlying component when assessing a person’s capacity to regulate and recover from heightened emotional processes. For example, if a partner has high vagal regulation he or she is more capable of a speedy recovery from emotional arousal (Diamond et al., 2011; Movius & Allen, 2005).

These physical domains of emotion regulation play a powerful role in the interpersonal competence of all individuals (Gross & Levenson, 1993) including those who are partners in romantic relationships (Diamond et al., 2011). Hence, there is a need to explore the bidirectional nature of how a couple’s day-to-day interactions relate to each partner’s physical health. One key indicator of vagal tone (or emotion regulation) comes through the capacity to suppress emotions when in a stressful moment or being able to recover from those emotions once the stressful moment has passed (Movius & Allen, 2005).

The vagus nerve is a cranial nerve that controls many organs in the body including the heart and digestive track (Porges et al., 1994). It plays a key role in the body’s ability to maintain homeostasis including the mediation of heart-rate (Porges et al., 1994). Quite often a person’s vagal tone is described as one’s autonomic flexibility, meaning that the body’s autonomic system is able to adapt to the various day-to-day stressors encountered by an individual (Kok & Fredrickson, 2010). Vagal tone is the measure of the body's ability to suppress the acceleration or stimulation of various organs including the heart when such stimulation is no longer needed (Porges et al., 1994), and one ideal way of measuring the vagal tone is to measure respiratory sinus arrhythmia (RSA). This is indicated by looking at the speeds and rhythmic changes in heartbeat (Porges et al., 1994).

Measures of RSA are used regularly to indicate levels of an individual's vagal tone including those assessed in a study by Eisenberg and colleagues (1996). Illustrating the link to interpersonal competence, Eisenberg and colleagues (1996) reported that a female child's vagal tone (indicated by RSA measures) was found to be negatively related to peer-reports of her prosocial behaviors. This indicates that as female children are more capable of suppressing or recovering from emotional arousal they are likely to have greater social competence. Movius and Allen (2005) provide another example of a study using vagal tone as an indicator of a person's recovery from emotional arousal. In a lab setting, RSA was assessed at three time periods: during a baseline task, a stress-inducing task, and a recovery task. In order to assess the level of the participants RSA recovery capacity, they measured the difference in RSA levels between the recovery task and the stress inducing task. The greater the difference in RSA levels meant the greater the capacity for vagal recovery, and this capacity was found to be tied to participant reports of lower anxiety.

Measures of vagal tone and vagal regulation have been used throughout the developmental literature to identify outcomes such as children behavioral outcomes (Doussard-Roosevelt, McClenny, & Porges, 2001), the positive emotions and social connections of adults (Kok & Fredrickson, 2010), and, as was previously mentioned, the dyadic emotional coping processes for romantic couples (Diamond et al., 2011). Providing evidence that emotion regulation includes elements beyond the psychological and social domains, Doussard-Roosevelt and colleagues (2001) identified that RSA played a role in childhood social competence. While looking at children with low-birth rate, a positive significant correlation was found between RSA maturation during infancy and a child's social competence during preschool (Doussard-Roosevelt et al., 2001).

RSA has also been associated with the social competence during adulthood. Studying 73 adults, Kok and Fredrickson (2010) found longitudinal evidence that RSA has a bidirectional or interdependent relationship with one's levels of positive emotions and social connections. Kok and Frederickson (2010) call this an upward spiral, and it means that if a person is able to regulate emotions more flexibly, he or she is then able to enhance social connections and experience positive emotions. This, in turn, enhances one's future capacity for emotion regulation. Finally, these levels of vagal regulation become salient when looking at how romantic partners interact one with another (Diamond et al., 2011). Also, just as there are physiological predictors of social interaction, there are also physiological outcomes from social interactions and stressors.

Stress Response Cycles

Stress in Relationships. Within families, stressors described by Lazarus (1993) as hardships or adversity have many impacts (especially emotional impacts) on parts of the system, but stressors and the accompanying emotions felt and expressed quite often occur in social contexts between various interdependent members of a system including partners in a romantic relationship (Bodenmann, 2005) and those in parent-child subsystems (Repetti et al., 2002). Families are impacted by stress from both within and outside of their households (Bradbury, Fincham, & Beach, 2000), and it has been shown that stressors can have a large impact on how family members interact with one another (Revenstorf et al., 1980).

Conger et al. (1990) developed and tested the family stress model that identified how the external financial stressors can impact couple interactions as well as interactions between parents and children (Conger et al., 1992). The model tests provided evidence suggesting that as a household's financial stressors increased there were decreases in warmth and increases in hostility between partners (Conger et al., 1990), and they found that this association held particularly true for men. Conger's model was initially tested with white middle-class couples from a rural area in Iowa (1990). This model has also shown to be somewhat valid in assessing the influence of outside stressors on couple interactions, and it was replicated with a sample of African American couples from a variety of socioeconomic and demographic backgrounds (Cutrona, Russell, Abraham, Gardner, Melby, Bryant, & Conger, 2003).

In a replication study, Cutrona and colleagues (2003) used observed couple interactions that showed how stressors such as negative life events and chronic hassles were significantly associated with decreases in warmth between partners during these discussions. When partners' stressors increase, the quality of their interactions decrease, and other research has shown that there are also emotional factors impacted by stress. Roberts and Levenson (2001) explored how job stress and exhaustion impacted 19 couples whose male spouses were police officers in urban areas of California. In this study, evidence was found that high levels of job stress predicted lower levels of self-reported positive affect and higher levels of self-reported negative affect (Roberts &

Levenson, 2001). Additionally the results from their study indicated that high job stress was related to higher levels of physiological reactivity during couple interaction tasks including cardiovascular activation for both husbands and wives in the form of shorter pulse transmission times (Roberts & Levenson, 2001).

Research on autonomic reactivity. Research has shown that a person's exposure to stress activates a variety of physiological responses involving various aspects of the autonomic nervous and endocrine systems (Wallenstein, 2003). The two most salient components from the autonomic nervous system are the sympathetic and parasympathetic systems, and each system acts in response to various stimuli in an effort to keep the body in a steady state commonly known as homeostasis (Wallenstein, 2003). These systems operate in effective and healthy manners when individuals are in the rare situations where a threat is perceived by an individual (Segerstrom & Miller, 2004). The HPA-Axis of the endocrine system works hand in hand with the autonomic nervous system in an effort to promote the adaptation and recovery of an organism to its environment including potential threats or stressors (O'Connor, O'Halloran, & Shanahan, 2000). These neuroendocrine responses to stressors are known collectively as part of a body's allostasis, otherwise known as the body's efforts to maintain stability while experiencing changes (McEwen, 1998; McEwen & Seeman, 1999).

However, when these threats or stressors become chronic many emotional and physiological health problems emerge (e.g., Porges & Furman, 2011; Segerstrom & Miller, 2004). Chronic levels of elevated stress keep one's immune systems either suppressed or hyper-vigilant creating vulnerabilities to various illnesses such as the common cold (Cohen et al., 1998) hypertension, and coronary heart disease (Kiecolt-

Glaser et al., 2003). One of the possible reasons for this vulnerability to health problems comes from the idea that chronic stress over a lifetime leads to greater allostatic loads (McEwen, 1998). In other words, as the human body works to maintain stability, it becomes problematic if the work becomes chronic leading to physiological dysfunctions as the mechanisms designed for acute stress "wear out" under the pressures of chronic stress. It stands to reason that if family members are exposed to chronic stressors within family systems and subsystems, they would also experience varying decreases in physical health (e.g., Broadwell & Light, 2005). On the other hand, if family members are exposed to more positive interactions within their home, they may experience increases to their physical health (e.g., Light, Grewen, & Amico, 2005). In fact, Light and colleagues (2005) explored how something as simple as a hug from a partner can decrease blood pressure levels and heart rate variability in women.

Heart-rate variability. An ideal way of measuring autonomic activation experienced by an individual in real time can be obtained by recording his or her heart-rate (Wallenstein, 2003). Heart-rate variability (HRV) is the measure of the oscillation of intervals between consecutive heart beats (Camm et al., 1996). According to Camm and colleagues (1996) HRV can be assessed using a variety of methods including the use of time domain measures that involve assessing time between R-waves and creating a mean heart-rate measure at specific intervals. R-waves are visual indicators of heart activity that can be used to measure various heart rhythms (MacKenzie, 2005).

HRV measures have also been used in various studies to assess risk for physical problems such as heart failure (Nolan et al., 1998) and myocardial infarctions (Rovere, Bigger, Marcus, Mortara, & Schwartz, 1998). Also important to note is that HRV measures have also been shown to associate with real time measures of negative and positive emotions (McCraty, Atkinson, Tiller, Rein, & Watkins, 1995) as well as global measures of psychological stress (Egizio et al., 2008).

Partners. Romantic partners who are exposed to high amounts of negativity and low amounts of warmth also experience decreases in their overall physical health. Results of a recent study of rheumatoid arthritis patients (Reese, 2010) indicated that partners' reports of higher marital satisfaction are tied to higher physical functionality and lower pain for those suffering from rheumatoid arthritis. In a study by Kiecolt-Glaser et al. (1993) looking at 90 newly-wed couples a link was found between down-regulated immune functionality and couples who had conversations considered relatively high in negativity. In the study, couples were instructed to discuss a conflict, and it was found that blood pressure tended to stay high in partners whose conversations were rated as the highest in negativity. In another study looking at 42 married couples, Kiecolt-Glaser and colleagues (2005) also found that when couples' conversations were relatively high in hostility, the speed of partners' wound healing would decrease. Also, couples who were high in hostility were shown to have higher local levels of pro-inflammatory cytokines when compared to those considered low in hostility during interactions (Kiecolt-Glaser et al., 2005). This is relevant because research has shown that increases of pro-inflammatory cytokines in the blood stream are linked to greater frequencies of age-related diseases (Kiecolt-Glaser et al., 2005). Mapping out a couple's ability to emotionally cope with stressors while simultaneously exploring physiological patterns of heart-rate variability may shed greater light on how to prevent negative health outcomes for partners in romantic relationships.

Micro-level Couple Patterns

With the emergence of new methods in couples' research come substantial breakthroughs in studying various processes that occur within relationships (e.g., Griffin, 2002) including the exploration of the interdependence of affect and physiology. Much has been discovered regarding the affective *content* in couple interactions, but there are gaps in what is known about the *structure* of the affect, and how this micro-level structure may be tied to factors such as marital quality (Gardner & Wampler, 2008) as well as a partner's physiological health (Ewart et al., 1991). More information is needed to explore how emotion felt within romantic partners can form interdependent patterns during a couple's interaction. Observational studies on couple affective processes have yielded substantial contributions to this body of literature (e.g., Revenstorf, 1980; Johnson et al., 2005), but these methods alone may not accurately capture the true nature of the affective states felt by partners. Griffin (2002) has suggested that there is a need to use some of these advances in analyses that may more effectively portray affect sequences in a way that isolates and identifies patterns. Methods that use continuous self-reported affect data have been used to capture more accurate partner affective scores, and these techniques may provide a better picture of these emotional processes than the use of observation alone (Gottman, 1985; Griffin, 1993, 2002. With a clearer picture of affective associations, more can be learned about what predicts each partner's global and relational health over time (e.g., Kiecolt-Glaser & Newton, 2001; Griffin, 2002).

Seldom found in the relationship literature is research that explores how continuously monitored streams of affect may associate with various outcomes for partners. Griffin (2002) has conducted some exploration of this nature using hidden

Markov models to observe how sequences of married couples' self-reported affect data could be predicted by the use of previous sequences. Griffin (2002) found differences in Markovian patterns of self-reported affect based on whether or not couples were distressed. There is a potential to use these intensive real-time sequential analyses of couple affect to test associations with global factors such as relationship adjustment, emotion regulation, and global stress. Furthermore it would expand the field of relationship science to include testing micro-level measures of heart-rate variability in relation to affect measures (e.g., Butler et al., 2003; Diamond, Hicks, & Otter-Henderson, 2006).

By identifying potential associations between heart-rate variability and affect on a microdimensional level, more can be learned about how emotions during interactions impact the health of each partner over time. Specifically, research has shown that when family members are routinely exposed to high levels negativity and low levels of positivity, a partner's health deteriorates, however, there are differences based on gender and context in how these exposures impact partners. The current study was an exploration of romantic couple' systems and of how real time patterns of partner mean heart-rate variability may be associated with real time patterns of partner affect. With a better understanding of how couples are in sync emotionally and physically during partner interactions, there can be more exploration on how to promote healthy interaction processes that promote both relational and physical health for romantic partners. Furthermore this study was an exploration for how these patterns may differ based on global factors including relationship satisfaction and partner reports of stress. By assessing how these links my very by global factors those in the field such as educators or clinicians may be able to more quickly identify romantic couples who are the most at risk for poor health (Kiecolt & Glaser, 2001) and relationship outcomes (Gottman & Krokoff, 1989; Gottman & Levenson, 2000).

The Current Study

The current research was an attempt to explore how romantic partners' affective processes are associated over time on intra-individual and inter-individual levels (i.e., testing associations both within each partner as well as between partners). It was an exploration of how certain lags of heart-rate variability were associated with other lags over time , and, finally, it was an exploration of how affective processes may be associated with heart-rate variability. Based on macro-level analyses, as an individual's capacity for emotion regulation increases one would expect that social competence and the ability to cope with negative emotions would also increase (Diamond et al., 2011; Eisenberg et al., 1996). This would lead to one partner's affect to become less dependent upon the other partner's.

The current study explored some of these unknown dependencies on a more microdimensional level of analysis as partners' self-reported measures of continuous affect are broken down into 3-second and 30-second occasions before being analyzed for dependencies both within and between partners. Using a combination of the APIM and multi-level modeling, the current study explored how partners' patterns of affect are associated when nested within various global measures, including measures of RSA, relationship satisfaction, and reports of overall stress. Furthermore the current study was an attempt to map out how these lags of mean affect may associate with each partner's mean measures of heart-rate variability (indicated by using 30-second occasions of each partner's mean heart-rate variability).

This study was an extension of a simpler study (Hubler, Burr, Larzelere, & Gardner, 2011) that sought to fill previous gaps in couple interactional research by using real-time partner affect data streams as a means of examining the micro structural movement of interactional couple affect through multi-level modeling. The previous study used a separate sample of 23 married couples who were asked to have a conflict discussion (reflecting on a time they felt hurt by their partners) and a positive discussion (reflecting on a time when they felt cared for by their partners). Later on, partners were asked to rate in real time how positive and negative they felt from moment-to-moment during these conversations while watching the videos of their interactions. This technique of gathering a self-reported continuous affect measure was validated by Gottman and Levenson (1985). In the study by Hubler et al., (2011) 3-second occasions of mean affect ratings were created to explore auto-regressive associations between various affect measures. In this study, mean affect ratings for lags of affect were found to be associated over time both between and within romantic partners.

The primary aim of the current study was to expand on the Hubler et al. (2011) study by exploring the structure of couples' patterns of mean self-reported affect in association with the structure of couples' patterns of mean heart-rate variability. A set of nested models were tested using 30-second occasions of affect and mean heart-rate, and another set of models were tested using 3-second occasions of affect. These occasions were created to examine the stability of one's own affect ratings (and measures of mean heart-rate) at the different occasions over time, as well as to assess the influence of those affect ratings (and measures of mean heart-rate) on the other partner's affect rating (and measures of mean heart-rate) over time. Hence the APIM (Kenny et al., 2006) which tests actor effects (also known as intra-individual effects or stability effects) and partner effects (also known inter-individual effects) was used for these series of tests.

To capture a more broad range of affective and physiological movements, data from both positively and negatively themed conversations was used simultaneously for comparison of affect and heart-rate structures. These continuous streams of affect data and heart-rate data were hypothesized to represent feedback loops that eventually stabilize to a level of homeostasis that may vary between couples based on global moderators such as couple level marital satisfaction or global reports of stress. Furthermore an exploration of affective associations being nested within couple level measures of emotion regulation (in this case RSA recovery) was also conducted.

Just as in Hubler et al., (2011) the methods in this study combine using the APIM (Kenny, Kashy, & Cook, 2006), the use of multilevel modeling in assessing associations at the micro level (Walls & Schafer, 2006), and the investigation of the effect of means and differences in marital satisfaction, global stress, and emotion regulation in the same analyses (Kenny et al., 2006). This paper is the second attempt to combine the APIM with intensive dynamic modeling of the stability and change in partner affective states and heart-rate variability over time. This study was an investigation of these stability and change of partners' affect and average heart-rate variability over time within a General Systems Perspective (Bertalanffy, 1950; 1972) framework. According to the systems concept of homeostasis (White & Klein, 2008), it was hypothesized that each partner's mean affect level (as well as mean heart-rate level) in each 30-second occasion would be strongly associated with the immediately preceding 30-second occasion. This is also known as a lag-1 autoregressive (AR[1]) effect. In addition, in this study, analyses were to explore the nature of lag-1 and lag-2 effects in patterns within ongoing mean affect levels and mean heart-rate levels over time, AR (2) effects. Also, a separate set of analyses using only 3-second occasions of mean affect was run to test for lag-1 and lag-2 effects.

In addition to assessing the autoregressive effects in predicting partners' own affect and heart-rate variability over time and following APIM procedures, the multilevel model was also an investigation of the extent to which partners' affect level and heart-rate influenced the trends in partners' affect and heart-rate beyond that predicted by their own ongoing autoregressive trends. Additionally, the study included tests of the effects of three coupled global variables (marital satisfaction, overall stress, and RSA-recovery) on the parameters defining the stability, change, and cross-partner effects in interdependent trends in partners' affect over time. It was expected that a relationship between global variables and partner feedback loops (affect and heart-rate patterns) would be detected.

This study utilized a General Systems Perspective to explore the feedback loops of married couples' continuous self-report affect data and heart-rate variability during two interactions regarding aspects of their relationship (Bertalanffy, 1950; 1972). Research in the past has shown that self-reported continuous affect measures are reliable indicators of a partner's emotional state (Gottman & Levenson, 1985) and that they are predictive of various intra-individual and inter-individual patterns within couples (Griffin, 2002). Participants provided a continuous self-report of their affective state over the course of the interaction in a video recall procedure 30 minutes following the end of the interaction episode. The heart-rate variability measures were obtained using Mindware—HRV 3.0.17 (Westerville, OH) that analyzes the physiological measures of heart-rate that were obtained during the couples' interactions using ECG (Electrocardiography measures) methods.

Research Questions and Hypotheses of Current Study

Based on prior research and theory, there remains a need to explore further how positivity and negativity within couple relationships are interdependent both within partners (intra-individual associations) and between partners (inter-individual associations) over brief increments of time. This type of exploration was an attempt to shed more light on the impact that romantic partners have on one another as they interact. There is also a need to explore whether each partner's mean heart-rate level is associated with his or her own mean heart-rate level over time, and how it is associated with his or her partner's mean heart-rate level over time. Finally, there is a need for an exploration for how affect levels influence one another's heart-rate over time. In consideration of the previously described research, one would expect that there are intra-individual as well and inter-individual associations and the following hypotheses were an effort to test some of these associations. Furthermore, the literature has shown that as romantic couples come from various contexts (e.g., high versus low marital satisfaction or high versus low stressful households) the interactions between partners vary (e.g., Griffin, 1993). Also, the association between affect factors and physiological factors should vary depending on the levels of these various global contexts. Using the data described below, the following hypotheses regarding partner emotions, partner HRV, partner RSA, partner reports of marital satisfaction, and partner reports of stress were tested:

Level-1 Model Hypotheses for 30-second Increments

Hypothesis 1: Each partner's affective states will be relatively stable over the 30-second and 60-second time lags, meaning actor effects should be significant over both of these increments of time in relationship to his or her current affect state.

Hypothesis 2: Each partner's mean heart-rate level will also be relatively stable over 30-second and 60-second increments of time.

Hypothesis 3a: If one partner's affect becomes more positive at 30-second and 60-second lags, the other partner's current affect will be more positive.

Hypothesis 3b: If one partner's mean heart-rate increases at 30-second and 60-second lags, the other partner's current mean heart rate will also increase.

Hypothesis 4: Each partner's 30-second and 60-second measures of affect will be negatively associated with their own current average heart-rate.

Hypothesis 5: (Partner effect on average heart-rate) Each partner's 30-second and 60-second measures of affect will also be negatively associated with the other partner's current average heart-rate.

Nested Model Hypotheses for 30-second Increments

Hypothesis 6: The partner effects will decrease in significance for both affect and average heart-rate for couples reporting higher relationship satisfaction when compared to couples reporting lower relationship satisfaction.

Hypothesis 7: The partner effects will increase in significance for both affect and average heart-rate for couples whose partner's report higher global stress when compared to those with partner who report lower global stress.

Level-1 Model Hypotheses for 3-second Increments

Hypothesis 8: Partner affective states will be relatively stable over the 3-second and 6-second time lags, meaning actor effects should be significant over both of these increments of time in relationship to his or her current affect state.

Hypothesis 9: One partner's affective state will be positively associated with the other's affective state. If one partner's affect becomes more positive at 3-second and 6-second lags, the other partner's affect will be more positive in his or her current affective state.

Nested Model Hypothesis for 3-second Increments

Hypothesis 10: As global levels of each partner's RSA-recovery decrease, partner effects will increase in magnitude and significance. Partner effects at 3-second and 6-second lags will be stronger when nested in couples with lower RSA-recovery levels.

General Hypothesis for All Model Tests

Hypothesis 11: The strengths of all of these associations would relatively decrease as time between occasions increased.

CHAPTER III

METHODOLOGY

Participants

The sample consisted of adult couples in committed romantic relationships who were recruited from Stillwater, Oklahoma and surrounding communities. The population for Stillwater is just under 46,000 (U.S. Census Bureau, 2010), and the town is considered neither rural nor metropolitan. Funding for this study was provided by the Administrators for Children and Families (ACF) to principal investigators Dr. Brandt Gardner and Ms. Kelly Roberts. Selection criteria were that the participants be heterosexual partners in a committed romantic relationship between the ages of 18 and 35 years. Recruiting was specifically targeted towards those in lower income brackets in order to comply with funding agency requirements.

Procedures

Following IRB approval the recruitment and assessment of participants began. The data used in this study was part of a larger federally funded multi-method study proposed to investigate recruitment barriers to couple and relationship education courses that were found in low-income couples. As was previously mentioned the data was collected as part of a larger ACF funded grant awarded to Dr. Brandt Gardner and Ms. Kelly Roberts of Oklahoma State University. The data used in this current research study was taken from the lab/observational portion of the study. The author served as a research assistant for the duration of the lab/observational assessment portion of the study that occurred from August 2007 to April 2009.

Research assistants distributed fliers and other study information and requirements to Medicaid approved clinics, local housing authority offices, Dollar Tree and Dollar General Stores, and local Laundromats. Fliers contained contact phone numbers for interested participants, and when these potential participants called, they were screened regarding study criteria and given information regarding participation details (including time of day, the location, and length each assessment). Appointments were then scheduled based on the availability of participants and research assistants. Participants were given a reminder telephone call the day before they were to attend an assessment.

After arriving to the Human Sciences building at Oklahoma State University, participants were escorted to the Human Development and Family Science department's Observation and Coding Center. After participants provided their informed consent, they were taken to separate rooms where each partner completed a battery of questionnaires including information regarding demographics, attitudes towards couple and relationship education, marital adjustment, and global stress. After the questionnaires were completed each partner was then interviewed and asked to identify and describe a time when he or she felt hurt or offended by his or her partner. They were then instructed to wait to discuss this topic at a designated time. Couples were then asked to engage in two distinct video-recorded conversations. In the conversation of interest (identified as the "negative and positive tasks conversation") for the current study, participants were asked to discuss for seven minutes the previously identified time when they felt hurt or offended by their partner, and then with a knock on the door, participants were asked to discuss, for five minutes, a time when they felt loved or cared for by their partner. In the second conversation, couples were asked to discuss for ten minutes, the pros and cons of relationship education as it applied to their relationship. During both interaction task conversations physiological data were also collected using Bio-Pac (Santa Barbara, CA) instruments designed to collect ECG, respiratory and skin conductance data. Two electrodes were connected to each side of their lower rib cage, a strap was wrapped around each partners upper chest to collect respiratory data, and special sensors were put on two fingers of each participant to collect skin conductance data.

Following both of the interaction task conversations, couples were taken to a room where they were asked to spend the next 30 minutes relaxing (doing whatever they pleased in a relaxation room). Couples were also video-recorded during this 30 minute relaxation session. Immediately following the resting period, the partners were then taken to a room to participate in the video-recall procedure where they separately watched videos of both of their interaction task conversations. Each participant used a continuous response measure instrument (Biocca, David, & West, 1994), to provide moment-to-moment ratings of how positive or negative he or she felt during each moment of their interaction tasks. Following the completion of the video-recall procedure, participants then visited with project personnel to identify if there were any potential relationship problems that needed addressed (i.e., problems potentially caused by the study), and they were debriefed per study protocol. Each couple then received $100 dollars for their voluntary participation in this research.

Measures

Demographics. Participants completed a demographic survey with information regarding each partner's age, gender, race/ethnicity, income, relationship status, and educational status. The majority of participants reported an annual income of less than $15,000 (36.4%), and most participants reported that they had at least some college. Some of the participant data (27 couples from the models of 30-second occasions and 31 couples from the models of 3-second occasions) was unavailable for the various analyses due to equipment malfunction for collecting the HRV, RSA, and/or affect data.

The study sample was taken from an overall sample was 99 couples. From this sample 67 % (N = 66) of participants reported that they were single (dating, cohabitating), and 33% (N = 33) reported that they were married. In terms of education, 5% had less than a high school education, 13.1% were high school graduates, 49.4% had obtained some college, 24.4% were college graduates, and 8.1% had done some postgraduate work or had a graduate degree. Regarding income, 48% reported an income of less than $15,000, 26% reported an income of between $15,000 and $35,000, 15% reported an income between $35,000 and $55,000, 6% reported an income of between

$55,000 and $75,000, and 5% reported an income of over $75,000. Among the participants, 2% were Asian or Pacific Islander, 8% were African American or Black, 4% were Hispanic or Latino, 8% were American Indian or Alaska Native, and 77% were Caucasian. Relationship partner mean age was 23.72 (*SD* = 4.49) years for females and 24.17 (*SD* = 4.15) years for males. The mean length of relationships for these participants was 47.76 months (*SD* = 39.82) or just under 4 years, with over 50 % of couples reporting being together for 3 years or less.

The following tables were designed to identify the demographics of those included and those excluded from the study due to the equipment problems. See Table 1 for more demographic details for those included in the first model tests of current study (*N* = 72), also, for comparison, Table 2 provides the demographic information for those who were not a part of the first model tests (*N* = 27). Chi-square difference tests showed no differences between included and excluded participants in relationship status ($\chi^2_D(1) = .92$, $p = .34$; $\chi^2_D(1) = .67$, $p = .41$, for males and females respectively.), education level ($\chi^2_D(5) = 6.02$, $p = .30$; $\chi^2_D(5) = 4.89$, $p = .43$, for males and females respectively), income ($\chi^2_D(5) = 5.99$, $p = .31$; $\chi^2_D(5) = 4.68$, $p = .46$, for males and females respectively.), and race ($\chi^2_D(4) = 6.99$, $p = .14$; $\chi^2_D(5) = 1.56$, $p = .90$, for males and females respectively.). Also, a test of independent samples was run to examine any potential differences in partner reports of relationship satisfaction, stress, age in years, and average length of their relationship, and this was to identify any potential differences in the two samples. No significant differences were found in these listed areas of comparison (See Table 3)

See Table 4 for demographic details about those included in the second model tests of the current study (N = 68), and see Table 5 for the information on those who were not a part of the second model tests (N = 31). Chi-square difference tests showed no differences between included and excluded participants in relationship status ($\chi^2_D(1) = 1.50$, $p = .22$; $\chi^2_D(1) = 1.15$, $p = .28$, for males and females respectively.), education level ($\chi^2_D(5) = 5.42$, $p = .37$; $\chi^2_D(5) = 4.16$, $p = .53$, for males and females respectively), income ($\chi^2_D(5) = 5.75$, $p = .33$; $\chi^2_D(5) = 2.26$, $p = .81$, for males and females respectively.), and race ($\chi^2_D(4) = 9.29$, $p = .05$; $\chi^2_D(5) = .95$, $p = .97$, for males and females respectively.). Also, a test of independent samples was run to examine any potential differences in partner reports of relationship satisfaction, stress, age in years, and average length of their relationship. No significant differences were found in these areas of comparison (See Table 6).

Table 1

Demographics of First Study Sample (*N* = 72 couples)

Variable	Males	Females
Age	*M*=24.19 (*SD* = 4.00)	*M*=23.86 (*SD* = 4.67)
Married	30.6%	30.6%
Cohabiting	36.1 %	26.4%
Dating	33.3%	41.7%
Education		
Less than high school	2.8%	2.8%
High school graduate	9.7%	5.6%
Some college	51.4%	51.4%
Trade/Technical/vocational training	4.2%	4.2%
College graduate	16.7%	23.5%
Postgraduate work/degree	11.1%	8.8%
Annual Income		
Less than $15,000	37.5%	38.9%
$15,000-$35,000	25.0%	29.2%
$35,000-$55,000	22.2%	9.7%
$55,000-$75,000	6.9%	5.6%
$75,000 +	1.4%	4.2%
Don’t Know	6.9%	11.1%
Race		
Asian or Pacific Islander	1.4%	2.8%
African American	9.7%	4.2%
Hispanic or Latino	6.9%	2.8%
American Indian or Alaska Native	12.5%	6.9%
White or Caucasian	68.1%	77.8%
Middle Eastern or Arab	0.0%	0.0%
Missing	1.4%	4.2%

Note: The above table describes the sample used in the comparison of data with 30-second occasions.

Table 2

Demographics of Excluded Sample—First Study (*N* = 27 couples)

Demographic Item	Males	Females
Age	*M*=24.11 (*SD* = 4.60)	*M*=23.37 (*SD* = 4.05)
Married	40.7%	40.7%
Cohabiting	11.1%	11.1%
Dating	48.1%	48.1%
Education		
Less than high school	7.4%	0.0%
High school graduate	18.5%	3.7%
Some college	37.0%	51.9%
College graduate	39.6%	40.7%
Postgraduate work/degree	7.4%	3.7%
Annual Income		
Less than $15,000	33.3%	29.6%
$15,000-$35,000	25.9%	18.5%
$35,000-$55,000	14.8%	11.1%
$55,000-$75,000	3.7%	7.4%
$75,000 +	11.1%	7.4%
Don’t know	11.1%	25.9%
Race		
Asian or Pacific Islander	3.7%	0.0%
African American	7.4%	7.4%
Hispanic or Latino	0.0%	3.7%
American Indian or Alaska Native	0.0%	7.4%
White or Caucasian	88.9%	81.5%

Note: The above table describes those excluded from the comparison of data with 30-second occasions.

Table 3

Results of 1st Test for Group Differences

Item	*M* (excluded in parentheses)	*SD* (excluded in parentheses)	t-value
Male Marital Satisfaction	49.63 (48.37)	8.64 (5.46)	-0.86
Female Marital Satisfaction	49.97 (48.73)	7.79 (8.17)	-0.67
Male Total Stress	42.32 (43.46)	9.97 (12.46)	0.41
Female Total Stress	42.71 (41.24)	8.76 (10.24)	-0.64
Male Age	24.19 (24.11)	4.00 (4.60)	-0.08
Female Age	23.86 (23.37)	4.67 (4.05)	-0.51
Length of Relationship in Months	44.45 (53.04)	39.01 (42.09)	0.89

$*p < .05$, $**p < 0.01$

Table 4

Demographics of Second Study Sample (*N* = 68 couples)

Variable	Males	Females
Age	*M*=24.28 (*SD* = 4.06)	*M*=23.76 (*SD* = 4.58)
Married	35.3%	44.1%
Cohabiting	35.3 %	25.0%
Dating	29.4%	29.4%
Education		
Less than high school	2.9%	2.9%
High school graduate	8.8%	5.9%
Some college	50.0%	51.5%
Trade/Technical/Vocational training	4.4%	2.9%
College graduate	17.6%	22.1%
Postgraduate work/degree	11.8%	8.8%
Missing	4.4%	5.9%
Annual Income		
Less than $15,000	36.8%	38.2%
$15,000-$35,000	23.5%	27.9%
$35,000-$55,000	23.5%	10.3%
$55,000-$75,000	7.4%	5.9%
$75,000 +	1.5%	4.4%
Don’t know	7.4%	11.8%
Race		
Asian or Pacific Islander	0.0%	1.5%
African American	10.3%	4.4%
Hispanic or Latino	7.4%	2.9%
American Indian or Alaska Native	11.8%	7.4%
White or Caucasian	69.1%	77.9%
Middle Eastern or Arab	0.0%	0.0%
Missing	1.5%	4.4%

Note: The above table describes the sample used in the comparison of data with 3-second occasions.

Table 5

Demographics of Excluded Sample—Second Study (*N* = 31 couples)

Variable	Males	Females
Age	*M*=23.94 (*SD* = 4.40)	*M*=23.65 (*SD* = 4.38)
Married	41.9%	41.9%
Cohabiting	16.1%	16.1%
Dating	41.9%	41.9%
Education		
Less than high school	6.5%	0.0%
High school graduate	19.4%	3.2%
Some college	41.9%	51.6%
Trade/Technical/vocational training	0.0%	3.2%
College graduate	25.8%	38.7%
Postgraduate work/degree	6.5%	3.2%
Annual Income		
Less than $15,000	35.5%	22.3%
$15,000-$35,000	29.0%	22.6%
$35,000-$55,000	12.9%	9.7%
$55,000-$75,000	3.2%	6.5%
$75,000 +	9.7%	6.5%
Don’t know	9.7%	22.6%
Race		
Asian or Pacific Islander	6.5%	3.2%
African American	6.5%	6.5%
Hispanic or Latino	0.0%	3.2%
American Indian or Alaska Native	3.2%	6.5%
White or Caucasian	83.9%	80.6%

Note: The above table describes those excluded from in the comparison of data with 3-second occasions.

Table 6

Results of 2nd Test for Group Differences

Item	*M* (excluded in parentheses)	*SD* (excluded in parentheses)	t-value
Male Marital Satisfaction	49.34 (49.16)	8.72 (5.80)	-0.12
Female Marital Satisfaction	49.97 (48.90)	7.92 (7.83)	-0.62
Male Total Stress	42.50 (42.86)	10.13 (11.83)	0.14
Female Total Stress	42.72 (41.41)	8.85 (9.86)	-0.62
Male Age	24.28 (23.94)	4.06 (4.40)	-0.37
Female Age	23.76 (23.65)	4.58 (4.38)	-0.12
Length of Relationship in Months	44.50 (49.53)	39.43 (41.22)	0.44

**p* < .05, ***p* < 0.01

Self-reported affect measures. In the current study a continuous-response measure was used along with a video recall procedure to gather the continuous self-report data on each partner's affective experience (Biocca, David, & West, 1994; also see Griffin, 1993; Gardner & Wampler, 2008). The software for this study, called "No Willow" (Griffin, 2002), continuously recorded changes in positivity and negativity (See Appendix A). This rating was created on a computer showing a colored, 9-point vertical scale, and each point was identified by boxes that changed color when highlighted by the cursor key. The four upper boxes, which became progressively wider in width as they moved higher, were colored blue when highlighted, and labeled "positive." The lower four boxes, which became progressively wider as they moved lower, were colored red when highlighted, and labeled "negative." The middle box on the scale was the most narrow in width, was colored grey when highlighted, and represented "neutral." Each partner was asked to rate how they felt during the conversation by sliding the mouse up or down based on whether they felt more negative or positive.

Using spreadsheet formulas, the data, which was originally recorded as a text file, was then converted into 3-second and 30-second occasions of mean affect for both conversations totaling 12 minutes of couple interaction. The lengths of the occasions were dependent on the models being tested, with 30-second occasions being constructed to run tests with the 30 second heart-rate variability data and 3-second occasions being used for a closer observation of affect movement. There were 240 occasions per partner with the 3-second increments, and there were 24 occasions per partner with the 30-second increments.

The ratings of the occasions of affect range from 0 through 8, with values of 0-3 considered the negative region, 4 considered the neutral region, and 5-8 considered the positive region of affect. Means were also created for the partners' affect ratings (*Female* $M = 4.76$, $SD = 2.10$; *Male* $M = 4.79$, $SD = 1.79$. In preparation for analysis, the affect scores were grand mean centered $M_{male\&female} = 4.78$) to ease the interpretation of the results (Kenny et al., 2006).

Micro-level measures of heart-rate variability (HRV). Using Mindware—HRV 3.0.17 (Westerville, OH) 30-second occasions of mean heart-rate were assessed using tachogram (ECG) measures of RR intervals, which are measures of oscillations between consecutive R-waves that were gathered during the baseline, negative, and positive tasks. There were 24 occasions per partner. R-waves are indices that can be used to measure the rhythms of ventricular depolarization that occurs within the heart, and it helps to measure variables such as heart-rate (MacKenzie, 2005). During positive and negative tasks participants' ECG data were collected using electrodes on each side of their lower rib cage, and the data were amplified using Bio-Pac ECG amplifiers (Santa Barbara, CA) set for a gain of 500 and using filters with a low-pass of 35Hz and a high-pass of .5 Hz (Schmeichel, Demaree, Robinson, & Pu, 2006). The heart-rate data was transformed using HRV 3.0.17 (Westerville, OH) detrending various types of information including average heart-rate measures at 30- intervals at the recommended frequency of 500 Hz (Harrison, Gray, Gianaros, & Critchley, 2010) over the duration of the partners' negative and positive tasks conversations. A measure 30-second occasions was used because it is the smallest available increment of time in which to reliably collect mean heart-rate data (Camm et al., 1996).

Data were considered missing if mean heart-rates were recorded below 40 beats per minute or above 150 beats per minute based on cut-offs established from prior research (e.g., Neumar et al., 2010) or if the data was not available through the HRV software. Within the sample 13.4% of the data were considered missing, as the heart-rate was dependent upon the functionality and errors of the data collection instruments, and these gaps were addressed by using linear interpolations similar to those used before when dealing with time-intensive data (e.g., Goldman et al., 2001).

For the current analyses each mean heart-rate measure was divided by ten in order to enhance interpretability of the magnitude of the coefficients (Kline, 2005) relative to the lags of affect. Means were also computed for partners' average heart-rates (*Female M* = 7.81, *SD* = 1.47; *Male M* = 7.22, *SD* = 1.58). In general the higher the means should be interpreted as a higher heart-rate for a participant, and lower means are lower heart-rates over time. In preparation for analysis, the mean heart-rate scores were centered according to partners' means ($M_{females}$ = 7.81; M_{males} = *7.22*) to ease the interpretation of the results (Kenny et al., 2006).

Global measures of respiratory sinus arrhythmia (RSA). Using Mindware—HRV 3.0.17 (Westerville, OH), a global measure of RSA recovery, which is an indicator of each individual's vagal tone, was computed by taking the difference between the means of each partner's RSA during the negative ($M_{females}$ = 11.60, *SD* = 2.84; M_{males} = 11.48, *SD* = 2.68) and positive discussion tasks ($M_{females}$ = 11.59, *SD* = 3.20; M_{males} = 11.31, *SD* = 2.95). RSA scores are a product of electronic wave measures taken from a participant's levels of heart-rate and respiratory rate (e.g., Demaree & Everhart, 2004). This method is similar to the analysis used by Movius and Allen (2005) when exploring vagal tone's association to various types of individuals' anxiety levels by comparing RSA scores during a recovery period to RSA scores during a stressful task. To get these mean estimates, RSA data were transformed using HRV 3.0.17 (Westerville, OH) detrending various types of information including RSA measures at 60-second intervals at the recommended frequency of 500 Hz (Harrison et al., 2010) over the duration of the partners' negative and positive tasks conversations.

Current Global Stress Level. To assess each partner's current global level of stress the total stress score from the Derogatis Stress Profile (DSP; Derogatis, 2000) was used. The DSP is a 77-item self-administered questionnaire with 11 primary dimensions that are under the three domains (Environmental Factors, Personality Mediators, and Emotional Responses) that were assessed to describe an individual's current level of total stress (See Appendix B). A total stress score for each partner was computed using a *t*-score transformation (Derogatis, 2000) that sums up all three domains of the questionnaire. Each individual's total stress score was used to assess the current overall stress felt by each individual. Studies of reliability have been conducted on this construct revealing Cronbach's alpha scores above 0.80 for each of the three domains and a range of 0.79 to 0.93 for all eleven of the dimensions under these domains (Derogatis, 2000). Another study revealed the test-retest reliability index for the total stress score to be 0.90 (Derogatis & Fleming, 1997), but the sample size of 34 should be acknowledged as relatively small in this study. Dobkin, Pihl, and Breault (1991) found that the total stress score had significant correlations with both the Daily Hassles Scale ($r = .46$, $p < .01$) and the Life Experiences Survey ($r = .48$, $p < .001$). For the current study male and female partners' mean stress levels were 42.32 and 42.71 respectively.

Relationship Quality. The Revised Dyadic Adjustment Scale (RDAS; Busby et al., 1995) was used to identify the partner reports of the quality of the couple relationship (See Appendix C). Considered a streamlined version of the Dyadic Adjustment Scale (Spanier, 1976) and shortened from 32 to 14 items, the RDAS has also been described as an improvement to the DAS to rate distressed and nondistressed couple relationships (Busby et al., 1995). The RDAS consists of 14 items where participants indicate their agreement or frequency according to the item (e.g., agreement on religious matters, career decisions, sex relations; frequency of activities engaged together, quarrelling, or considerations of separation). Responses are marked on a Likert-type scale ranging from 0 = *always disagree* to 6 = *always agree* or 0 = *never* to 6 = *all the time* for each item. Scores on the RDAS range from 0 to 69, with lower scores being associated with low relationship adjustment and higher scores being associated with high relationship adjustment (Busby et al., 1995). The instrument has reported good internal consistency, with Cronbach's alpha coefficients of .90 and construct validity was supported with a higher correlation with the Marital Adjustment Test (r = .68) than the original DAS (r = .66) (Busby et al., 1995; Crane, Middleton, & Bean, 2000). For the current study male and female partners' mean RDAS levels were 49.63 and 49.97 respectively.

Table 7

Variable Descriptive Statistics

Variables	N	Min	Max	Mean	*SD*
Affect					
30 Second Occasions Male	1,854	0.00	8.00	4.79	1.79
30 Second Occasions Female	1,855	0.00	8.00	4.76	2.10
3 Second Occasions Male	17,760	0.00	8.00	4.77	1.97
3 Second Occasions Female	17,760	0.00	8.00	4.78	2.22
Heart-rate					
30 Second Occasions Male	1,847	3.51	14.81	7.22	1.58
30 Second Occasions Female	1,851	3.54	14.65	7.82	1.47
Global factors	40	0	121.18	15.84	21.66
Mean Relationship Satisfaction	72	24.00	64.00	49.80	6.99
Male RSA Recovery	68	-4.58	5.45	-0.06	1.98
Female RSA Recovery	68	-5.48	3.66	-0.17	1.83
Male Total Stress	72	20.00	65.00	42.32	9.97
Female Total Stress	41	20.00	62.00	42.71	8.76

Data Analysis Plan

The cross-lagged, two intercept regression model developed by Kenny et al. (2006, pp. 344-359) to estimate both actor and partner effects was adapted and applied to the current study with the purpose of estimating these cross lagged effects in terms of affect scores and mean heart-rate variability scores. Versions of this adapted model from the one presented in Kenny et al. appear in Figures 1 through 6. To test the various models, the software Hierarchical Linear and Nonlinear Modeling (HLM; Raudenbush, Bryk, & Congdon, 2011) was used for the statistical analyses. A 2-level model was also created to perform the analyses in HLM 7.0 (time nested within persons and dyads). Multilevel modeling has proven useful in analyzing intensive longitudinal data (Walls & Schafer, 2006), but it has rarely been used for dyadic data (Campbell & Kashy, 2002; Kenny et al., 2006). This study was an effort to explore the use of these methods in analyzing affective and physiological processes.

To test hypotheses 1, 2, 3a, and 3b, the current study included a plan to set-up initial models of affect and mean heart-rate (predicting affect levels from prior lags of affect and predicting mean heart-rate levels from prior lags of mean heart-rate) using only 1-lag of the 30-second occasions (See Figures 1 and 2.). Lag-1 was considered the baseline model because it included occasions that were the closest together.

Figure 1: Initial Model of Affect With Only 1 Lag

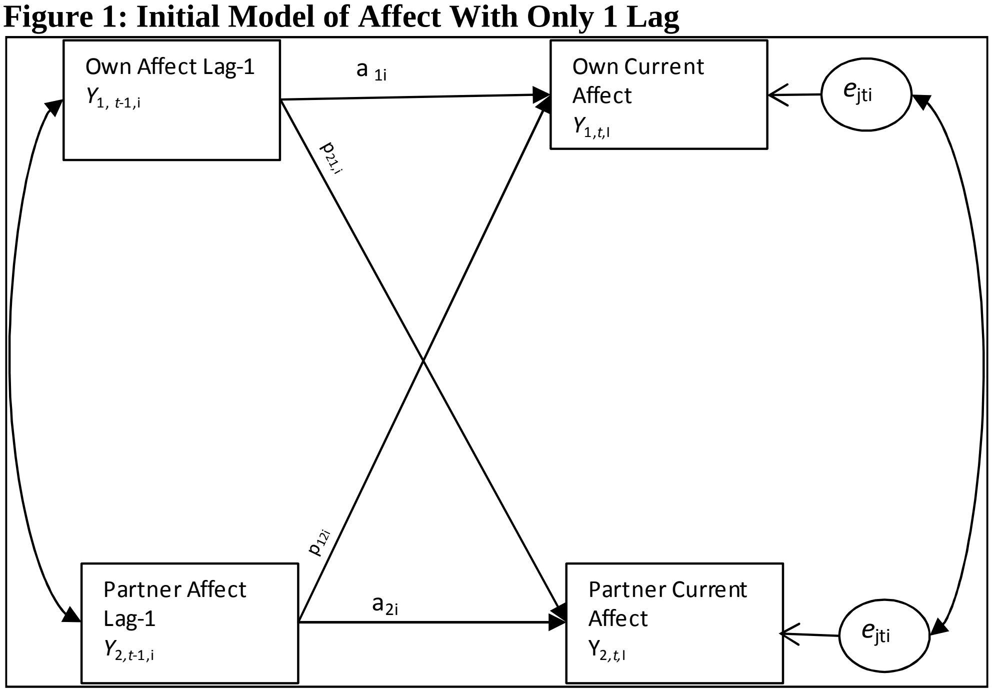
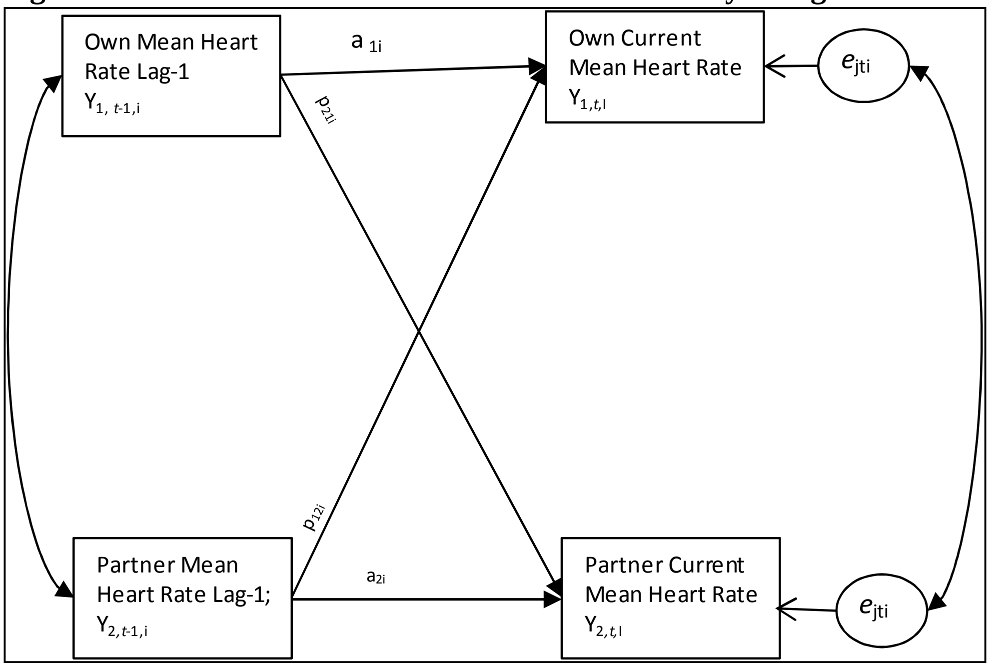


Figure 2: Initial Model of Mean Heart-rate With Only 1 Lag



Following the 1-lag model, models with only the second lag were tested. Following the "2-lag only" models, the first lags were brought back into the 2-lag models to run simultaneous tests of associations in an effort to identify if the second lag of affect (and mean heart-rate) predicted the current state above and beyond the first lag (See Figures 3 and 4).

Figure 3: Cross-lag Regression Model of Affect With 2 Lags

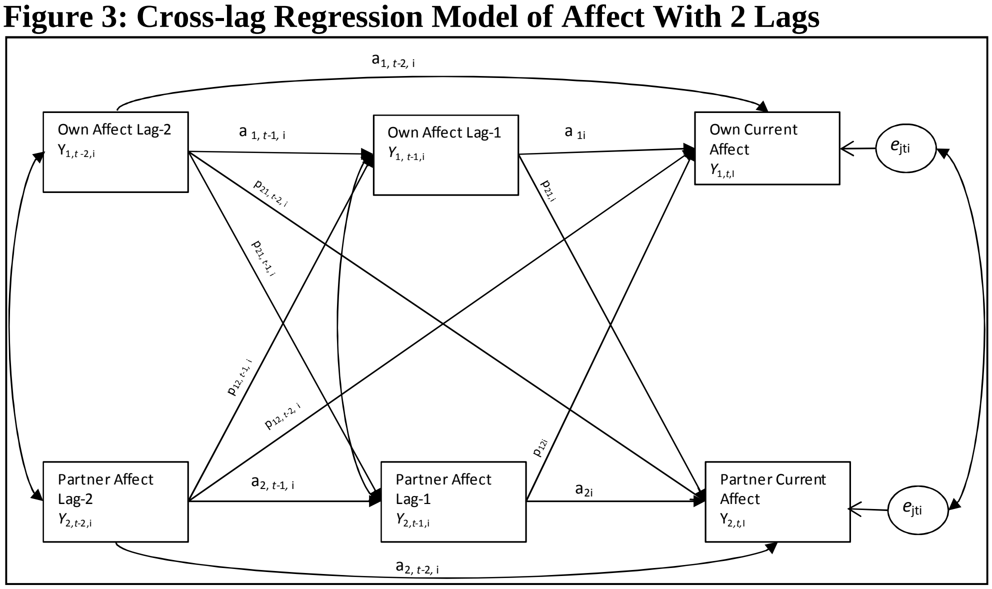
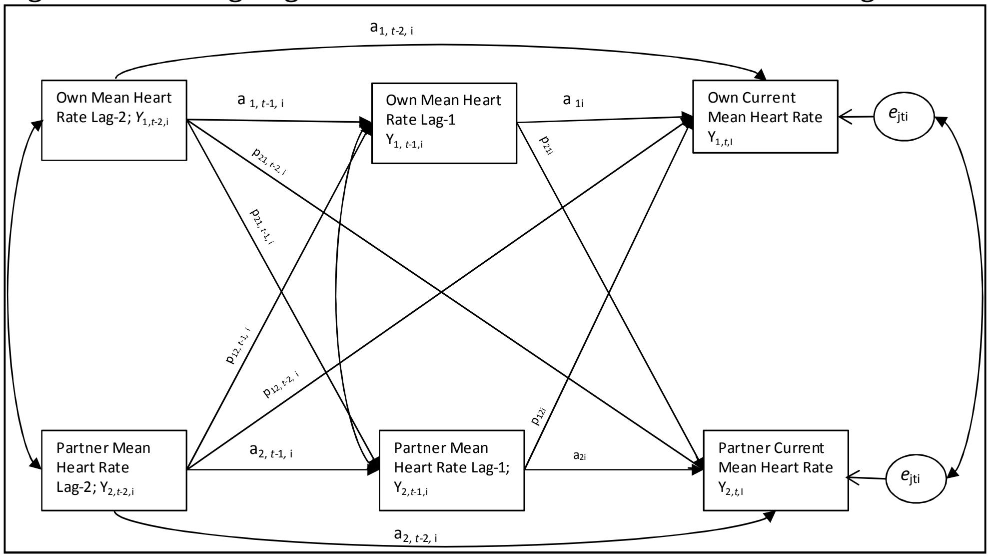


Figure 4: Cross-lag Regression Model of Mean Heart-rate With 2 Lags



To test the fourth and fifth hypotheses, models were built with each partner's current mean heart-rate being the outcome variable and the partner's affect levels at lag-1 and lag-2 being the predictor variables (See Figure 6). As with the prior model tests, a 1-lag model was initially tested before adding the second set of lags (See Figure 5).

Figure 5: Initial Model of Partner Affect Levels on Mean Heart-rate With Only 1 Lag

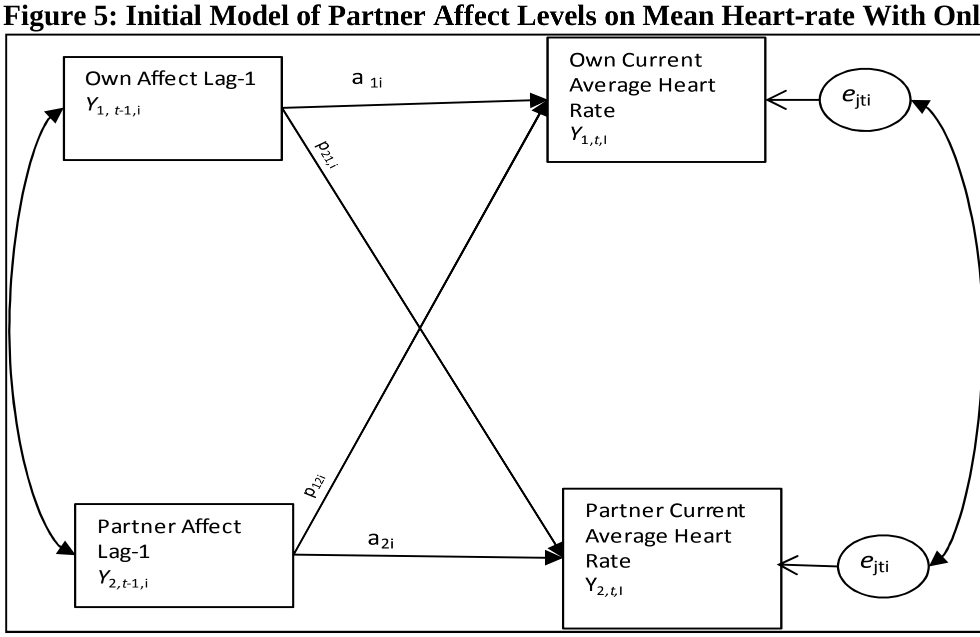
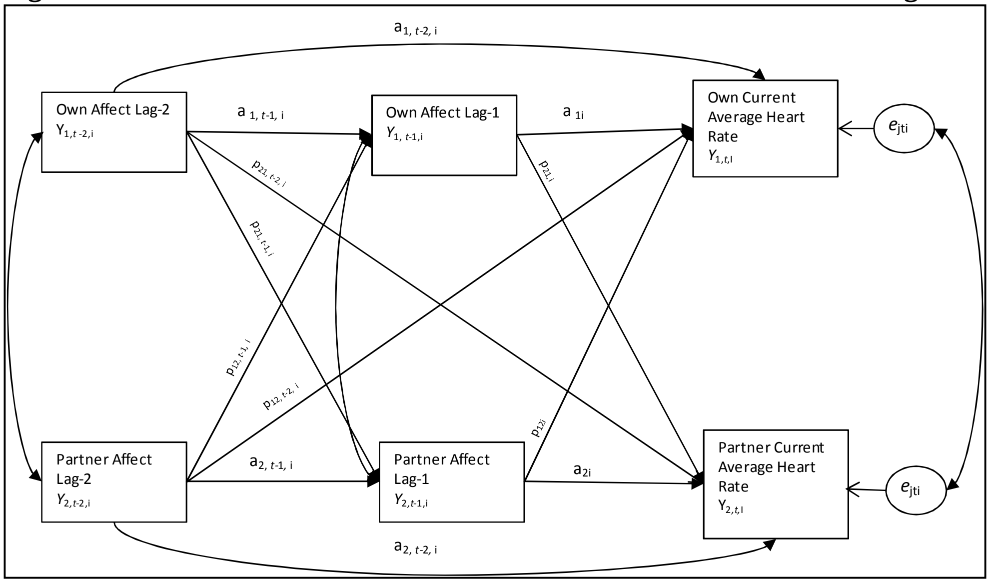


Figure 6: Model of Partner Affect Levels on Mean Heart-rate With 2 Lags



To test the sixth and seventh hypotheses, the initial models (Figures 1 and 2) were nested within level-2 variables of marital satisfaction (hypothesis 6) and global stress (hypothesis 7). For hypotheses 8 through 10, models parallel to the 1-lag (Figure 1) model and 2-lag (Figure 3) model were constructed, but for these tests, the occasions of affect were 3 seconds in length. Also, the two models were then nested within a level-2 variable of RSA-recovery to test how affective associations change when nested in various levels of RSA regulation. Each time that a model including both first and second lags was tested (See Figures 3, 4, & 6), Hypothesis 11 was being tested as well.

CHAPTER IV

RESULTS

Affect Models Tested

For the model called Affect Model 1, a Level-1, lag-1 model was used testing how lag-1 actor and partner affect ratings (30-seconds) were associated with current ratings of partner affect (*N* = 72). This combines the APIM with a lag-1 analysis of affect over time. The equation used in this analysis is similar to the formula suggested in Kenny et al., 2006 and is provided below for the reader:

$$Y_{jti}=c_{1i}D_{1i}+c_{2i}D_{2i}+a_{1i}D_{1i}Y_{1,t\text{-}1,i}+a_{2i}D_{2i}Y_{2,t\text{-}1,i}+p_{12i}D_{1i}Y_{2,t\text{-}1,i}+p_{21i}D_{2i}Y_{1,t\text{-}1i}+e_{jti},$$

where Y_{jti} is one's own affect at time *t* (the outcome variable), and D_{1i} and D_{2i} represent two dummy codes used for the female and male partners. $Y_{j,t\text{-}1,i}$ is the affect rating for the actor effect if it is the actor's affect score on the preceding interval (t – 1). It is considered the partner effect if it is the partner's affect score from the preceding interval. Note that each dummy code was set up to select the portion of the overall equation that predicts either female or male affect from an intercept and both persons' affect and/or mean heart-rate from the preceding interval (see Kenny et al., 2006, pp. 344-359).

As was initially hypothesized the results from this analysis indicated strong positive stability effects for both male and female partners (one's own affective state at lag-1 predicted one's current affective state (female partners, $\beta = .77$, $p <.01$; male partners, $\beta = .68$, $p <.01$). Also, supporting the third research hypothesis, the results indicated a significant partner effect from female to male partners ($\beta = .09$, $p <.01$), and a significant partner effect from male to female partners ($\beta = .10$, $p < .01$). This provides evidence of romantic partner interdependence regarding affect (See Table 8 for tested associations between the measures of affect).

Table 8

Results From Affect Model—Lag-1 Only (N = 72 Couples)

	Affect Model 1			
Variable	*Standardized β*	*SE β*	*t-ratio*	
Female Partner's Own Stability Effect; Lag-1	.76	.02	39.46**	
Male Partner's Own Stability Effect; Lag-1	.68	.03	23.18**	
Male to Female Partner Effect: Lag-1	.10	.02	4.47**	
Female to Male Partner Effect: Lag-1	.09	.02	4.57**	
Random Effect	*Variance Component*	*df*	χ^2	*p* Value
Female Partner's Own Stability Effect; Lag-1	.01	71	113.41	.001
Male Partner's Own Stability Effect; Lag-1	.02	71	178.35	.001
Male to Female Partner Effect: Lag-1	.01	71	81.88	.178
Female to Male Partner Effect: Lag-1	.01	71	93.87	.04
Level-1 effect, *r*	1.45			

$*p < .05$. $**p < .01$.

Next, the researchers explored how actor and partner effects would change after doubling the lag interval to 60 seconds. To do this, an identical Level-1 model was constructed using only lag-2 predictors. This equation is provided below for the reader:

$$Y_{jti}=c_{1i}D_{1i}+c_{2i}D_{2i}+a_{1i}D_{1i}Y_{1,t\text{-}2,i}+a_{2i}D_{2i}Y_{2,t\text{-}2,i}+p_{12i}D_{1i}Y_{2,t\text{-}2,i}+p_{21i}D_{2i}Y_{1,t\text{-}2i}+e_{jti}$$

Results for this lag-2 only model indicated actor and partner effects for both female and male partners after 6 seconds of time, but the effect sizes for the stability effects decreased (for female partners, $\beta = .53$, $p < .01$; for male partners, $\beta = .42$, $p < .01$). This supports the idea that as time increases between emotional states, it becomes less likely to predict one's current affect based on his or her prior affect state. However, the effect sizes for the partner effects from female to male partners ($\beta = .12$, $p < .01$) and from male to female partners ($\beta = .12$, $p < .01$) were actually larger when compared to those of the lag-1 model (See Table 9). Overall, the initial model with lag-2 variables added provides support for partner affective states staying stable over 30- and 60-second time lags, and it also supports the hypothesis that one's affect level 30- and 60-seconds before, impacts his or her partner's current affect state above and beyond his or her own intra-personal associations.

Table 9

Results From Second Affect Model—Lag-2 Only (N = 72 Couples)

	Affect Model 2			
Variable	*Standardized B*		*SE β*	*t-ratio*
Female Partner's Own Stability Effect; Lag-2	.53		.03	15.69**
Male Partner's Own Stability Effect; Lag-2	.42		.04	10.65**
Male to Female Partner Effect: Lag-2	.12		.03	3.56**
Female to Male Partner Effect: Lag-2	.12		.03	4.24**
Random Effect	Variance Component	*df*	χ^2	*p* Value
Female Partner's Own Stability Effect; Lag-1	.04	71	154.22	.001
Male Partner's Own Stability Effect; Lag-1	.05	71	144.09	.001
Male to Female Partner Effect: Lag-1	.03	71	109.95	.002
Female to Male Partner Effect: Lag-1	.02	71	98.03	.02
Level-1 effect, *r*	1.45			

$^*p < .05$. $^{**}p < .01$.

Finally, I tested a model that simultaneously included both lag-1 and lag-2 measures of affect. Although lag-1 actor and partner effects were found to be significant in this model, no lag-2 effects were found (See Table 10). This indicates the lag-2 actor and partner effects do not predict current states of affect above and beyond lag-1 effects, and this shows again how, that as time passes, predicting future emotional states from prior emotions becomes much more difficult. This finding provides support for hypothesis 11 suggesting that as time increases between occasions that effects decrease in strength.

Table 10

Results From Affect Model—Lag-1 & Lag-2 (N = 72 Couples)

	Affect Model 3			
Variable	*Standardized B*	*SE β*	*t-ratio*	
Female Partner's Own Stability Effect; Lag-1	.75	.03	22.24**	
Female Partner's Own Stability Effect; Lag-2	.00	.03	.14	
Male Partner's Own Stability Effect; Lag-1	.69	.05	15.30**	
Male Partner's Own Stability Effect; Lag-2	-.04	.04	-1.00	
Male to Female Partner Effect: Lag-1	.12	.04	3.21**	
Male to Female Partner Effect: Lag-2	-.03	.04	-.75	
Female to Male Partner Effect: Lag-1	.10	.03	3.53**	
Female to Male Partner Effect: Lag-2	.01	.03	.37	
Random Effect	Variance Component	*df*	χ^2	*p* Value
Female Partner's Own Stability Effect; Lag-1	.02	71	120.47	.001
Female Partner's Own Stability Effect; Lag-2	.03	71	98.51	.02
Male Partner's Own Stability Effect; Lag-1	.08	71	229.42	.001
Male Partner's Own Stability Effect; Lag-2	.06	71	129.57	.001
Male to Female Partner Effect: Lag-1	.04	71	97.56	.02
Male to Female Partner Effect: Lag-2	.04	71	113.61	.001
Female to Male Partner Effect: Lag-1	.01	71	83.38	.15
Female to Male Partner Effect: Lag-2	.01	71	60.50	.50
Level-1 effect, *r*	1.33			

$+p < .10$, $*p < .05$, $**p < .01$

Heart-rate Models Tested

The second level-1, lag-1 model was tested by assessing how mean heart-rate measures (30-second means of heart-rate) at lag-1 influenced each partner's current mean heart-rate measures at both the actor and partner level. An equation parallel to the Affect Model 1 was used in this analysis, but in this model mean heart-rate measures were used in place of affect measures. The results from this analysis provided evidence of stability (or actor effects) effects for both partners showing that a partner's own mean heart-rate at lag-1 predicted his or her own current mean heart-rate (female partners, $\beta = .31$, $p < .01$; male partners, $\beta = .25$, $p < .01$). However, no significant partner effects were found in this model test (See Table 11).

Also, the lag time for this model was doubled (60-second lags) to explore for any changes in association when observing only lag-2 effects. The results from this model again indicated significant lag-2 actor effects on current mean heart-rate for both partners, but the effect sizes for these associations decreased relative to the lag-1 only model (female partners, $\beta = .11$, $p < .01$; male partners, $\beta = .10$, $p < .01$) (See Table 12).

Table 11

Results From Heart-rate Model—Lag-1 Only (N = 72 Couples)

	Heart-rate Model 1			
Variable	*Standardized β*		*SE β*	*t-ratio*
Female Partner's Own Stability Effect; Lag-1	.31		.03	9.27**
Male Partner's Own Stability Effect; Lag-1	.25		.03	7.98**
Male to Female Partner Effect: Lag-1	-.03		.03	-.77
Female to Male Partner Effect: Lag-1	.00		.03	.17
Random Effect	Variance Component	*df*	χ^2	*p* Value
Female Partner's Own Stability Effect; Lag-1	.02	71	116.76	.001
Male Partner's Own Stability Effect; Lag-1	.02	71	97.14	.001
Male to Female Partner Effect: Lag-1	.02	71	105.65	.005
Female to Male Partner Effect: Lag-1	.00	71	68.92	.50
Level-1 effect, *r*	1.00			

$^*p < .05$. $^{**}p < .01$.

Table 12

Results From Heart-rate Model—Lag-2 Only (N = 72 Couples)

Heart-rate Model 2				
Variable	*Standardized β*		*SE β*	*t-ratio*
Female Partner's Own Stability Effect; Lag-2	.11		.04	3.390**
Male Partner's Own Stability Effect; Lag-2	.10		.04	2.73**
Male to Female Partner Effect: Lag-2	-.03		.03	-.81
Female to Male Partner Effect: Lag-2	-.01		.03	-.28
Random Effect	Variance Component	*df*	χ^2	*p* Value
Female Partner's Own Stability Effect; Lag-1	.02	71	69.89	.500
Male Partner's Own Stability Effect; Lag-1	.03	71	127.48	.001
Male to Female Partner Effect: Lag-1	.03	71	107.42	.004
Female to Male Partner Effect: Lag-1	.00	71	63.35	.50
Level-1 effect, *r*	1.06			

$*p < .05$. $**p < .01$.

Finally a test was run that simultaneously included lag-1 and lag-2 mean heart-rate in the model. As with the prior model that was an exploration of affect, the lag-2 mean heart-rate measures failed to predict current mean heart-rate measures in either partner above and beyond lag-1 measures (See Table 13). However, the results in this model indicated a male to female partner effect ($\beta = -.07$, $p < .01$) at lag-1. This may provide evidence of a suppressor effect as lag-1 this partner effect was not significant in the initial heart-rate model, (See Figure 2 & Table 11) but was found to be significant when controlling for lag-2 variables (See Figure 4). Overall, these test results provided partial support for hypothesis # 2, suggesting that mean heart-rate within partners would be stable over time, but that stability decreases as the time between lags increases, especially when controlling for more recent lags. The findings also indicate that a male's mean heart-rate may negatively influence his partner's mean heart-rate 30-seconds later.

Table 13

Results From Heart-rate Model—Lag-1 & Lag-2 (N = 72 Couples)

	Heart-rate Model 3			
Variable	*Standardized B*	*SE β*	*t-ratio*	
Female Partner's Own Stability Effect; Lag-1	.29	.04	7.42**	
Female Partner's Own Stability Effect; Lag-2	.03	.04	.84	
Male Partner's Own Stability Effect; Lag-1	.23	.04	6.39**	
Male Partner's Own Stability Effect; Lag-2	.06	.04	1.68+	
Male to Female Partner Effect: Lag-1	-.07	.04	-2.03*	
Male to Female Partner Effect: Lag-2	.01	.03	.52	
Female to Male Partner Effect: Lag-1	.04	.03	1.54	
Female to Male Partner Effect: Lag-2	-.04	.03	-1.35	
Random Effect	Variance Component	*df*	χ^2	*p* Value
Female Partner's Own Stability Effect; Lag-1	.04	71	179.58	.001
Female Partner's Own Stability Effect; Lag-2	.03	71	105.47	.005
Male Partner's Own Stability Effect; Lag-1	.03	71	135.11	.001
Male Partner's Own Stability Effect; Lag-2	.04	71	197.59	.001
Male to Female Partner Effect: Lag-1	.04	71	97.56	.001
Male to Female Partner Effect: Lag-2	.01	71	113.61	.50
Female to Male Partner Effect: Lag-1	.01	71	83.38	.50
Female to Male Partner Effect: Lag-2	.01	71	60.50	.50
Level-1 effect, *r*	.91			

$+p < .10$, $*p < .05$, $**p < .01$

Affect on Heart-rate Models Tested

The third level-1 model tested associations between lags of each partner's current mean heart-rate and lag-1 of each partner's own affect state (30 seconds prior to the each partners current mean heart-rate). Both lag-1 partner and actor effects were included in the initial third level-1 model. Results from this analysis found significant actor effects for the female partner (β = -.04, p <.05) indicating that as a female partner's affect at lag-1 increases her current mean heart-rate decreases (See Table 14). Also, actor effects were approaching significance for the male partner (β = .03, p = .12). A multivariate hypothesis test was run using HLM, and the difference based on gender was found to be significant (χ^2 = 5.93, p < .05). A further test was run to see if significant actor effects of lag-1 affect on a partner's own current heart-rate would remain significant after controlling for mean heart-rate at lag-1, but the results failed to show significant actor effects above and beyond mean heart-rate. Further tests of 60-second affect lags found no significant effects.

Table 14

Results of Model Predicting Heart-rate from Lag-1 Affect (N = 72 Couples)

	Affect on Heart-rate Model 1			
Variable	*Standardized β*		*SE β*	*t-ratio*
Female Partner's Own Stability Effect; Lag-1	-.04		.02	-2.04*
Male Partner's Own Stability Effect; Lag-1	.03		.02	1.58+
Male to Female Partner Effect: Lag-1	-.01		.02	-.44
Female to Male Partner Effect: Lag-1	.01		.02	-.39
Random Effect	Variance Component	*df*	χ^2	*p* Value
Female Partner's Own Stability Effect; Lag-1	.01	71	98.96	.01
Male Partner's Own Stability Effect; Lag-1	.00	71	78.50	.25
Male to Female Partner Effect: Lag-1	.01	71	86.41	.10
Female to Male Partner Effect: Lag-1	.01	71	111.70	.00
Level-1, *r*	1.09			

$+p < .10$, $*p < .05$, $**p < .01$

Nested Models Tested

Finally, the level-2 variables were added to the model to identify how partner effects on mean heart-rate and affect would be differ when nested in varying different levels of marital satisfaction (RDAS) and mean reports of global stress (Derogatis, 2000). First two level-2 variables were added to the first model tested in this study. Following Kenny et al. (2006, pp. 82-85), the following two RDAS predictors were used: averaged partner RDAS scores (grand-mean centered), and the difference in partner RDAS scores (male - female; *M* = -.35; *SD* = 8.68). Note that the mean of the RDAS difference scores indicated that females on average reported higher relationship satisfaction.

The results of this first model (See Table 15) indicated that as difference between the two partners' reports of relationship satisfaction increased the male partners' actor effects increased ($\beta = .01$, $p < .01$), meaning that as the difference in perception of relationship satisfaction increased, so did male partner stability effects. A further test of this first model included testing for actor and partner effects nested within partner reports of global stress. The following two Derogatis Stress Profile predictors were used: Female partner' total stress scores and male partner's total stress scores (both grand-mean centered). The results (See Table 16) from this initial level-2 stress model showed only marginal evidence of a male actor effect ($\beta = .01$, $p < .05$), but failed to provide evidence for any partner effects (Note: The intercept of the actor effect was marginally significant ($p < .10$). When all four level-2 variables were tested in a model simultaneously, no significant associations were found.

Table 15

Results From Affect Model Nested in Marital Satisfaction (N = 70 Couples)

	Nested Affect Model 1			
Variable	*Standardized β*		*SE β*	*t-ratio*
Female Partner's Own Stability Effect; Lag-1				
Intercept	.59		.13	4.42**
Mean RDAS	.00		.00	1.17
RDAS Difference Score M-F	.00		.00	.49
Male Partner's Own Stability Effect; Lag-1				
Intercept	.75		.20	3.82**
Mean RDAS	.00		.00	-.36
RDAS Difference Score M-F	.01		.00	3.54**
Male to Female Partner Effect: Lag-1				
Intercept	.29		.15	1.91+
Mean RDAS	.00		.00	-1.31
RDAS Difference Score M-F	.00		.00	.60
Female to Male Partner Effect: Lag-1				
Intercept	.02		.15	.16
Mean RDAS	.00		.00	.45
RDAS Difference Score M-F	.00		.00	-1.78+
Random Effect	Variance Component	*df*	χ^2	*p* Value
Female Partner's Own Stability Effect; Lag-1	.00	69	104.17	.004
Male Partner's Own Stability Effect; Lag-1	.02	69	153.52	.001
Male to Female Partner Effect: Lag-1	.00	69	80.47	.163
Female to Male Partner Effect: Lag-1	.00	69	90.39	.04
Level-1 effect, *r*	1.45			

$+p < .10$, $*p < .05$, $**p < .01$

Table 16

Results From Affect Model Nested in Partner's Levels of Stress (N = 70 Couples)

	Nested Affect Model 2			
Variable	*Standardized β*		*SE β*	*t-ratio*
Female Partner's Own Stability Effect; Lag-1				
Intercept	.83		.10	8.22**
Male's Stress	.00		.00	-.43
Female's Stress	.00		.00	-.44
Male Partner's Own Stability Effect; Lag-1				
Intercept	.29		.16	1.80+
Male's Stress	.00		.00	.44
Female's Stress	.01		.00	2.23*
Male to Female Partner Effect: Lag-1				
Intercept	-.16		.11	-1.40
Male's Stress	.00		.00	1.62
Female's Stress	.00		.00	1.15
Female to Male Partner Effect: Lag-1				
Intercept	.18		.11	1.6
Male's Stress	.00		.00	.23
Female's Stress	.00		.00	-1.07
Random Effect	Variance Component	*df*	χ^2	*p* Value
Female Partner's Own Stability Effect; Lag-1	.01	69	105.72	.003
Male Partner's Own Stability Effect; Lag-1	.03	69	163.80	.001
Male to Female Partner Effect: Lag-1	.00	69	75.00	.29
Female to Male Partner Effect: Lag-1	.01	69	91.61	.04
Level-1 effect, *r*	1.45			

$+p < .10$, $*p < .05$, $**p < .01$

These same level-2 variables (couple's relationship satisfaction and partner stress) were added to the second level-1 model which tested associations between occasions of partners' mean heart-rate (See Tables 17 & 18). Interestingly, when the model was nested within couple's reports of relationship satisfaction, there was a significant partner effect found from male partners to female partners (β = .01, p <.05; $p_{\gamma 12msatdiff,\, t\text{-}1}$ = .01, p <.05). With a negative intercept nested within this positive level-2 coefficient (β = - .47, p <.05), the nested coefficient indicates that as couples report greater relationship satisfaction the negative male to female partner association over time decreases. Furthermore, as differences between reports of relationship satisfaction increased male to female partner effects decreased in their negative associations. A further test was run to see if adding partner reports of global stress as a level-2 variable would have an impact on any of the model effects, but there were no significant associations when stress was added to the model.

Table 17

Results From Heart-rate Model Nested in Marital Satisfaction (N = 70 Couples)

	Nested Heart-rate Model 1			
Variable	*Standardized β*	*SE β*	*t-ratio*	
Female Partner's Own Stability Effect; Lag-1				
Intercept	.62	.27	2.31*	
Mean RDAS	.00	.00	-1.16	
RDAS Difference Score M-F	.00	.00	.14	
Male Partner's Own Stability Effect; Lag-1				
Intercept	.25	.23	1.11	
Mean RDAS	.00	.00	-.01	
RDAS Difference Score M-F	.00	.00	.77	
Male to Female Partner Effect: Lag-1				
Intercept	-.47	.23	-2.10*	
Mean RDAS	.01	.00	2.01*	
RDAS Difference Score M-F	.01	.00	2.00*	
Female to Male Partner Effect: Lag-1				
Intercept	.09	.21	.43	
Mean RDAS	.00	.00	-.40	
RDAS Difference Score M-F	.00	.00	.48	
Random Effect	Variance Component	*df*	χ^2	*p* Value
Female Partner's Own Stability Effect; Lag-1	.02	69	116.01	.001
Male Partner's Own Stability Effect; Lag-1	.02	69	97.46	.01
Male to Female Partner Effect: Lag-1	.02	69	95.50	.02
Female to Male Partner Effect: Lag-1	.00	69	69.47	.5
Level-1 effect, *r*	1.00			

$+p < .10$, $*p < .05$, $**p < .01$

Table 18

Results From Heart-rate Model Nested in Partner's Levels of Stress (N = 70 Couples)

	Nested Heart-rate Model 2		
Variable	*Standardized. β*	*SE β*	*t-ratio*
Female Partner's Own Stability Effect; Lag-1			
Intercept	.41	.20	2.06*
Male's Stress	.00	.00	.35
Female's Stress	.00	.00	-.86
Male Partner's Own Stability Effect; Lag-1			
Intercept	.16	.19	.86
Male's Stress	.00	.00	-.12
Female's Stress	.00	.00	.54
Male to Female Partner Effect: Lag-1			
Intercept	-.07	.20	-.39
Male's Stress	.00	.00	.28
Female's Stress	.00	.00	.06
Female to Male Partner Effect: Lag-1			
Intercept	.04	.16	.26
Male's Stress	.00	.00	-.50
Female's Stress	.00	.00	.16

Random Effect	Variance Component	*df*	χ^2	*p* Value
Female Partner's Own Stability Effect; Lag-1	.02	69	110.66	.001
Male Partner's Own Stability Effect; Lag-1	.02	69	97.56	.01
Male to Female Partner Effect: Lag-1	.02	69	105.71	.003
Female to Male Partner Effect: Lag-1	.00	69	68.09	.5
Level-1 effect, *r*	1.00			

$+p < .10$, $*p < .05$, $**p < .01$

Modeling 3-Second Occasions of Affect

Since affective responses may occur in much smaller increments of time further tests of intra- and inter-partner affective associations were run using a separate model with shorter increments of affect ratings (3-seconds). Also the sample size for this model was slightly smaller (N = 68) as some were removed due to missing data (I.e., some of the self-reported affect measures weren't complete enough for the smaller increments of time.). The initial lag-1 3-second model tested was parallel to the first lag-1, level-1 model in that there were again tests for both actor and partner effects from lag-1, but in this model the increments of affect rating were 3 seconds in length. Results from the initial lag-1 3-second model indicated actor (for female partners, β = .95, p <.01; for male partners, β = .91, p <.01) and partner effects (male to female partners, β = .02, p <.01; female to male partners, β = .03, p <.01) for both male and female partners (See Table 19). The higher effect sizes estimated for the actor effects of both partners perhaps indicate how intra-individual affect is more stable and predictable over shorter increments of time.

Table 19

Results of 3-Second Occasions of Affect Model-1 (N = 68 Couples)

		3-second Occasions Model 1		
Variable	*Standardized β*		*SE β*	*t-ratio*
Female Partner's Own Stability Effect; Lag-1	.95		.00	209.20**
Male Partner's Own Stability Effect; Lag-1	.91		.01	111.32**
Male to Female Partner Effect: Lag-1	.02		.00	3.77**
Female to Male Partner Effect: Lag-1	.03		.00	6.85**
Random Effect	Variance Component	*df*	χ^2	*p* Value
Female Partner's Own Stability Effect; Lag-1	.00	67	262.70	.001
Male Partner's Own Stability Effect; Lag-1	.00	67	487.78	.001
Male to Female Partner Effect: Lag-1	.00	67	115.11	.001
Female to Male Partner Effect: Lag-1	.00	67	183.40	.001
Level-1 effect, *r*	.38			

$+p < .10$, $*p < .05$, $**p < .01$

Following this first test, a lag-2 model was tested to identify if actor and partner effects would be found over 6-seconds increments as well (See Table 20). As was expected, as time increases actor effects for both male and female partners decreased, although they remained significant (for female partners, $\beta = .86$, $p <.01$; for male partners, $\beta = .78$, $p <.01$). Also estimates for partner effects again increased (male to female partners, $\beta = .06$, $p <.01$; female to male partners, $\beta = .07$, $p <.01$), showing similar patterns to the lag-1 and lag-2 models tested with 30-second increments. This provides further support for partners' affect ratings being clearly dependent on one another throughout couple interactions.

Table 20

Results of 3-Second Occasions of Affect Model-2 (N = 68 Couples)

		3-second Occasions Model 2		
Variable	*Standardized β*		*SE β*	*t-ratio*
Female Partner's Own Stability Effect; Lag-2	.86		.01	68.98**
Male Partner's Own Stability Effect; Lag-2	.78		.02	47.96**
Male to Female Partner Effect: Lag-2	.06		.01	6.48**
Female to Male Partner Effect: Lag-2	.07		.01	7.18**
Random Effect	Variance Component	*df*	χ^2	*p* Value
Female Partner's Own Stability Effect; Lag-2	.01	67	579.16	.001
Male Partner's Own Stability Effect; Lag-2	.02	67	789.44	.001
Male to Female Partner Effect: Lag-2	.00	67	263.09	.001
Female to Male Partner Effect: Lag-2	.00	67	337.65	.001
Level-1 effect, *r*	.82			

+$p < .10$, *$p < .05$, **$p < .01$

Both models were then combined, with the next analysis incorporating both lag-1 and lag-2 effects in the lag-1 3-second model. The results in this model test were similar to those found by Hubler et al. (2011), and seem somewhat counterintuitive at first glance. In what was quite different from the results when lag-2 effects were tested by themselves, the lag-2 actor effects in this model were negative and significant when controlling for lag-1 actor effects (β = -.26, *p* <.001; β = -.24, *p* <.001, for female partners and male partners respectively) (See Table 21).

Table 21

Results of 3-Second Occasions of Affect Model-3 (N = 68 Couples)

	3-second Occasions Model 3			
Variable	*Standardized B*	*SE β*	*t-ratio*	
Female Partner's Own Stability Effect; Lag-1	1.19	.01	86.70**	
Female Partner's Own Stability Effect; Lag-2	-.26	.01	-20.35**	
Male Partner's Own Stability Effect; Lag-1	1.13	.02	56.10**	
Male Partner's Own Stability Effect; Lag-2	-.24	.01	-16.50**	
Male to Female Partner Effect: Lag-1	.03	.00	4.81**	
Male to Female Partner Effect: Lag-2	.00	.00	-.14	
Female to Male Partner Effect: Lag-1	.05	.00	5.92**	
Female to Male Partner Effect: Lag-2	-.01	.00	-1.50	
Random Effect	Variance Component	*df*	χ^2	*p* Value
Female Partner's Own Stability Effect; Lag-1	.01	67	253.41	.001
Female Partner's Own Stability Effect; Lag-2	.01	67	147.80	.001
Male Partner's Own Stability Effect; Lag-1	.02	67	723.58	.001
Male Partner's Own Stability Effect; Lag-2	.01	67	323.37	.001
Male to Female Partner Effect: Lag-1	.00	67	69.85	.40
Male to Female Partner Effect: Lag-2	.00	67	63.09	.50
Female to Male Partner Effect: Lag-1	.00	67	84.46	.07
Female to Male Partner Effect: Lag-2	.00	67	60.65	.50
Level-1 effect, *r*	.35			

$+p < .10$, $*p < .05$, $**p < .01$

As was suggested by Hubler et al., (2011) these unexpected results can possibly be explained as a lag-2 "affective momentum" effect that occurs above and beyond the lag-1 stability effect. In essence, when controlling for the lag-1 stability effect, this negative coefficient implies that a downward momentum coming into the lag-1 effect, from the lag-2 effect is likely to show its impact on the current 3-second interval of affect. In essence, the associations of affect may be more complex than were initially anticipated when simultaneously controlling for prior lags.

Nested Model of 3-Second Affect Lags

The final hypothesis was to test how these associations may differ when nested within global levels of RSA-recovery which is a physiological indicator of emotion regulation (Movius & Allen, 2005). It was expected that as partner's RSA-recovery levels increase partner effects would decrease. Following the model of Kenny et al. (2006, pp. 82-85), the following two RSA recovery predictors were added as level-2 predictors to the lag-1 3-second model: The female partners' RSA recovery scores and the male partner's RSA recovery scores. Results from this model showed no significant associations between the level-2 and level-1 variables (See Table 22). However, there was one estimate that was approaching significance, perhaps suggesting that as a male partner's RSA increases the male to female lag-1 partner effects decrease (β = -.002, p =.10).

Table 22

Results From Affect Model-1 Nested in Partners' RSA Recovery (N = 68 Couples)

	Nested Affect Model 3			
Variable	*Standardized β*		*SE β*	*t-ratio*
Female Partner's Own Stability Effect; Lag-1				
Intercept	.95		.00	202.23**
Male RSA Recovery	.00		.00	-.21
Female RSA Recovery	.00		.00	.17
Male Partner's Own Stability Effect; Lag-1				
Intercept	.91		.00	108.24**
Male RSA Recovery	.00		.00	.12
Female RSA Recovery	.00		.00	-.80
Male to Female Partner Effect: Lag-1				
Intercept	.02		.00	6.58**
Male RSA Recovery	.00		.00	-1.66+
Female RSA Recovery	.00		.00	.06
Female to Male Partner Effect: Lag-1				
Intercept	.03		.00	6.90
Male RSA Recovery	.00		.00	-.19
Female RSA Recovery	.00		.00	1.61
Random Effect	Variance Component	*df*	χ^2	*p* Value
Female Partner's Own Stability Effect; Lag-1	.00	65	262.94	.001
Male Partner's Own Stability Effect; Lag-1	.00	65	493.34	.001
Male to Female Partner Effect: Lag-1	.00	65	110.47	.001
Female to Male Partner Effect: Lag-1	.00	65	169.02	.001
Level-1 effect, *r*	.38			

$+p < .10$, $*p < .05$, $**p < .01$

This may indicate a trend that could be investigated further as it may suggest that as a male's capacity for emotional recovery increases, a female becomes less influenced by her male partner's affect. However, this is not a significant finding, so the results should be interpreted with caution.

Results Summary

Regarding partner affect ratings, the findings support hypotheses 1 and 8, in that each romantic partner's actor effects remained significant over 3-, 6-, and 30-seconds of time. Also, the findings support hypotheses 3 and 9 as partner effects were found to remain significant over 3-, 6-, and 30-seconds of time. The heart-rate models yielded similar findings regarding actor effects, but the initial heart-rate tests failed to support the hypothesis regarding partner effects on mean heart-rate. However, when testing how affect predicts current heart-rate levels, evidence of a difference based on gender was found. As female affect increases, her current heart rate decreases 30-seconds later, but as male affect increases, his current heart rate increases 30-seconds later. In general, as was hypothesized, as the length of time between lags was increased the magnitude of the coefficients decreased, and some estimates were even reduced to non-significance associations.

With regard to the nested models, some of the associations of affect and heart rate were significant based on levels of relationship satisfaction as well as differences in reports of relationship satisfaction indicating evidence of these global factors serving as moderators. However, there was minimal evidence of differences based on reported levels of partner's global stress. Finally, the findings fail to find significant associations that would support the idea that RSA recovery has an impact on the interdependence of partners' affect, but there was one finding that approached significance. Perhaps there are other confounding contextual factors at play within these partner interactions that may more fully predict affective interdependence.

CHAPTER V

DISCUSSION

This study was unique in its approach to exploring the systemic nature of romantic partner's affective processes as well as changes in his or her own heart rate (actor effects) during partner interactions. Furthermore it explored how one partner's processes may influence the other partner (partner effects). It was also unique in its effort to explore how these associations may have varied when nested within certain couple-level and partner-level global factors. The study expanded on the use of newer methods with the use of intense microdimensional physiological data and affect data to test APIM models with romantic partners, and further expansion of the field was made by nesting these models within individual and coupled global measures.

Key Findings

Interactions between romantic partners can be quite complex when controlling for the multiple inputs and outputs as well as the many associations that take place both within and between individual partners during interactions (Gottman et al., 1998). This study was an effort to gather more nuanced details regarding romantic couple's conversations by exploring how moments of each partner's affect may associate with his her own later moments of affect as well as his or her partner's later moments of affect. It also explores how measures of each partner's heart-rate variability may influence his or her own later measures of heart-rate variability as well as his or her partner's later measures of heart-rate variability. While prior evidence has shown links between the quality of interchanges between partners and their physiological health (e.g., Ewart et al., 1991; Kiecolt-Glaser et al., 2005), there has been limited information on how the microdimensional components of these interchanges, such as affect positivity and negativity, are linked to partner physiology. This research explores these components by assessing how each partner's affect may associate with his or her own later measures of heart-rate variability as well as his or her partner's measures of heart-rate variability.

The results of this study provide some limited support for the intra-individual associations of affect levels within a person as well as links between affect and each person's own measures of heart-rate. These findings are particularly salient as the literature describes how routine experiences of fluctuations in cardiovascular reactivity can lead to other health problems (Ewart et al., 1991; Kimmel et al., 2000). Also, the research has shown that when one gets stuck in negative states over time (such as anger), there are decreases in their cognitive and social functioning (e.g., Murray et al., 1990;

Gottman, 1998; Gross & John, 2003). There was also partial support for inter-individual partner effects regarding affect and heart-rate. Furthermore, there was partial support for the idea that some of these associations differ based on global variables such as relationship satisfaction, partner reports of stress, and the capacity of partners to regulate their emotions.

Associations with affect. As was initially hypothesized, each romantic partner's current affective state was highly dependent upon his or her own affective state up to 3-, 6-, and even 30-seconds prior. This shows how the influence of each partner's current emotions predicts his or her future emotions in the short-term. Furthermore, with the models of 30-second occasions, evidence of partner effects was found. One partner's level of affect 30-seconds prior is shown to associate with the other partner's current level of affect. When one partner reported negative affect, there was a greater chance that the other partner would report negativity 30-seconds later. Parallel findings were also found with the models of 3-second occasions. This shows how one partner's negativity or positivity can influences the other partner's. For romantic partners in interactions, this can be a very profound finding, as they can see how their efforts to change their own moods towards positivity can impact their partners' moods.

The results also provide evidence of the systemic interdependence found between two partners. According to family systems perspectives a couple operates as a self-regulating system that maintains homeostasis through corrective feedback loops (Bertalanffy, 1950). A model where one partner's negativity (or positivity) predicts another partner's later negativity (or positivity) illustrates a type of positive feedback loop, where partner emotions influence one another. This provides insight into how the affective environment for partners may be calibrated to be either more negative or more positive. If a clinician or educator can teach romantic partners how to stand back and recognize their own influence on their homes' emotional climates (particularly during interactions), they can begin to take steps towards shaping an environment with more positivity.

Furthermore, when using 3-second occasions of mean affect ratings there was evidence that when lag-1 and lag-2 were controlled for in the same model, the stability (actor) effects of lag-2 on the current ratings of affect were significant and negative, which was a reverse in sign compared to the lag-1 stability effects (See Table 21). This suggests that predicting current affect ratings based on prior lags may prove to be a bit more complex. However, this "momentum effect" parallels the results of similar tests conducted by Hubler et al., (2011) suggesting that as a partner's affect ratings move towards a state of stability, there are numerous positive and negative movements that take place along the path towards stability.

Often these types of processes within a family's system are compared to the underlying functions and purposes of a thermostat (Jackson, 1984). Over the course of a day a thermostat goes through various fluctuating processes of change in an effort to maintain a consistent desired temperature (Jackson, 1984). Likewise, when partners are working to stay within a steady and comfortable emotional climate, there are various invisible affective mechanisms that fluctuate behind the scenes. These momentum effects show how affective movements may reflect these types of micro-dimensional fluctuations within each partner as a couple systems moves towards a more stable emotional state. This finding also sheds light on the importance of looking at emotional movement from moment-to-moment rather than taking a mean measure over long periods of time. In essence, many of these movements are lost in global means, and may be particularly important when considering how emotional flexibility can predict other problems such as poor health outcomes (e.g., Rozanski & Kublansky, 2005).

Heart-rate measures. Tests of the heart-rate models produced similar findings regarding actor effects, but the tests found limited evidence for partner effects. In the heart-rate model that simultaneously tested for lag-1 and lag-2 effects on each partner's current mean heart-rate (See Table 13), results indicated a male to female partner effect that had a negative association (β = -.07, $p < .01$). This would suggest that as a male's heart-rate increases his partner's heart rates decreases 30-seconds later. A potential explanation of this finding may be tied to how repair attempts are handled with couples who report higher relationship satisfaction (Gottman, 1998; Revenstorf, 1980). When a couple's interaction becomes too intense, quite often one partner will attempt to "repair" the conversation by saying or doing something to decrease the negativity experienced (Gottman, 1998).

Affect and heart-rate combined. When tests were run looking at the impact of lag-1 partner affect levels on current partner heart-rate, a significant actor effect for females was found. The negative coefficient suggests that as female's rating of affect becomes more positive her current mean heart-rate decreases. This supports the idea that positive emotions lead to lower cardiovascular reactivity (Ewart et al., 1991). If partners are interacting in negative conversations on a regular day-to-day basis this may prove to be problematic for a female partner's physiological health (Kiecolt-Glaser et al., 2005; Repetti et al., 2002) as increases in heart-rate are often evidence of a stress-response

(Wallenstein, 2003). This becomes very important to explore when one considers that cardiovascular disease is the leading cause of deaths for women in the United States (Lloyd-Jones et al., 2010; Mosca et al., 2011). For instance, if females are usually less sensitive to the physiological arousal associated with anger or negative affect (Levenson et al., 1994), they may be experiencing more of these negative consequences without even knowing it. This in turn, can lead to greater risk for health problems later in life (Brosschot & Thayer, 1998).

Also, a positive trend that was approaching significance was found supporting an actor effect for male partners, and this provided preliminary evidence of a potential difference based on gender in how each partner's affect influences his or her heart-rate. Results from the follow-up multivariate hypothesis test gave further evidence of this difference based on gender. Research has shown that when physiological reactions of males and females are measured during couple interactions, males on average are more reactive to stressful stimuli than females (Gottman, 1994). They are also found to be more sensitive to the physiological arousal associated with negative affect (Levenson, Carstensen, & Gottman, 1994). Perhaps these differences based on gender in the intraindividual associations between mean heart-rate variability measures over time may provide another confirmation of these prior findings in the literature (Gottman, 1994; Levenson et al., 1994).

This may also indicate a difference based on gender in the way emotions are managed while partners interact with each other (e.g., Christensen & Heavey, 1990; Kiecolt-Glaser, Newton, Cacioppo, MacCallum, Glaser, & Malarkey, 1996). Research has shown that male partners will often exhibit avoidant behaviors when faced with feelings of negativity (Christensen & Heavey, 1990), whereas females may be less sensitive to negativity as research has shown that they are more capable of tolerating negative physiological and emotional arousal when compared to male partner (Levenson et al., 1994). This may have been reflected in the decrease in mean heart-rate for males, and the increase in mean heart rate for females. Either way, this may warrant a closer look at how moment-to-moment feelings of positivity or negativity impact a partner's physiology differently based on the gender of the partner. This also gives credence to the salience of helping romantic partners learn how their emotions impact their relational health (e.g., Johnson et al., 2005). Also, with various measures of heart-rate variability being tied to risks for various cardiovascular health problems (e.g., Kop et al., 2001) there remains the importance of paying attention to how these emotions impact each partner's physiological health (e.g., Ewart et al., 1991), and identifying any possible differences in these impacts based on gender (Zhang & Hayward, 2006). Since research has shown that females appear to be less sensitive to feelings of negativity, this may be reflected in these findings of differences based on gender.

Nested models. The results of this initial nested affect model (See Figure 1 & Table 15) showed evidence that when there were increases in the differences between partners' reports of relationship satisfaction, male partners were more stable in their affect movement during conversations. This may indicate that as partners report differences in their relationship satisfaction that male partners follow more stable emotional paths over time. This means that as the differences between male and female reports of relationship satisfaction increases, a male partner will most likely stay in a particular affect state (either positive or negative), at least for the brief moment of 30-

seconds. The literature has shown that males and females may be asynchronous in their processes of dealing with emotions (Laurenceau & Bolger, 2005).

Also, the results from the initial nested heart-rate model (See Figure 2 & Table 17) provided evidence indicating that as the differences between male and female reports of relationship satisfaction increased, a male's increase in heart-rate was less likely to predict a female's decrease in her heart-rate 30-seconds later. In essence the negative association in the male to female partner effect decreases as relationship satisfaction increases. Research in the past has indicated that quite often there are physiological responses to emotional movement (e.g., Anderson, Keltner, & John, 2003). In fact, some evidence of this was found in this current study when predicting heart-rate from affect (See Table 14). Perhaps this was physiological evidence for the idea that certain interactions make male partners more uncomfortable while at the same time not impacting female partners and vice versa (e.g., Levenson et al., 1994). However, this also shows that as satisfaction increases this physiological asynchrony between male partners and female partners decreases.

A possible explanation for why this partner effect decreases with increases in relationship satisfaction could stem from the idea that when couples are considered nondistressed or high in relationship satisfaction, they tend to color their past and current interactions in a more positive light (Hawkins et al., 2002). This positive framing of the relationship can then impact how physiologically dependent one partner may be on the other partner's cues during interactions. This could also be a measure of how a romantic couple's emotional divergence (or how similar partner's emotions become) is less likely when the relationship is higher in satisfaction.

However, as the difference in male and female reports of relationship satisfaction increases these negative male to female partner effects again decrease. These associations between nested factors and global factors here may show that just as the partners are less dependent to one another on their reports of relationship adjustment, so too are they disconnected physiologically when they interact as couples. In their use of daily diary study research, Laurenceau and Bolger (2005) suggested that perhaps there were some couples in which husband's and wife's anger movement were in sync while other couples experienced more asynchronous emotional movement on a day-to-day level. Perhaps this finding supports this idea on not only a more microdimensional level, but also on a physiological level.

Research has shown that in romantic relationships females are often more attentive and understanding of their own conflict management behaviors as well as their male partner's behaviors (Hojjat, 2000). With this in mind, another possible explanation could be that if one partner is reporting high relationship adjustment while the other partner's report is much lower, then perhaps this is a reflection of one of the partners being more attentive to the conversation during the interaction while the other partner may be "checked out."

A closer look at the observational data may give more light to the associations of heart-rate. For instance, in research by Harris (2001), it was found that the suppression of feelings of embarrassment was linked to higher blood pressure. Perhaps there are other factors beyond affect negativity and positivity that may need controlled for in this study such as observable cues such as a words said by each partner. Research has shown that one partner may perceive another partner's words as hurtful, and this may impact partners physiologically (e.g., Vangelisti & Young, 2000). The fact that this finding was nested within marital satisfaction may also indicate that romantic partners are more capable of expressing the need to address a problem when they are in more satisfied relationships (e.g., Ben-Ari & Lavee, 2011). For instance, Ben-Ari and Lavee (2011) found that romantic partners were less likely to express their emotions when relationship satisfaction was low.

The final nested model included nesting associations between 3-second occasions of affect within global levels or RSA-recovery. It was hypothesized that as levels of RSA-recovery decreased, partner effects would increase in magnitude and significance. This was based on the general idea that as one's capacity to regulate emotions increases, so does his or her interpersonal competence (Gross & John, 2003). However, only one association that was approaching significance was found in the model indicating that as a male partner's RSA-recovery decreases, a male-to-female lag-1 partner effect increases (See Table 22). This may indicate a trend that could warrant further investigation because it may suggest that as a male's capacity for emotional recovery increases, a female becomes less influenced by her male partner's emotions. This suggests that there are systemic contexts where affective interdependence is stronger between partners, and this may also support the idea of interpersonal competency. However, this was a nonsignificant finding that was trending in the expected direction, so the results should be interpreted with caution.

Although one should use caution when interpreting this result, as it is only a trend approaching significance, it is important to note that evidence of affective interdependence both between and within partners was found in this study. As partners interact with one another, it is important to pay attention to the intra-individual influences of negative and positive affect. If one partner continues to feel negativity, this can lead to even more negativity as conversations continue, and this can lead to detrimental social and physical outcomes (e.g., Brosschot & Thayer, 1998). However, evidence from this study also shows that one partner's affect rating can influence the other partner's affect, suggesting that if a spouse wants to decrease the negative "mood" of a conversation, they may have some substantial influence.

Implications for Couples, Clinicians, and Educators

With some associations between micro-dimensional occasions of affect and current mean levels of heart-rate, there is evidence supporting the idea that male and female partners process emotions differently. This warrants further investigation into how positive and negative emotions felt during a couple's interaction have an immediate impact on each other's physiological health. Although some tests of associations have been done with longer-term physiological measures such as means of heart rate over a 5 minute period (e.g., Gottman, Jacobson, Rushe, & Shortt, 1995; Light et al., 2004), this is one of the first studies to observe these heart-rate data within smaller occasions of time. If male partners process affect differently than females, then perhaps clinicians and educators could pay attention to these differences when looking for biofeedback responses during sessions (e.g., Olson, Robinson, Geske,& Springer, 2011).

Evidence was also found showing how differences in reports of relationship satisfaction moderate male to female partner effects. This becomes highly relevant because relationship adjustment impacts marital sentiment override (Hawkins et al., 2002), and this, in turn, affects how partners impact one another emotionally. This could possibly indicate that when partners are not satisfied with their relationships they often miss emotional cues that may presented to each other. Relationship adjustment is also found to predict the level of emotional expression partners will show to one another, with higher satisfaction predicting more expressions. (Ben-Ari & Lavee, 2011). Perhaps these nested associations are a product of how comfortable romantic partners are in expressing their own affect to one another. Research in the past has shown how partners may on average be in sync during conflicts (e.g., Davis, Haymaker, Hermecz, & Gilbert, 1988), however, this synchrony may be limited when measured on a microdimensional level (e.g., 3-second and 30-second increments of time).

Implications and Future Steps for Methodologists

Intensive longitudinal modeling has been done in the past (e.g., Walls & Schafer, 2006), but this study (along with Hubler et al., 2011) is one of the first to use Kenny et al.'s (2006) APIM to analyze these types of microdimensional associations. To my knowledge, this is also one of the first tests of this type of model to test for associations between affect and heart-rate occasions simultaneously. Although, some tests have been conducted to model current affect states from those immediately preceding them (e.g., Griffin, 2002), this study was unique as it was an attempt to test for associations between measures in prior lags and measures in the current state while simultaneously controlling for more recent lags (See Table 21). This study also proves the usefulness of the cross-lagged 2-intercepts regression model for intense longitudinal dyadic data analyses (Kenny et al., 2006).

Also, with each model tested, it was found that when more time was added between the lags (both of affect and heart-rate) and the current state, that the magnitude of the associations decreased with some of them being reduced to nonsignificance. This indicates how difficult it can be to predict affect levels based on prior measures without taking into account specific observed occurrences or ratings such as identifying potential time-based conflicts, observing which partner did most of the talking, or identifying who felt the strongest about the specific topics being discussed during the interaction tasks. Levenson and Gottman (1985) matched the self-reported continuous affect measures with moment-to-moment observer ratings of the affect when they tested the validity of these types of methodology. Perhaps this study warrants this type of intense look at these factors in order to control and nest according to these potentially observable issues.

The ability to analyze brief patterns of continuous affect and heart-rate measures shows the potential to identify subtle nuances of affect exchange between partners, as well as the physiological outcomes from these exchanges. This study confirms the proposition by Hubler et al. (2011) that predicting one partner's own affect based on prior lags of his or her own affect may be highly dependent on the timing and length of the lags. Although one can predict some significant stability and partner effects over time, the fact that these effects decrease as time increases suggests that there are limitations to these types of predictions unless other confounds are controlled. Future studies would warrant further observational ratings of affect from third parties to further confirm the validity of these types of movement.

Limitations

There were some limitations to this study that need to be accounted for when interpreting the results. First of all, the magnitudes for some of the coefficients for partner effects and nested effect were relatively low (e.g., the nested male actor effect from Nested Affect Model 2 was the following: $a_{\gamma 2i\text{msatf}, t\text{-}1} = .01$, $p < .05$). So although these may be considered significant findings, there may be limitations on whether there is true meaning behind the significant associations, especially when they would only account for such a small percentage of the variance in a model. On the other hand, the argument could be made that with the APIM being used, perhaps even these effect sizes have meaning when nonindependent associations between two participants are taken into consideration (Kenny et al., 2006).

This study brings to light some of the difficulties that come into accounting for the various factors that impact relationships, especially when looking at the micro-dimensional processes. With only affect measures and heart-rate measures, the information tested in this study is based on limited information regarding the couples' interactions, and this can limit the generalizability of these findings. Further exploration would require more details regarding observable events surrounding these two other constructs. For instance, Light and colleagues found that as hugs increases between partners, female blood pressure and heart-rate decreased (Light et al., 2005). Revenstorf and colleagues (1980) identified sequential patterns of observable behaviors that were different based on whether or not the couples were distressed. Also, Gottman and Krokoff (1989) found that when partners engaged in specific dialectical processes that included confronting areas of agreement and disagreement, certain outcomes regarding relationship satisfaction were evident. Perhaps further analyses that capture these types of confounding factors would paint a clearer picture of these associations within and between the actor and partner effects of heart-rate variability and affect. Also, the lab setting for these assessments may limit how these associations may generalize onto more naturalistic home environments. In his seminal paper describing some of the challenges of observing the interactions of romantic couples, Heyman (2001) suggests steps to reduce errors common to these data, including the tests of these types being conducted in other naturalistic settings such as the home. Current advances in technology would make the gathering of this type of data more possible within the home.

Conclusion

As the field continues to focus more on how the emotional, social, and physical domains of relationship health are associated, (e.g., Wood et al., 2007) this study brings forth support for these types of interdependent associations. Recognizing the various dyadic processes that occur when regulating affect is important to romantic partners and the clinicians that may treat them (Fosha, 2001). For instance if, during interactions, female partners are less sensitive than males to the physiological arousal associated with affect negativity (Levenson et al., 1994), a clinician may help romantic partners to recognize these differences and be more accepting of these emotions during interactions.

Certainly the continued exploration of the underlying emotional and physiological processes within couple interactions will shed even greater light on these types of models, and nesting these interdependent models within global factors such as relationship satisfaction (e.g., Ben-Are & Lavee, 2011) will also help clinicians and researchers in their efforts to identify couples and/or partners who may need the most attention with regards to their health as well as to their means of regulating affect (Fosha, 2001) and heart-rate (Ewart et al., 1991). This study provides partial support to previous findings that there are potential differences based on gender in how affect movement as well as heart-rate processes are linked over time both within as well as between partners.

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APPPENDICES

APPENDIX A

NO WILLOW SOFTWARE INTERFACE

APPENDIX B

DEROGATIS STRESS PROFILE (DSP) COPY

DSP®

Name: ______________________ Age: ________ Sex: M _____ F____ Date: ____________

I.D. No: ____________________ Location: ______________________________

Marital Status: Single________ Married________ Separated________ Widowed________ Divorced____________

Education: ______________________ Job Description: ______________________

INSTRUCTIONS

Below are a series of statements that describe the way some people feel about themselves. Please read each statement carefully and select one of the numbered descriptors below to indicate the extent to which the statement is true of you. Consider yourself as you **typically** behave or feel, and place the descriptor number in the open block to the right of the statement. If you change your mind, erase your first selection completely. If you have any questions, ask the technician.

DESCRIPTORS:

0 = Not at all true of me
1 = Slightly true of me
2 = Moderately true of me
3 = Very true of me
4 = Extremely true of me

1. I feel there is never enough time to get things done . . . . ☐
2. I rarely have feelings of being trapped or caught in life . . . . ☐
3. I feel rules were made to be broken . . . . . . ☐
4. I take some time out almost every day just to relax . . . . ☐
5. I laugh easily . . . . ☐
6. My job provides me many opportunities for challenging and satisfying activities . . . . ☐
7. When I am on vacation with my family I don't have as much fun as I think I should . . ☐
8. I get into frequent arguments . . . . ☐
9. I rarely feel tense and under pressure . . . . . ☐
10. I rarely exercise . . . . ☐
11. I feel no interest in things . . . . ☐
12. I would like to be with my family more, but I can never seem to find the time . . . . ☐
13. I never worry about being a "workaholic" . . . ☐
14. I believe that if you don't beat the other guy to the punch, he will beat you . . . . ☐
15. I never sit still for very long . . . . ☐
16. I am not very good at telling funny stories or jokes . . . . ☐
17. I get great pleasure from the people I work with . . . . ☐
18. I have a satisfying sex life . . . . ☐
19. I have no problems with control of my temper . . . . ☐
20. I am usually worried about something . . . . ☐
21. I smoke too much . . . . ☐
22. I rarely feel lonely . . . . ☐
23. When I eat, I usually take my time . . . . ☐
24. I frequently say I am going to spend less time on work, but I don't seem to be able to . . . . ☐
25. Most things I do I see as a challenge . . . . ☐
26. I am not very interested in hobbies or sports . . . ☐
27. I seem to be more focused on the future than the present . . . . ☐
28. My full range of talents are not utilized on my job . . . . ☐
29. I have a good relationship with my wife/ husband (or unmarried partner) . . . . ☐
30. Sometimes I just feel like hitting somebody . . . ☐
31. I rarely feel nervous or uptight . . . . ☐
32. I am in good physical shape . . . . ☐
33. I sometimes have feelings of worthlessness . . . . ☐
34. I rarely feel pressed for time . . . . ☐

 PAGE ONE PLEASE CONTINUE ON OTHER SIDE ▶

DSP®

DESCRIPTORS:
0 = Not at all true of me
1 = Slightly true of me
2 = Moderately true of me
3 = Very true of me
4 = Extremely true of me

35. The more things I achieve in life the less I seem to enjoy them .... ☐
36. I tend to be impatient.................. ☐
37. I sometimes just "tune out" of work and get involved in other things................ ☐
38. Sex is an important part of life for me...... ☐
39. I am frequently frustrated in my work...... ☐
40. Interacting with my family and friends is a great source of enjoyment for me......... ☐
41. I rarely have angry thoughts about people.. ☐
42. When I know I have something unpleasant to do I worry about it for a long time......... ☐
43. I don't take antacids for heartburn or gas... ☐
44. I usually have plenty of energy........... ☐
45. I enjoy being under pressure and doing a good job on many projects at the same time. ☐
46. I really look forward to my vacations....... ☐
47. I make a serious effort to achieve a balance between work and fun................. ☐
48. It is not difficult for me to unwind after work. ☐
49. I really believe it is lonely at the top........ ☐
50. Doing my job gives me a good feeling about myself............................. ☐
51. I have a good balance between family activities and work activities................ ☐
52. I get easily annoyed or irritated........... ☐
53. I frequently have the feeling that something bad is going to happen to me............ ☐
54. I believe having good health is more important than anything.................... ☐
55. Sometimes I feel hopeless about the future. ☐
56. When I am driving the car, I almost never rush through traffic.................... ☐
57. Every day I must get something tangible accomplished or I don't feel good about myself. ☐
58. I feel the most important thing in life is that you achieve something with it................. ☐
59. The idea of meditation or relaxation training has not had much appeal for me................ ☐
60. I believe you can get a lot of help from others in getting the job done in life................. ☐
61. There are significant parts of my job that are frankly dull and boring..................... ☐
62. I don't interact much with friends or neighbors.. ☐
63. I rarely clench my fists during conversation.... ☐
64. I rarely let things get me anxious or tense because I know they always get worked out somehow... ☐
65. I am very careful about my diet............. ☐
66. I sometimes have thoughts of ending my life... ☐
67. When I have an appointment I rarely arrive late or at the last minute...................... ☐
68. Once I get started on a project, I don't like to stop until I am finished........................ ☐
69. I believe competition builds character and is good for you........................... ☐
70. I have trouble relaxing................... ☐
71. I believe life is a struggle and you don't get anything for free out of it.................. ☐
72. When I wake up in the morning, I really look forward to going to work.................. ☐
73. I really enjoy going to parties and meeting people. ☐
74. If someone expresses a stupid idea, I rarely publicly disagree........................ ☐
75. Sometimes I feel tense and anxious for no apparent reason......................... ☐
76. I take tranquilizers to relax or sleep.......... ☐
77. I rarely blame myself unduly for things that go wrong............................... ☐

Please indicate what you believe your current level of stress to be by placing an "X" on the line below.

Totally Free of Stress ●——————————————● Extremely Highly Stressed

APPENDIX C

THE REVISED DYADIC ADJUSTMENT SCALE

Circle one: Female Male

The Revised Dyadic Adjustment Scale

Most persons have disagreements in their relationships. Please indicate below the approximate extent of agreement or disagreement between you and your partner for each item on the following list.

	Always Agree	Almost Always Agree	Occasionally Disagree	Frequently Disagree	Almost Always Disagree	Always Disagree
1) Religious Matters						
2) Demonstrations of Affection						
3) Making major decisions						
4) Sex relations						
5) Conventionality (correct or proper behavior)						
6) Career decisions						

	Every day	Almost every day	Occasionally	Rarely	Never
7) Do you and your partner engage in outside interests together?					

	All the time	Most of the time	More often than not	Occasionally	Rarely	Never
8) How often do you discuss or have you considered divorce, separation, or terminating your relationship?						
9) How often do you and your partner quarrel (or argue)?						
10) Do you ever regret that you married (or lived together)?						
11) How often do you and your partner "get on each other's nerves?						

How often would you say the following events occur between you and your partner?

	Never	Less than once a month	Once or twice a month	Once or twice a week	Once a day	More often
12) Have a stimulating exchange of ideas						
13) Work together on a project						
14) Calmly discuss something						

APPENDIX D

IRB APPROVAL LETTER

Oklahoma State University Institutional Review Board

Date:	Thursday, February 02, 2006
IRB Application No	HE0640
Proposal Title:	Researching Recruitment Challenges in Low-Income Marriage Education Programs
Reviewed and Processed as:	Exempt

Status Recommended by Reviewer(s): Approved Protocol Expires: 2/1/2007

Principal Investigator(s

Brandt Gardner
233 HES
Stillwater, OK 74078

Kelly Roberts
233 HES
Stillwater, OK 74078

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

☑ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Beth McTernan in 415 Whitehurst (phone: 405-744-5700, beth.mcternan@okstate.edu).

Sincerely,

Sue C. Jacobs, Chair
Institutional Review Board

VITA

Daniel Spencer Hubler

Candidate for the Degree of

Doctor of Philosophy

Thesis: TESTING NESTED ASSOCIATIONS BETWEEN MICRODIMENSIONAL AND GLOBAL INDICATORS OF ROMANTIC RELATIONSHIP OUTCOMES

Major Field: Human Environmental Sciences, with option in Human Development and Family Science

Biographical:

Education:

Completed the requirements for the Doctor of Philosophy in Human Environmental Sciences, with option in Human Development and Family Science at Oklahoma State University, Stillwater, Oklahoma in May, 2012.

Completed the requirements for the Master of Science in Human Development and Family Science at Oklahoma State University, Stillwater, Oklahoma in May, 2009.

Completed the requirements for the Bachelor of Science in Family Studies at Weber State University, Ogden, Utah in 2006.

Experience:

Professional Memberships: National Council on Family Relations; Oklahoma Council on Family Relations

Name: Daniel S. Hubler Date of Degree: May, 2012

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: TESTING NESTED ASSOCIATIONS BETWEEN MICRODIMENSIONAL AND GLOBAL INDICATORS OF RELATIONSHIP OUTCOMES

Pages in Study: 136 Candidate for the Degree of Doctor of Philosophy

Major Field: Human Environmental Sciences

Scope and Method of Study: There is limited information on how emotions and heart rate are associated on microdimensional levels both within and between romantic partners over time. We used multilevel modeling to assess associations between microdimensional occasions of affect and heart-rate nested within varying levels of global factors including marital satisfaction to explore how emotions and physiological indicators are linked both between and within partners over time.

Findings and Conclusions: There is limited evidence of affective interdependence both between and within romantic partners over time. These affective links on both actor and partner levels decrease as time increases. Furthermore, limited evidence was found indicating that heart-rate variability may be stable within romantic partners, but that there is very small evidence indicating partner effects. Finally evidence was found that many of these interdependent relationships were moderated by various contextual levels of global factors including couple's reports marital quality and partner's vagal regulation.

ADVISER'S APPROVAL: Dr. Brandt C. Gardner