Social Affect Regulation and Physical Affection Between Married Partners: An Experimental Examination of the Stress-Buffering Effect of Spousal Touch and the Role of Adult Attachment

by

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ABSTRACT

Background: When studying how humans regulate their affect, it is important to recognize that affect regulation does not occur in a vacuum. As humans are an inherently social species, affect plays a crucial evolutionary role in social behavior, and social behavior likewise assumes an important role in affect and affect regulation. Emotion researchers are increasingly interested the specific ways people help to regulate and dysregulate one another's affect, though experimental examinations of the extant models and theory are relatively few. This thesis presents a broad theoretical framework for social affect regulation between close others, considering the role of attachment theory and its developmental foundations for social affect regulation in adulthood. Affectionate and responsive touch is considered a major mechanism of regulatory benefit between people, both developmentally and in adulthood, and is the focus of the present investigation. *Method:* A total sample of 231 heterosexual married couples were recruited from the community. Participants were assigned to engage in affectionate touch or sit quietly, and/or engage in positive conversation prior to a stress task. Physiological data was collected continuously across the experiment. *Hypotheses:* Phasic respiratory sinus arrhythmia (RSA) was used to index the degree of regulatory engagement during the stressor for those who did and did not touch. It was hypothesized that touch would reduce stress appraisal and thus the need for regulatory engagement. This effect was predicted to be greater for those more anxiously attached while increasing the need for regulatory engagement in those more avoidantly attached. Secondarily, partner effects of attachment on sympathetic activation via pre-ejection period (PEP) change were tested. It was predicted that both attachment dimensions would predict a decrease in partner PEP change in the touch condition, with avoidant attachment having the strongest effect. *Results*: Hierarchical linear modeling techniques were used to account for nonindependence in dyadic observations. The first set of hypotheses were not supported, while the second set were partially supported. Wives' avoidance significantly predicted husbands' PEP change, but in the positive direction. This effect also significantly increased in the touch condition. Theoretical considerations and limitations are discussed.

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Chapter 1

Introduction

Emotion and Emotion Regulation: Theory and Perspectives

The Process Model. The ability to modulate one's emotional response to a stimulus—threatening or otherwise—at any point along the unfolding of the generative process is crucial to healthy functioning and navigation within the modern environment (Gross, 1998; Gross, 1999; Gross, 2002; Panksepp, 1998). The more rudimentary components of our response tendencies are thought to have evolved in order to allow organisms to detect and respond to stimuli relatively quickly and in a manner that maximizes the likelihood of survival (Gross, 1999; Tooby & Cosmides, 1990). While a relatively strong and inflexible biasing of behavior and cognition can be very effective at achieving basic goals of survival, this inflexibility can also be a detriment, especially as the environmental demands and consequences that drove their selection change over time (Clore & Ortony, 2000; Gross, 1999; Panksepp, 1998; Tooby & Cosmides, 1990). The ability to better evaluate stimuli and actively or passively modulate the coordinated physiological, cognitive-experiential, and behavioral responses or consequences with respect to short and long-term goals and demands allows much greater flexibility for an organism in regard to the environment, an ability that is especially pronounced in humans through their complex neocortex and its interface with subcortical systems.

The selection and modulation of the experience and expression of emotion in congruence with goals and situations is often referred to in the contemporary literature as *emotion regulation* (Gross, 1998; Gross, 1999; Gross, 2002; Thompson, 1991). This process includes targeting the dynamic features of each emotional component, such as latency or magnitude of a physiological response or subjective experience, as well as the way that the domains of emotion coordinate and relate to one another (Gross, 2002; Thompson, 1991). Gross' Process Model is a popular model of emotion regulation that describes and categorizes regulation strategies in relation to which point across the emotion generative process they target. At the most basic level, these are broken up into antecedent-focused strategies, which are strategies deployed prior to the full engagement of emotional response tendencies, and response-focused strategies, which occur during or after emotion generation (Gross, 1998; Gross & Barrett, 2011; Gross, 2002).

There are, however, some issues with this model. While the model doesn't preclude inclusion of automatic processes, Gross does seem to largely focus on the discussion of conscious or willful strategies. More importantly, it pertains largely to the self-regulation of emotion without explicitly considering between-person or person-environment dynamics and reciprocity. One major issue in this vein, which underscores a problem with the idea of emotion regulation at large, is that emotion affects the deployment of antecedent strategies themselves. The decisions involved in the antecedent strategies of situation selection and situation modification may in turn be influenced by the components of emotion, so how can one say that they are antecedent at all? For example, in order to reduce anxiety, one might decide to avoid social situations through what Gross would call situation selection, yet actual anxiety experienced by anticipating the anxiety that might be felt in a social situation would likely guide the selection of an avoidance strategy. This means in order to self-regulate emotion through antecedent situation selection, one must first self-regulate emotion through response-focused modulation. This sort of chicken-egg problem with emotion and emotion regulation will be discussed further, but regardless, the Process Model is a useful way to parse emotion regulation as happening across different points of a generative process, and serves as an important baseline model on which to elaborate when considering more socially-focused and reciprocal emotion processes.

Emotion or Affect? Regulation or Generation? The study of affect, emotion, motivation, stress, and their regulation has origins spanning multiple disciplines and perspectives. This inevitably results in a lack of uniformity and agreement on terms and their definitions, so it is important to clarify what is meant herein by emotion and affect. Affect is often used as a synonym for emotion, or as a subordinate category that describes the valenced experiential component of emotion. Gross (1998) citing Scherer (1984), however, defines affect as a superordinate category that includes all valenced states, including emotion, mood, and what Gross refers to as emotional episodes. For the sake of clarity and consistency, Gross' organization of affect and emotion will be used, with affect subsuming emotion next to more diffuse states of mood. Therefore, affect will not refer only to the experiential aspects of these states or tendencies, and instead, the subjective or experiential components of emotion will be qualified as such.

Much debate among emotion researchers since the emergence of emotion regulation in the literature has centered on whether or not emotion regulation is usefully or realistically extricable from emotion or the emotion generative process itself (Campos, Mumme, Kermoian, & Campos, 1994; Gross, 1998). In a review, Gross (1998) acknowledges this conundrum as legitimate and scientifically important, concluding that a perspective of *relative regulation* is best, considering the complexity and reciprocity of neural processes that give rise to emotion across domains in the first place. More systematically exploring this topic, Gross and Barrett (2011) organize what they see as the predominant theoretical perspectives of emotion as a continuum, with increasing levels of parallel processing, reciprocal processing, and constructionism coinciding with decreasing mechanistic distinguishability between emotion generation and emotion regulation. However, they propose that regardless of whether substrates for distinct generation and regulation processes actually exist, emotion regulation may still be a phenomenologically important construct. They state

> The generation–regulation distinction might lie in the subjective experience of agency or will. Emotion generation might refer to instances when there is no sense of agency in making an affective state meaningful, whereas regulation refers to instances that are accompanied by an experience of agency. To understand emotion regulation, then, is to understand the nature, causes, and functions of this phenomenological distinction. (Gross & Barrett, 2011, p. 13)

The present investigation takes a similar perspective amongst the theoretical uncertainty, operating from the position that the concept of emotion regulation is *at least* descriptive of features of a dynamic and reciprocal emotion generative process within and between individuals, and is therefore a theoretically relevant construct in the conversation about emotion and its mechanisms. The perspectives discussed in the cited review represent components and levels of analysis and do not necessarily contradict one another's explanations, nor do they entirely preclude conceptualizations of generative process trajectories continuously modified by regulation processes and vice-versa. The discussion herein is bio-centric in nature, but attempts to approach the theory in an integrative manner that bridges perspectives—from basic to social constructionist—in order to account for the critical aspect of the social environment, without neglecting the internal processes with which it interacts.

Emotion Regulation in a Social Context

Overview. Humans are an inherently social species, and social behavior tends to be facilitated by affect in order to build and maintain social relationships (Baumeister & Leary, 1995; Burleson & Davis, 2014; Gross, 1998; Schoebi & Randall, 2015). The relationships and social networks we build can be considered a subset of the environment—our social environment, with the affective-cognitive components of human social behavior affording flexibility there as well (Beckes & Coan, 2011). From the frame of reference of an individual, a major utility of these social relationships is in providing additional resources and support in both concrete and abstract form at multiple levels across the lifespan (Baumeister & Leary, 1995; Beckes & Coan, 2011). For example, friends or family can provide monetary support in the event of job loss, they may help watch children, and offer advice, guidance, or reassurance in times of conflict, grief, or indecision.

In addition to the tangible resources or immediate assistance others can provide in various times of need, these resource-laden bonds are important in how people perceive and appraise stimuli, as well as how they formulate and pursue goals (Beckes & Coan, 2011; Coan & Sbarra, 2015; Coan, Schaefer, & Davidson, 2006); simply having reliable social bonds can modulate emotion and mood through appraisal by engendering confidence, competence, and providing general feelings of security in the face of threat and opportunity, and can directly influence emotion, motivation, physiology, and mood by acting as conditioned cues (Burleson & Davis, 2014). These are largely the pillars of what is often termed “social support”. Beyond this more passive influence, relationships also serve as an active system where behaviors and displays between agents further influence one another’s emotion and mood from moment to moment. Therefore, social relationships both shape and are shaped by affect and play an integral and reciprocal role in maintaining or disrupting goal-directed behavior. Consequently, other individuals may be conceptualized as external affect regulation resources that satisfy drives toward social bonding itself, in addition to providing a means of affect modulation within the context of a relationship through behavioral interactions with close others. This section will broadly discuss a conceptual framework for each of these coarse-grain levels of emotion regulation as they pertain to relationships. Then, specific components and mechanisms of interpersonal affect regulation important to the study at hand will be expounded in the following sections.

Relationship Formation and Social Proximity as Affect Regulation. A review by Baumeister and Leary (1995) discusses an inherent need to belong as a fundamental motivation for the formation of interpersonal relationships. This suggests that relationship formation is a goal in and of itself, with affective and cognitive consequences that guide one’s behavior towards achieving that goal. This is congruent with the general idea that interpersonal relationships and social behavior greatly contributed to survival and fitness, likely because of the resources and division of risk that they provide to each individual within a species (Beckes & Coan, 2011; Coan & Sbarra, 2015). In other words, the value relationships provide through their interpersonal resources across domains means that building, maintaining, and simply having relationships can itself be regulatory through direct and indirect affective outcomes.

Beckes and Coan (2011) frame the emotional and motivational effects of social proximity and close relationships in terms of risk distribution, Bayesian risk assessment, and metabolic resource optimization. This Social Baseline Theory (SBT) posits that humans have adapted to a social environment comprising cooperative and interdependent relationships with shared goals, and in turn, the human brain is functionally organized in a way to "expect" access to relationships and close proximity to others and to guide behavior in order to achieve these adaptive ends (Beckes & Coan, 2011; Coan & Sbarra, 2015). In other words, social behavior and relationship formation acts as a functional baseline vis-à-vis affect and well-being, from which interruptions lead to dysregulation of affect or deviations from normal and healthy functioning.

According to this perspective, behavior is at least partially the result of an implicit Bayesian cost-benefit analysis in regard to mobilizing metabolic resources, with such analyses influencing behavior and decisions through affect. Cited studies show that individuals are less motivated to exert energy when internal metabolic resources are low in relation to the challenge, with evidence demonstrating that this manifests as actual perceptions and appraisals of obstacles as being physically more steep or longer in distance when an individual facing them is tired, hungry, less physically capable, or carrying more weight (Gross & Proffitt, 2013; Proffitt, Stefanucci, Banton, & Epstein, 2003; Schnall, Zadra, & Proffitt, 2010), while a related study also found perceptual biases in height estimation as a function of the threat perception of heights (Clerkin et al., 2009). Likewise, another cited experiment shows similar perceptual distortions when facing physical obstacles absent a partner, as opposed to facing an obstacle with a friend (Schnall, Harber, Stefanucci, & Proffitt, 2008). This motivational infrastructure that optimizes energy resource expenditure in the face of physical obstacles, challenges, and opportunities, is therefore thought to generalize to our social environment, with others acting as extensions of our own perceived resources to deal with its demands and reducing the perceived cost of responding (Gross & Proffitt, 2013). This means that the presence or availability of others influences the appraisal of situations and subsequent affective responses—an important notion when it comes to predicting how people will regulate one another.

Within this framework, the ecological principle of risk distribution in social species is used to partially explain the affective consequences of simple social proximity as a means of social support. Humans—like other social species—are thought to be motivated toward social proximity because groups tended to reduce the risk of predation toward any individual within a group (Beckes & Coan, 2011; Coan & Sbarra, 2015; Krebs & Davies, 2009; Davies, Krebs, & West, 2012; Lima, 1995; Roberts, 1995; Roberts, 1996). As a part of this hypothesis, the distribution of risk across members allows each individual to allocate more of their own cognitive resources to other tasks, including regulatory processes in humans. So, because of these benefits afforded by social proximity, people tend to feel less threatened and more responsive to environmental demands when they are near similar others, though not necessarily others with whom they share close relationships (Beckes & Coan, 2011; Coan & Sbarra, 2015). Conversely, people tend to be more vigilant toward threat and less approach-oriented when they don't feel that others are readily available (Coan et al., 2006).

Beyond simple social proximity, the theory seeks to explain the greater affective consequences of increasingly meaningful relationships, where mutual trust, cooperation toward shared goals, and dependence on one another tend to be hallmarks. These relationships among family, friends, and significant others offer a rich array of tangible and intangible social resources—what Beckes and Coan (2011) refer to as load sharing. Because of these rich social resources, close relationships should diversely and more effectively mitigate the perceived cost in responding to the environment and reduce the load on one's own cognitive and affective resources, maximizing flexibility when dealing with internal and external demands (Butler & Randall, 2013; Coan & Sbarra, 2015; Hennesey, Kaiser, & Sachser, 2009).

Interaction and Dynamics in Social Affect Regulation. While SBT provides a broad framework and ecological context for explaining how and why social support and close relationships with others modulate emotion and mood early within—and prior to—the emotion generative process, the literature doesn't completely explore the details of social affect regulation mechanisms and patterns at the level of individuals within one or multiple relationships. The dynamics of interpersonal influences on the facets of emotion and mood at the group, individual, and intra-individual levels can provide important ecological insight into processes and mechanisms of emotion regulation, explicitly examining it as a bidirectional process that builds and unfolds over time between two or more close individuals (Diamond & Aspinwall, 2003). While infant-parent relationship researchers have been analyzing these components for some time, an increasing number of researchers who study group dynamics, affect regulation, and relationships have been focusing on this interdependence modeling, especially within the context of adult romantic relationships.

The modeling of social affect regulation as a dynamic interpersonal system has been broadly referred to as *coregulation* in the literature. Butler and Randall (2013) make a case for reserving this term for a particular type of interpersonal affect regulation, and although their definition isn't universal, the discussion explains important observed characteristics among the patterns of interpersonal emotion dynamics. They operationalize coregulation as "a bidirectional linkage of oscillating emotional channels…between partners, which contributes to emotional and physiological stability for both partners in a close relationship (p. 203)." According to this definition, coregulation refers not only to the bidirectional nature of emotional influence between individuals, but also a particular pattern of allostatic emotional stabilization. In this delineation, measures of emotion or arousal tend to fluctuate in response to a partner's behavior and accompanying emotional state from time point to time point. Coregulation occurs when measures of emotion oscillate in response to a partner in order to maintain a flexible set point—one which depends on each person's internal capacities and external demands (for additional evidence and discussion of coregulation patterns in adults, see Butner, Diamond, & Hicks, 2005; Ferrer & Helm, 2013; Helm, Sbarra, & Ferrer, 2014; Laurent & Powers, 2007; Mikulincer, Shaver, & Pereg, 2003; Reed, Randall, Post, & Butler, 2013; Saxbe & Repetti, 2010; Sbarra & Hazan, 2008).

Butler and Randall (2013) and Butler, Wilhelm, and Gross (2006) refer to this emotional interdependence and optimization as morphostatic oscillation or synchrony, asserting that the pattern is a necessary component of coregulation that distinguishes it from other similar patterns of interpersonal affect regulation or dysregulation, such as morphogenic dysregulation. In such a pattern, emotional measures are still correlated or synchronized between partners. However, rather than maintaining flexible-yet-stable bounds of emotional responses between individuals, a morphogenic pattern is considered to be characterized by a mutual escalation or de-escalation in one or multiple measures of emotional intensity or valence, resulting in a drifting trend of positive feedback on these observable measures. On the other hand, social proximity as a stress buffer would be characterized by at least one person's divergence on a measure of stress response, with a faster return to baseline in the presence of another person. It is important to note that some researchers in the field (e.g. Hudson, Fraley, Brumbaugh, & Vicary, 2014) operationalize coregulation to include these dynamics of partner effects, but more broadly as coordinated responses between partners. In congruence with what is discussed in Social Baseline Theory, this stress buffering effect exists in the proximity of mere strangers but is typically strengthened when the other person is a close partner with shared goals, trust, positive expectations of reliability, and interdependence between them (Butler & Randall, 2013; Hennesey, Kaiser, & Sachser, 2009).

It is these aspects of close relationships that are of particular interest when studying interpersonal affect regulation between close partners. Regardless of operational definitions or modelling techniques, the effects of one close partner on the other depend largely on certain individual characteristics. What if one partner doesn't trust the other, or one or both partners have generally ambivalent expectations about other people's availability? These individual differences in expectations about others are crucial in predicting to what extent social affect regulation will occur and how it may manifest at many levels of analysis.

Attachment Theory: A Developmental Theory of Adult Regulation

Attachment Theory integrates a broad array of psychological and physiological mechanisms to create a framework of reciprocal, bootstrapping processes that culminate in a stable series of cognitive social schemas and their associated cognitive-affective responses to close others in adulthood. Early on, these processes can help build and maintain affiliative bonds that act as "templates" for other social relationships in terms of social cognitions. They also appear to help shape affective systems and one's own capacity to self-regulate emotion (Coan, 2008; Fox, 2003, 1989; Fraley, 2002; Jean, Stack, & Arnold, 2014; Pratt, Singer, Kanat-Maymon, & Feldman, 2015; Sbarra & Hazan, 2008; Tottenham, 2013). In fact, attachment appears to be so inextricably linked with self and social affect regulation, that Schore and Schore (2008) describe modern attachment theory as a comprehensive theory of affect regulation as a whole.

As with many developmental models, the interaction between trait and environment can be difficult to disentangle across the developmental span, especially when the construct involves interactions between individuals. This creates many "meta" considerations that support the overall theme of emphasis on social interaction, context, individual differences, and reciprocity when discussing the components of affect and affect regulation. Additionally, this functions to support the notion that attachment, self-regulation, and social affect regulation are all facets of a set of interwoven processes (Hofer, 2006).

According to Bowlby (1982a, 1982b, 1988), children are born with an innate drive toward proximity-seeking—a basic view endorsed by SBT and Baumeister and Leary (1995). Under a fundamental description of a healthy trajectory of attachment development, this proximity-seeking is self-reinforcing through affect regulation, and over time, a child learns that close others are a reliable source of security and that the environment is generally safe to approach and navigate—embedding close others and associated cues in the experience and formation of a homeostatic set point. Thus, stable secure attachment schemas are formed and generalized across close social relationships, and healthy, flexible affective responses to the environment are developed (Bowlby, 1988; Fraley, 2002; Hofer, 2006; Mikulincer, Shaver, & Pereg, 2003; Sbarra & Hazan, 2008). Likewise, disruptions in this normal developmental process may result in insecurity and maladaptive functioning of affective systems. This suggests that the processes and mechanisms in infancy, childhood, and adolescence help to construct the more stable cognitive-affective infrastructure that guides how these same processes and mechanisms influence affect in adulthood, which may further differ across specific relationships and contexts.

Touch and Physical Affection: Mechanisms of Social Affect Modulation

Responsive physical contact plays a central mediating role in the interrelationship between attachment and affect regulation among close others, beginning in infancy. (Connor, Siegel, McFarland et al., 2012; Dunbar, 2010; Fox, 1989, 2003; Gallace & Spence, 2010; Hertenstein & Campos, 2001). In adulthood, the extant research on affectionate touch between romantic partners has shown a general tendency of positive and affectionate physical contact to buffer perceived stress, physiological stress responses, and contribute to overall well-being (Burleson & Todd, 2007; Burleson & Davis, 2014; Grewen, Anderson, Girdler, & Light, 2003; Jakubiak & Feeney, 2016a, 2016b). There are several mechanisms that underlie these effects of touch on affect at multiple levels (Jakubiak & Feeney, 2016a), but the discussion here will be limited to the biochemical mediator that has been at the forefront of much recent research on social cognition and emotion: oxytocin.

Although much of the research on oxytocin originally focused on its role in promoting positive social affect, cognition, and prosocial behavior, evidence has demonstrated that it is not simply a mediator of positive social bonding. A review by Bartz, Zaki, Bolger, and Ochsner (2011) points out the importance of context and moderating individual differences when considering the effects of oxytocin, an interactive complexity that underlies the context-sensitive flexibility that affect normally confers to social behavior in general. Notably, they cite a placebo-controlled, double-blind study that found exogenous intranasal oxytocin to bias feelings toward an attachment figure in either direction—depending on the individual's attachment security (Bartz, Zaki, Ochsner et al., 2010). Those who received the oxytocin treatment recalled their mothers as more caring and close compared to baseline and placebo, but only if they were more securely attached. Those who were less securely attached actually recalled their mothers as being less caring and close compared to baseline and placebo. This suggests that oxytocin—as a partial mediator of affectionate touch—is involved in building and maintaining affective responses toward an attachment figure in a manner congruent with past experiences and expectations subsumed by one's attachment security.

Aims of the Present Study

Influence of Partner Touch on Regulatory Engagement. The moderating effects of attachment security on the affective consequences of social interaction with close others are the main focus of this investigation. The reliance on close others as a regulatory resource should theoretically depend on general and relationship-specific experiences with close others that form one's attachment schemas across the developmental span. Moreover, attachment security is multi-dimensional, such that both the level and type of attachment security may differentially impact the regulatory function of partner touch and its associated mechanisms.

Evidence across multiple measures has shown differential effects of partner presence or touch based on the level of attachment security or style. For example, in addition to the cited oxytocin study, Krahe, Paloyelis, Condon et al. (2015) found that those with higher avoidant attachment scores actually had increased subjective pain ratings and evoked potentials when stimulated with a laser, as compared with those who were not in the presence of their partner. This suggests that those who are more avoidantly attached may be more dysregulated by their partner under certain circumstances, especially when it comes to the appraisal of a threatening stimulus.

Under the extensive theoretical framework presented, the stress-buffering effects of one's spouse were examined experimentally. The first analysis looked at touch as an overall potentiator of the cognitive and affective consequences of social bonding—for better or for worse. Here, phasic Respiratory Sinus Arrhythmia (RSA; see the Methods section for a brief overview) change was used as a measure of regulatory engagement, such that the size of the net increase or attenuated decrease in RSA reactivity (i.e., a greater RSA difference score) was thought to correspond to a greater engagement in emotion self-regulation and cognitive load during a stress task. Conversely, a greater net decrease in RSA from baseline (i.e. a lower RSA difference score) was assumed to reflect both the contribution of normal vagal withdrawal during stress and decreased parasympathetic stimulation related to regulatory engagement (Butler, Wilhelm, & Gross, 2006; Fagundes, Diamond, & Allen, 2012). Therefore, the buffering effect of spouse interaction was indexed by the degree of regulatory engagement as measured by RSA reactivity, such that a reduced need for engagement or effort indicated a greater buffering effect at stress appraisal.

This use of phasic RSA as an index of regulatory effort is based on findings by Butler, Wilhelm, & Gross (2006), who presented evidence that differences in baseline RSA reflect differences in trait emotional reactivity and flexibility, while RSA reactivity during response-focused regulation strategies reflects the degree of regulatory effort or engagement. In their experiment, participants were instructed to either suppress negative emotional expression or reappraise during an emotional film, while a third group was not given regulation strategy instructions. Both groups engaging in regulatory strategies showed an increase in RSA, while the uninstructed participants did not. This occurred in both regulation groups, despite the suppressors reporting the same amount of subjective negative emotion as the uninstructed group, demonstrating an effect of regulatory engagement independent of positive affect or regulatory outcome.

Within the present experiment, heterosexual married couples were assigned to either engage in positive physical contact with one another, engage in positive relationship-specific conversation with one another, neither, or both. For this investigation, only differences between the "touch" and "no-touch" conditions were of interest, however. Couples engaged in this interaction task prior to a stress task, meaning that the interaction with one's partner should regulate—or dysregulate—at the level of appraisal.

Overall, people in healthy long-term marriages should act as social affect regulators for one another, leading to decreased stress appraisals after being in close proximity to their spouses, and thus less need to engage in response-focused regulation. Above and beyond proximity, however, engaging in positive physical contact should potentiate the influence of one's partner, through various mediating mechanisms. However, the stable attachment schemas that describe one's general attitudes about close others, expectations of a partner's availability, and associated security should influence how the presence and interaction with a partner affects one's stress appraisal and subsequent regulatory engagement. Therefore, it was hypothesized that:

1a.) Those in the touch condition will have a significantly lower RSA change compared to those in the no-touch condition, indicating a reduced need for regulatory engagement.

1b.) Participants who are more anxiously attached will show a pronounced effect of touch, demonstrating an increased reliance on partner interaction in the face of a stressor compared to those who are less anxiously attached.

1c.) Participants who are higher on avoidant attachment will show the opposite effect—they will have a significantly higher RSA change score compared to those who are less avoidantly attached. This would suggest that for those who are avoidantly attached, engaging in physical contact with their partners before a stressor would increase their stress appraisal, in turn resulting in greater regulatory engagement during the stressor.

The Influence of Partners' Attachment on Stress Reactivity. While the primary set of hypotheses is concerned with how partner interaction contributes to emotion regulation based on participants' own attachment, the secondary set considers the degree that partners' attachment schemas predict participants' stress reactivity after interacting with their partner. Beyond one's own schemas, knowledge about a partner's attitudes and tendencies related to their attachment could influence the overall regulatory benefit a partner bestows on an individual, and this knowledge is potentially primed and made more salient after interacting with a partner—adding an additional layer of complexity when considering how romantic partners influence one another's emotions across contexts or individual factors. This may, in part, contribute to relation-specific and longitudinal fluctuations around more stable attachment schemas. Here, stress reactivity is measured by the change in sympathetic nervous system activation via cardiac pre-ejection period (PEP; see the Measures section for a brief overview of PEP and its measurement). It is hypothesized that:

2a.) Partner attachment will negatively predict one's own PEP reactivity, such that a greater degree of attachment insecurity on either attachment dimension will predict a larger decrease in PEP from baseline, reflecting greater sympathetic cardiac outflow during the stressor.

2b.) This effect will be moderated by touch condition, where the effect is significant for those who engaged in positive physical contact before the stressor, but non-significant for those who did not.

2c.) Partners' avoidant attachment will have the strongest relationship.

Chapter 2

Method

Participants

Sample Characteristics. The data used for the present analyses are those from a larger National Institutes of Health grant-funded study lead by Mary Burleson, the chair and advisor on this thesis. A planned total of 240 heterosexual married couples were recruited from the Greater Phoenix Metropolitan Area through community advertising via flyers and online postings. This target sample size was based on the estimated number of couples required to achieve adequate power to detect moderate effect sizes in a multilevel model, once considering the number of parameters proposed for the main hypotheses in the grant proposal.

In total, 231 couples were included in the dataset, yielding 462 individuals. Of those, 226 couples had at least one member with data for the included epochs and predictors. With the analysis techniques used, individuals need not be excluded for missing data outright; as long as they had data for at least one individual-level variable in the model, they could be included in the analysis. However, both couple members had to be excluded if either one was missing couple-level data (i.e. experimental condition), or if both members were missing data on either the outcome variable or all individual-level variables in the model. For the analysis technique used with the PEP data, couple-level deletion also occurred if a couple member was missing their outcome variable and predictors, since their predictors are also used in their partner's equation. This means that one partner's missing data can also result in missing data for the other couple member, increasing the likelihood of couple-level deletion (Kenny, Kashy, & Cook, 2006).

These missing data constraints resulted in a sample size of $N = 224$ couples and $N = 425$ individuals for the full-model RSA analysis. Of those with insufficient data, all were excluded based on individual-level and outcome variables, as no couples were missing experimental condition coding. The PEP analysis had a smaller sample size of $N = 204$ couples with $N = 381$ individuals.

Inclusion/Exclusion Criteria. Participants were deemed eligible for the study if they were married for at least 6 months, both members of the couple agreed to participate, both could read and speak English, both identified as the same ethnicity, and both were between the ages of 21 and 75. Couples were excluded if the wife was pregnant or nursing at the time of screening in order to reduce differences in endogenous hormones between participants. Due to the possible effects of estrogen on oxytocin (McCarthy, McDonald, Brooks, & Goldman, 1997), they also could not be taking exogenous hormones other than oral contraceptives, which—while unfavorable—were allowed due to their common use. Men did not have any sex-specific physiological exclusions.

No participants could be taking any class of anxiolytics, beta-adrenergic receptor blockers, or calcium channel blockers due to their affective and physiological effects—especially those effects on cardiovascular functioning. Recreational drugs were exclusionary only if they were consumed more than three times per week, and alcohol consumption was exclusionary above moderate levels

(10 or more beverages per week for women and 15 or more for men). Binge-drinking consumption patterns were not explicitly considered. Chronic severe illnesses (e.g. Type 1 diabetes mellitus, cancer, rheumatoid arthritis, or kidney disease) or moderate to severe depression also disqualified candidates so as to reduce other sources of abnormal variability in physiological functioning and affective response. Other screening criteria limited vigorous exercise to less than 20 hours per week, a body mass index to 33 or below, and disallowed tobacco use at a dosage of more than six cigarettes per day, as tobacco, excessive weight, and heavy cardiovascular exercise can influence cardiovascular functioning, measurement, and stress reactivity. Additionally, non-users of tobacco had to have been abstinent from tobacco use for at least 6 months prior to screening, and light smokers were excluded if they consumed their first cigarette within an hour of waking.

Because the goal was to examine the normal social regulatory functions served by relatively healthy relationships, only participants who answered a three or above on a one to six scale inquiring about their marital satisfaction were invited to participate. Furthermore, data from participants who scored below a 70 on the Martial Adjustment Test (MAT; Lock & Wallace, 1959) or an equivalent score on the Dyadic Adjustment scale (DAS; Montesino, Gomez, Fernandez et al., 2013; Sharpley & Cross, 1982; Spanier, 1976; Spanier & Cole, 1976) were excluded from the data, as these scores indicate mild to moderate marital distress. Participants also could also not be enrolled in marital therapy at the time of the study.

Materials

Experiences in Close Relationships Scale—Revised. The Experiences in Close Relationships—Revised (ECR-R) scale was administered as part of a larger battery of questionnaires within the study. This revised version of the Experiences in Close Relationships scale (ECR; Brennan, Clark, & Shaver, 1998) was developed by Fraley, Waller, and Brennan (2000) through an item-response analysis on the original ECR to further refine the construct validity and reliability of the scale. Like the original ECR, the revised scale contains two dimensions of Anxious and Avoidant attachment security (however, see the Discussion section for caveats and issues related to its purported orthogonality). Evidence over years of extensive use has demonstrated strong psychometric characteristics, including stable test-retest reliability (Sibley, Fischer, & Liu, 2005). As for internal consistency, the inverse variance-weighted Cronbach's alpha (α) was found to be .909 for the anxiety dimension and .919 for the avoidance dimension across 227 studies (Cameron, Finnegan, & Morry, 2012).

Respiratory Sinus Arrhythmia. Respiratory sinus arrhythmia (RSA) is a specific measurement of the cyclical fluctuations in heart period due to parasympathetic slowing of the heart via the vagus nerve's innervation on the sinoatrial node (Berntson, Bigger, Eckberg et al., 1997; Berntson, Quigley, & Lozano, 2007; Denver, Reed, & Porges, 2007; Hughdahl, 1995; Stern, Ray, & Quigley, 2001). These oscillations of heart period variability can be decomposed by Fourier transformation into component frequencies, where the high-frequency band that corresponds to the respiration cycle is then extracted as high-frequency heart-rate variability, or RSA (Berntson et al., 1997).

RSA is commonly used in psychophysiological research as an index of cardiac parasympathetic activation, where resting or tonic RSA is typically thought to reflect trait allostatic flexibility (Berntson et al., 1997; Butler, Wilhelm, & Gross, 2006; Hughdahl, 1995; Porges, 2007), while phasic RSA or RSA reactivity appears to reflect two opposing processes. During stress, there is a normal decrease in RSA—referred to as vagal withdrawal—that allows for adaptive fight-flight responding to a threat. However, RSA increases have been associated with general cognitive effort (Berntson et al., 1997) or regulatory effort and engagement in such contexts (Butler, Wilhelm, & Gross, 2006). During stress, these influences on parasympathetic outflow could occur simultaneously, leading to a net decrease or increase that reflects the degree of regulatory engagement.

During the experiment, heart rate variability was collected with Mindware Systems electrocardiograph (ECG) hardware and BioLab software. RSA was cleaned then extracted from the high frequency band by way of spectral analysis of the frequency components using Mindware HRV software.

Pre-Ejection Period. The cardiac pre-ejection period (PEP) is the latency between atrioventricular depolarization and the release of blood into the aorta from the left ventricle. As a measure of contractile force, it is highly negatively correlated with cardiac sympathetic input (Hugdahl, 1995; Stern, Ray, & Quigley, 2001); sympathetic input speeds the cardiac cycle. The components of PEP calculation were collected using Mindware ECG and impedance cardiograph hardware, and BioLab software. Impedance cardiography was used to measure the thoracic electrical resistance changes attributable to changes in aortic bloodflow. The first derivative of this signal was calculated and the data were cleaned using Mindware IMP software. Using this derivative signal, the opening of the aortic valve is marked; using ECG data, the initial wave of ventricular depolarization is marked. PEP is calculated as the time between the two events.

Procedure

Screening. Interested couples were directed to the study website or the study phone line. On the website, individuals were first pre-screened on major inclusion-exclusion criteria using a brief online pre-screening questionnaire. If cursory eligibility was determined per the pre-screen questionnaire, they were then contacted and fully screened by research assistants over the telephone. Fully-eligible couples were then invited to participate, scheduled for a lab session, and provided the HCQ to complete, which was to be completed after a daily diary portion of the larger study. If participants had reliable internet access, they were directed to the online version of the HCQ. Otherwise, they had the option to have a paper copy mailed to them. Also provided were instructions for the daily diary portion of the study, however those data and procedures are not relevant to the current analyses and are therefore not discussed here.

Laboratory Session Set-up Procedures. Participants arrived at the laboratory and were briefed on and consented to the procedures. After they used the restroom and height, weight, and blood pressure were collected, each couple member was administered a series of in-lab questionnaires that assessed current positive and negative affect, feelings toward their partners, and assessments of the laboratory stressor. Parts of this questionnaire were administered longitudinally at different points throughout the procedure to measure any changes in subjective ratings. The research assistants (RAs) then placed the surface electrodes for electrocardiography and impedance cardiography measurements. Additionally, a finger-pulse plethysmograph and skin conductance sensors were placed on the finger and palm, respectively, while a respiration belt was fitted around the lower chest. Blood pressure cuffs were placed prior to the initial blood pressure check.

Once signals were checked and necessary adjustments made, a baseline measurement was collected with both members of the couple sitting in separate rooms. After this initial baseline, one member—who was randomly-designated as the "mover"—was moved into the room with his or her partner, where a second baseline reading was taken while the members sat quietly next to one another.

Experimental Manipulations. Couples who were randomly-assigned to the control condition were instructed to listen to an educational recording while refraining to look at, touch, or otherwise interact with one another during what would otherwise be the positive conversation and physical affection tasks. Participants engaged in this quiet listening task while physiological data was collected across approximately seven minutes. Notably, half of the control couples were assigned to do this next to one another, while half were assigned to be separated into different rooms. For these analyses, both control sub-groups were treated as a single control group, without respect to whether they sat quietly alone or together.

The "talk" condition utilized conversation topics from the set of longitudinal questionnaires provided at the outset of the procedure. One of these questionnaires asked each couple member about relationship-specific topics that give them the "warm fuzzies" (e.g., how they first met or their accomplishments as a couple). Each topic was rated from a zero to six on a "pleasantness" rating scale, as well as a zero to six on an "easiness" scale that pertained to the ease of discussing the topic. Since most of the topics were by default highly-rated as pleasant, the two topics rated as the easiest to discuss were chosen for the conversation task. Couple members in the talk condition were then instructed by an RA to discuss the two selected topics with one another for about five minutes.

In the "touch" condition, couples were first instructed to stand and then turn and embrace one another in a hug. They performed a practice hug first to ensure that the sensors would remain in place. After any necessary adjustments, they were instructed to sit next to one another with their legs touching and hands, arms, etc. interlinked—however they would naturally sit together in an affectionate manner. The RA then initiated data collection for the epoch. If the couple was also assigned to the talk condition, they performed the positive conversation task for the first five minutes leading up to the approximately 30 second embrace, while still maintaining the resting affectionate contact. Otherwise, participants listened to the educational audio recording for the first five minutes while maintaining contact. After the manipulation, the couple member who was assigned to be the mover was transferred to the other room, while their partner remained. After checking the signals once more, a one minute post-manipulation baseline recording was collected from each member.

Stress Tasks. The task used to invoke a stress response is a variation of the Trier Social Stress Test (TSST; Kirschbaum, Pirke, & Hellhammer, 1993), a commonly utilized laboratory stressor. In this adaptation, RAs informed each partner that they would be delivering a speech about the most negative and positive characteristics of their partner, which they had written down and rated in one of the study questionnaires. They were given four minutes to prepare the speech, after which they delivered the three-minute speech to one of the laboratory cameras. After the speech was performed, a one minute recovery epoch was recorded.

Immediately afterward, couple members were briefed on the math portion of the task. They were instructed to count backward by threes, starting from different numbers. The RAs assigned to instruct and interact with each subject were switched so that they would be unfamiliar to each participant. If either participant made an error, the corresponding RA corrected her or him, while maintaining a neutral demeanor throughout. Each counting period lasted for one minute, with six periods for the couple member designated as the mover, while the stayer performed seven iterations of the task. While the stayer finished the seventh set, the mover was disconnected from the Mindware recorder and moved back into the room with their spouse.

Recovery, Close-out, and Debriefing*.* The recovery epoch was manipulated as well, with independent random assignment to either a touch condition, no-touch condition, or "separate room" condition, where couple members were left in their respective rooms after the math stressor. In the touch recovery condition, participants were instructed to display affection toward one another as they would naturally, once they were moved back into the same room. However, they were instructed not to talk with one another. In the no-touch condition, participants simply sat quietly without touching or otherwise interacting. After a seven-minute epoch, questionnaires were once again administered. These included another affective rating scale, as well as reactions to the stressor and the recovery manipulation.

After all sensors were removed, participants were debriefed on the goals of the study and had any questions answered. They were also informed of their baseline blood pressure reading. Stipend forms were completed and permission was gathered to contact them about any future studies they might be eligible for. A final questionnaire was administered, after which participants were provided parking compensation and discharged.

Design and Analyses

Design. The experimental design is that of a 2x2, where couples either did or did not engage in positive conversation with one another, and either did or did not engage in displays of physical affection toward one another. Although both experimental factors were entered as covariates into the model, only main effects of the touch conditions were the focus of these analyses.

Hierarchical Linear Modeling: A Brief Conceptual Overview. In order to simultaneously test both couple-level effects of experimental group and individual-level or within-couple effects of attachment style dimensions and gender, a multilevel (MLM) or hierarchical linear modeling (HLM) approach was taken. This extension of general linear model (GLM) regression is a highly flexible maximum-likelihood (ML) or generalized-least-squares-estimated (GLS) family of analyses that can simultaneously account for variance at the within-group and between-group levels, while modeling both fixed and random effects (Hoffman & Rovine, 2007; Huta, 2014; Kreft & de Leeuw, 1998; Raudenbush & Bryk, 2002; Raudenbush & Willms, 1995; Woltman et al., 2012). This makes multilevel modeling suitable for many different applications where data have a “nested” or hierarchical structure, such as within-subjects data or data with generalizable contextual effects on a particular outcome or subsumed variable.

An intuitive application of this concept is that which is classically used in education research. Take for example an analysis of standardized test scores among students as predicted by some individual factor like study time. One might simply want to sample students across different schools in a city and model their standardized test scores as a function of differences in study time between students. However, scores among these students will likely tend to cluster based on unmodeled variance attributable to similarities between students who share a common learning or geographical environment (or other factors that vary across schools) (Garson, 2013; Kreft & de Leeuw, 1998; Raudenbush & Bryk, 2002). In other words, there will be correlated error terms due to some grouping factor—school, in this case. This means that student observations cannot be assumed to be independent as required by ordinary least squares (OLS) regression—a violation that could result in inefficient (and therefore non-optimal) or biased estimates and subsequent incorrect effect magnitudes or directions (Garson, 2013; Huta, 2014; Kreft & de Leeuw, 1998; Raudenbush & Willms, 1995). Rather than sacrificing power and the aim of the analysis by aggregating data and taking the average within each school, or inflating standard errors by disaggregating any school-level factors, HLM allows for the simultaneous partitioning of the between-school (level 2) and within-school (level 1) variance components (Garson, 2013; Hoffman & Rovine, 2007; Kreft & de Leeuw, 1998). This creates regression models within each school, while accounting for differences in student-level parameters that exist between them.

To achieve this, students in the example are modeled as nested within the schools to which they belong. This is done in HLM by predicting standardized test scores for each student as a function of the linear combination of student-level parameters, just as would be done in a typical OLS regression. However, in a full HLM model, at least some of these level 1 parameters are in turn treated as stochastically-sampled outcomes of linear combinations of level 2 parameters. This treats level 1 parameters as random to the extent that they vary across a random variable of school. More concisely, schools are treated as a sample of schools, while the intercept and slope are estimates of within-school data that are assumed to vary across the sample of schools.

The example hypothesizes that there is a positive relationship between time spent studying and standardized test scores. To begin testing this hypothesis, one would specify a null model that includes no parameters except for level 1 and level 2 intercepts (equations 1 and 2).

$$Score_{ij} = \beta_{0j} + r_{ij} \tag{1}$$

$$\beta_{0j} = \gamma_{00} + U_{0j} \tag{2}$$

Where:

β_{0j} = mean test score for the *jth* school;

γ_{00} = grand mean test score across schools;

r_{ij} = residual level 1 variability, representing all the within-school or between-student variance in the intercept-only model

U_{0j} = error in the estimation of the school mean, representing all the between-school variance

This one-way random effects ANOVA acts as a baseline upon which to add predictors, as well as a test of between-school variability that determines whether a multilevel model is necessary in the first place. (Hox, 1995; Kreft & de Leeuw, 1998; Woltman et al., 2012). Here, a student's score is equal to their school mean score plus between-student error, or the within-school variability around that school mean. This school mean is itself a function of the grand mean of all the schools, plus between-school variability, allowing it to vary across schools. Therefore, the variability of the mean scores are treated as a random effect of school.

To examine whether scores truly vary across schools, this null model partitions the total test score variance entirely into within and between-school components. If the between-school variance represented by the level 2 error term is sufficiently large relative to the total variance represented by the sum of the between and within-school terms (the intra-class correlation), then the data can be said to cluster within each school, warranting the use of HLM. If scores don't cluster, then OLS regression would be sufficient to examine student-level effects without concern regarding independence of observations, given no other serious violations that would contraindicate OLS regression (Hox, 1995; Woltman et al. 2012).

Once it is determined that observations do in fact cluster systematically, a level 1 model can be built with random slopes and intercepts (Hox, 1995). In this case, the model is described by equations 3, 4, and 5:

$$Score_{ij} = \beta_{0j} + \beta_{1j}(\text{Study Time})_{ij} + r_{ij} \quad (3)$$

$$\beta_{0j} = \gamma_{00} + U_{0j} \quad (4)$$

$$\beta_{1j} = \gamma_{10} + U_{1j} \quad (5)$$

Where :

β_{0j} = test score for the *jth* school when study time for students in the school equals zero;

β_{1j} = slope describing the linear relationship between study time and test scores for the *jth* school;

γ_{00} = mean score across all schools when controlling for study time;

γ_{10} = mean relationship between study time and test scores across all schools (pooled main effect of study time on test score).

This allows the hypothesis regarding study time and test score to be tested while taking into account the nested nature of the observations. The level 1 variable here is left uncentered for simplicity of interpretation.

At this point, it can be shown that both intercepts and slopes differ between schools, but no school-level variables have been presented to account for this variability. To this end, HLM also allows group-level factors to be included to account for differences in intercepts and slopes across groups. Perhaps study time did not significantly predict test scores in the previous analysis as expected, so it may be hypothesized that a characteristic that varies between schools may be moderating the relationship between study time and test scores. Thus, it is predicted that school funding will negatively predict mean test scores across schools. Additionally, the relationship between study time and test scores will depend on the amount of funding the school receives. This would be represented by the following equations:

$$Score_{ij} = \beta_{0j} + \beta_{1j}(\text{Study Time})_{ij} + r_{ij} \tag{6}$$

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{Funding}) + U_{0j} \tag{7}$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11}(\text{Funding}) + U_{1j} \tag{8}$$

Where:

β_{0j} = test score for the *jth* school when study time for students in the school is equal to the school mean;

β_{1j} = slope describing the relationship between study time and test scores for the *jth* school;

γ_{00} = mean score across all schools when assuming average study time and school funding;

γ_{01} = slope describing the relationship between school funding and test scores when holding study time constant at its mean;

γ_{10} = mean relationship between study time and test scores across all schools (pooled main effect of study time on test score) when accounting for school funding;

γ_{11} = moderating effect of school funding on the relationship between study time and test scores.

In this model, study time is group mean-centered, while funding is grand mean-centered, altering the interpretation of the slopes and intercepts, improving estimation, and providing true main effect and interaction estimates (Hoffman & Gavin, 1998; Pacaggnella, 2006; Kreft, de Leeuw, & Aiken, 1995; Woltman et al., 2012). The main effect of school funding on test scores over-and-above students' study time can be analyzed, as well as the cross-level interaction between school funding and study time. While this full model illustrates the concepts underlying multilevel modelling techniques, it doesn't demonstrate its flexibility in dealing with dyadic data. The following sections will discuss the application of MLM techniques toward couples' data, including its application to the analysis of these data.

Applications Toward Dyadic Data Analysis. This basic statistical framework can be applied to any data that is inherently nested in structure. In the case of the present analyses, the nested data are those of individuals within a married couple: the couple is the group, while the individuals in each couple are nested within-group. Like data measured within individuals or within groups like schools, data within couple units are assumed to be correlated or non-independent—especially when performing a task where they interact with one another (Atkins, 2005; Gonzalez & Griffin, 2012; Kenny, Kashy, & Cook, 2006; Sayer & Klute, 2005). Rather than dealing with this correlated error by simply analyzing husbands' and wives' data in separate OLS regression models or by examining fixed effects at either the couple or individual level, MLM allows for a full-model analysis of an experimental dyadic paradigm. The specific MLM-based approach executed depends on the goals of the analysis and the constraints posed by the data themselves.

The Interaction Approach for RSA Change. The first approach is essentially a direct translation of the school example to dyads. Couples are treated as the group, while individuals are treated as observations within each group. Again, fixed factors that vary across individuals are placed at level 1, while any fixed factors whose values are the same between individuals in the same couple, but vary across couples, are considered level 2 factors. For the RSA data, this gives the following full model for each individual i in couple j:

$$\Delta RSA_{ij} = \beta_{0j} + \beta_{1j}(\text{Anx})_{ij} + \beta_{2j}(\text{Avoid})_{ij} + \beta_{3j}(\text{Gender})_{ij} +$$

$$\beta_{4j}(\text{GenAnx})_{ij} + \beta_{5j}(\text{GenAvd})_{ij} + r_{ij} \quad (9)$$

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{Touch}) + \gamma_{02}(\text{Talk}) + U_{0j} \quad (10)$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11}(\text{Touch}) + \gamma_{12}(\text{Talk}) \quad (11)$$

$$\beta_{2j} = \gamma_{20} + \gamma_{21}(\text{Touch}) + \gamma_{12}(\text{Talk}) \quad (12)$$

$$\beta_{3j} = \gamma_{30} + \gamma_{31}(\text{Touch}) + \gamma_{12}(\text{Talk}) \quad (13)$$

$$\beta_{4j} = \gamma_{40} + \gamma_{41}(\text{Touch}) + \gamma_{12}(\text{Talk}) \quad (14)$$

$$\beta_{5j} = \gamma_{50} + \gamma_{51}(\text{Touch}) + \gamma_{12}(\text{Talk}) \quad (15)$$

The similarity with the previous school data model is apparent, but there are a few key differences. Because individuals making up the heterosexual married couple dyads are uniformly distinguishable, a gender variable is included along with its interactions with the attachment variables. Of course, this could also be done with the school data if gender differences were of interest, but it plays a slightly more prominent role in this case due to the nature of the data. The most important difference, however, lies in the random components of the model. In the case of a dyadic model, each group contains only two observations, which means that there are not enough degrees of freedom to allow all the level 1 parameters to vary across couples. Therefore, the intercept is allowed to vary randomly, while slope variability is fixed across couples (Kenny & Cook, 1999; Kenny, Kashy, & Cook, 2006; Sayer & Klute, 2005). This random parameter is what accounts for nonindependence of the within-dyad observations, while slope estimates remain unbiased (Kenny, Kashy, & Cook, 2006).

The above method has advantages in that it is an intuitive adaptation of MLM to dyadic data, and allows for easier interpretation for hypotheses that might lie within a more typical GLM framework. In the present case, the hypotheses for RSA are concerned with mean differences in individuals' RSA change between experimental conditions, as well the moderation of these mean differences and values based on an individual's level of anxious or avoidant attachment. Like the school example, we might test this with an OLS regression if it were not for the problem of nonindependence posed by the dyadic data and experimental manipulation. Moreover, testing the hypotheses in a "traditional" MLM parameterization allows for the relatively simple probing of interactions and interpretation of parameters. This means that the specific conditional group and gender differences in RSA change viewed as a smaller increase or larger decrease can be readily examined using the simple effects methods adapted for MLM (Bauer & Curran, 2005; Preacher, Curran, & Bauer, 2006) and the computational tools written by Preacher, Curran, and Bauer (2010).

There are some limitations to this method of distinguishable dyadic data analysis, depending on one's goals. For one, interactions can compound quickly in an ostensibly simple moderated experimental model. If differences between touch conditions were to be compared across positive conversation conditions, this would result in a two-way interaction between experimental conditions at level 2, and a cross-level interaction with the level 1 interaction between gender and attachment dimensions, yielding four-way interactions. This becomes difficult to manage and interpret, as the commonly available computational tools for simple effects in MLM only deal with up to 3-way interactions (Preacher, Curran, & Bauer, 2006). In this case, a two-intercept parameterization for distinguishable dyads might be desired if only to create separate parameters for each couple member and simplify the interactions, though this in turn makes probing higher-order conditional effects much less straightforward and doesn't allow for statistical comparison of gender differences without fixing terms and model comparisons.

The Two-Intercept APIM Approach for PEP Change. This two-intercept approach to analyzing dyadic data falls under the Actor-Partner Interdependence Model (APIM), which is a set of modeling techniques developed to directly test the influence each dyad member's level 1 variables on one another's outcomes (Campbell & Kashy, 2002; Kenny & Cook, 1999; Kenny, Kashy, & Cook, 2006). For distinguishable married couple dyads in MLM, this is accomplished by essentially removing the level 1 intercept and "replacing" it with two dummy-coded variables representing the husbands' and wives' data ("0" for wives and "1" for husbands on the Husband variable and vice-versa for the Wife variable). Each dyad member has an "Actor" version of each predictor variable that comprises their own value on that variable, as well as a "Partner" version of the variable that indicates the other dyad member's value. These are then multiplied by each dummy-coded Husband and Wife variable to yield separate parameters for husbands' effects on their own outcome (husband actor effects), wives' effects on their husbands' outcome (husband partner effects), and vice-versa (Kenny, Kashy, & Cook, 2006; Raudenbush, Brennen, & Barnett, 1995). For example, the record for the husband's outcome will have a "1" for the Husband dummy variable and a "0" for the Wife dummy variable. Multiplying the Husband dummy variable with the husband's Anxious Attachment variable provides the husband's Actor score on that variable, while multiplying the husband's value with the Wife dummy variable will result in a zero for that variable on that record. Likewise, multiplying the Husband dummy variable by the wife's attachment value on his own line of data provides the Husband Partner variable, which predicts the husband's outcome using the wife's value as the predictor (Cook & Kenny, 2005). In total, this process yields four "interaction" terms for each predictor—an actor and partner variable for each spouse—that give non-zero values for actor and partner variables on a couple member's own line of data, while giving a value of zero for the variables that predict the opposite couple member's outcome. If desired, one could also include only the actor effects for each husband and wife, creating separate effects for each couple member and eliminating the need for a distinguishing gender variable, as mentioned in the previous section.

Here, the two-intercept APIM is suitable for testing the second set of hypotheses using the PEP data. In this case, the interest is in the relationship between each couple members' anxious or avoidant attachment on their own and their partner's sympathetic cardiac outflow, as measured by PEP. Furthermore, the magnitude of these effects, their significance, and how they differ between experimental conditions is of primary concern. This yields the following model:

$$\Delta PEP_{ij} = \beta_{1j}(\mathrm{H})_{ij} + \beta_{2j}(\mathrm{W})_{ij} + \beta_{3j}(\mathrm{HAAnx})_{ij} + \beta_{4j}(\mathrm{HPAnx})_{ij}$$

$$+ \beta_{5j}(\mathrm{WAAnx})_{ij} + \beta_{6j}(\mathrm{WPAnx})_{ij} + \beta_{7j}(\mathrm{HAAvd})_{ij} + \beta_{8j}(\mathrm{HPAvd})_{ij}$$

$$+ \beta_{9j}(\mathrm{WAAvd})_{ij} + \beta_{10j}(\mathrm{WPAvd})_{ij} \quad (16)$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11}(\mathrm{Touch}) + \gamma_{12}(\mathrm{Talk}) + U_{1j} \quad (17)$$

$$\beta_{2j} = \gamma_{20} + \gamma_{21}(\mathrm{Touch}) + \gamma_{22}(\mathrm{Talk}) + U_{2j} \quad (18)$$

$$\beta_{3j} = \gamma_{30} + \gamma_{31}(\mathrm{Touch}) + \gamma_{32}(\mathrm{Talk}) \quad (19)$$

$$\beta_{4j} = \gamma_{40} + \gamma_{41}(\mathrm{Touch}) + \gamma_{42}(\mathrm{Talk}) \quad (20)$$

etc.

Where:

γ_{10} = The average change in PEP for husbands while controlling for condition and level 1 predictors,

γ_{11} = main effect of touch on husbands' change in PEP,

…

γ_{30} = effect of husbands' anxious attachment on their own change in PEP, controlling for condition and level 1 predictors

γ_{31} = interaction between touch condition and the effect of husbands' anxious attachment on their own change in PEP,

γ_{41} = effect of wives' anxious attachment on their husbands' change in PEP, etc.

This means that for husbands' data (when the Husband dummy variable = 1), the level 1 equation 16 becomes:

$$\Delta PEP_{ij} = \beta_{1j}(\text{H})_{ij} + \beta_{2j}(\text{HAAnx})_{ij} + \beta_{3j}(\text{HPAnx})_{ij} + \beta_{4j}(\text{HAAvd})_{ij} + \beta_{5j}(\text{HPAvd})_{ij} \quad (21)$$

and for wives' data (when the Wife dummy variable = 1), equation 16 becomes:

$$\Delta PEP_{ij} = \beta_{1j}(\text{W})_{ij} + \beta_{2j}(\text{WAAnx})_{ij} + \beta_{3j}(\text{WPAnx})_{ij} + \beta_{4j}(\text{WAAvd})_{ij} + \beta_{5j}(\text{WPAvd})_{ij} \quad (22)$$

This parameterization is analogous to having two correlated and reciprocal regression equations for husband and wife outcomes, mimicking what would be done in a structural equation model of the same data. For wives' outcomes, only the wives' actor and partner variables are included as predictors, with the husband variables all equal to zero. Likewise, husband outcomes only include Husband Actor and Partner predictor variables. Another important characteristic of this parameterization is that the level 1 error term is fixed to zero, near-zero, or one, effectively eliminating the residual error at level 1 while modeling non-independence using covariance estimates (Kenny & Cook, 1999). This use of covariance instead of variance—which is squared and therefore always positive—allows interdependence to be negative, which is a possibility under the hypotheses presented (Kenny & Cook, 1999; Kenny, Kashy, & Cook, 2006). Finally, level 2 variances are fixed for all husband or wife "interaction" terms (level 1 predictors), leaving only the faux-intercepts with a random covariance component (Kenny & Cook, 1999).

Chapter 3

Results

Test of Primary Hypotheses: Regulatory Engagement and Stress Buffering Through Appraisal

Null Model and Intra-Class Correlation. Restricted Maximum Likelihood estimation (REML) was utilized for parameter estimates throughout, and estimates using robust standard errors are reported. HLM 6.08 was used for all hypothesis tests, while SPSS version 24 was used to create and manage the datasets and examine descriptive statistics. A modification of the method outlined by Hox (1995) was used to specify the models in a step-wise process. First, a one-way random effects ANOVA was specified to create a null model and provide variance components for intra-class correlation (ICC) calculation using the change in RSA (ΔRSA) as the outcome measure (see equations 1 and 2 for an example). This change score was calculated by subtracting the mean RSA across the speech preparation epoch from the mean of the second baseline, where couples sat next to one another in the same room. The speech preparation epoch was chosen because talking (which occurred during both speech delivery and math tasks) can significantly impact RSA values through irregularities in respiration (Berntson et al., 1997).

Within the sample, the grand mean ΔRSA was significantly different from zero and negative overall, $\gamma = -.081$, $t(225) = -2.358$, $p < .05$, demonstrating an expected overall decrease in RSA during the preparation epoch. The random variance component was also statistically significant, X^2 (225, N = 226) = 14.14, $p <$ .05, indicating that ΔRSA couple means differed across couples. The ICC was calculated as the level 2 between-couple variance component, tau (τ), divided by the total variance ($\tau + \sigma^2$). Here, the ICC was relatively low, with ICC = .089, so while ΔRSA within couples was relatively weakly correlated, the variability across couples was still statistically significant. Model deviance was 953.25 with two parameter estimates, and the reliability for the random variance component estimate was .159.

Level 2 Only Model. Next, a random-intercepts model was specified with touch entered at level 2 predicting the level 1 intercept, with talk entered as a level 2 covariate. No level 1 variables were entered as covariates or outcomes of the level two conditions. Touch and talk variables were effects-coded and grand mean-centered to yield true main effects of condition in their coefficients (Cohen, Cohen, West, & Aiken, 2003; Kreft & de Leeuw, 1998).

There was a significant difference in ΔRSA between touch conditions, $\gamma = -.071$, $t(223) = -2.07$, $p < .05$, such that those in the touch condition ($M = -.153$) had a lower ΔRSA than those in the no-touch condition ($M = -.009$), with both group means reflecting an overall decrease from baseline. The estimate reliability was again relatively low at .149. Model deviance was 957.54 for two parameter estimates.

Full Model. In the final step, all level 1 variables were entered into the model, with experimental condition predicting the intercept and all level 1 slopes (see equations 9 through 15). Again, the intercept was allowed to vary across couples, but there were no random slopes due to dyad groups containing just two observations each. Experimental condition variables were centered on their grand means, while level 1 attachment variables, gender, and attachment-gender interactions were group mean-centered. All dichotomous variables (i.e. gender, touch, and talk) were effects-coded.

With individual-level covariates in the model, the main effect of touch condition was no longer significant, but remained marginal at $p = .074$. No significant main effects of anxious or avoidant attachment were found, nor were there any cross-level interactions between touch condition and attachment dimensions that would indicate a moderating effect of anxious or avoidant attachment on the effect of touch. Notably, there was a significant cross-level interaction between avoidant attachment and talk condition, where those in the talk condition had a higher ΔRSA than those in the no talk condition, which increased with greater avoidant attachment. However, those results are not relevant to the present hypotheses. The random effect reliability estimate was .15, while model deviance was 929.31 for two estimated parameters.

Test of Secondary Hypotheses: Partner's Attachment as a Predictor of One's Stress Reactivity

Null Model and Intra-Class Correlation. Although the models for the PEP data utilize an altered parameterization and null model, a RE-ANOVA was still run with ΔPEP as the outcome measure to examine the ICC and the significance test of the between-couple variance component. The fixed effects test showed that there was an overall significant decrease in PEP from baseline in the sample, γ = -4.977, $t(222)$ = -10.25, p < .001, indicating that sympathetic activation increased from baseline during the speech prep epoch as expected. ΔPEP differed significantly between couples, X^2 (222, N = 223) = 277.32, p < .01, with ICC = .107 and a reliability estimate of .182.

For the APIM null model, only the husband and wife dummy variables were included as intercepts, with the true intercept deleted. The level 1 error variance was fixed to one, freeing up a parameter and allowing for the second intercept's random variance component to be estimated. Error correlations between husband and wife intercepts were r = .118, while the reliability estimates were .991 for husbands and .986 for wives. Both husband and wives' mean ΔPEP showed a significant decrease from baseline to speech preparation (M = -4.318, M = -5.665, respectively). Model deviance was 3041.084 with five parameter estimates

Level 1 Only Model. Next, a model with all level 1 actor and partner variables was tested to examine any effects and test model fit change from the baseline model. Interestingly, it was discovered that the model would only run in HLM 6 if level 1 variables were grand mean-centered, while the dummy intercepts were left uncentered, despite no mention of this in the literature on the technique.

Only the husband mean ΔPEP showed a significant decrease from baseline, γ = -21.874, $t(203)$ = -2.642, p < .01, while wives actually demonstrated a nonsignificant increase. The only significant effect was the effect of wives' avoidance attachment scores on husbands' ΔPEP, γ = 5.178, $t(371)$ = 2.638, p < .01, meaning husbands who had more avoidantly-attached wives had reduced sympathetic reactivity from baseline during the stressor, independent of their own attachment. The correlation between husband and wife random variance components was r = .122, with reliability estimates of .991 and .986, respectively. Model deviance was 2754.840 with three parameters.

Full Model. Level 2 predictors were added to each slope and intercept in the model to see if the significant partner effect differed by touch condition, or if any other significant effects emerged based on condition. Like the RSA model, experimental conditions were effects-coded and centered around the grand mean.

There were no significant main effects of touch condition for either partner. The significant effect of wives' avoidant attachment score on their husbands' PEP reactivity remained and slightly increased in magnitude, $\gamma = 6.001$, $t(351) = 2.943$, $p < .01$. Moreover, this effect significantly differed between touch conditions, $\gamma = 4.817$, $t(351) = 2.259$, $p < .05$. Specifically, the mean effect in the touch condition (γ = 10.819) was larger than it was for those who did not engage in touch (γ = 1.185). The correlation between husband and wife random variance components was r = .133, with reliability estimates of .991 and .986, respectively. Model deviance was 2680.034 with three parameters.

Chapter 4

Discussion

Overview and Discussion of Results

The first set of models sought to test the hypothesis that married couples who were randomly-assigned to engage in affectionate touch prior to a laboratory stressor would show a reduced need for regulatory engagement and effort, as indicated by a greater reduction in RSA from baseline. Furthermore, it was predicted that attachment dimensions would show opposite moderating effects on touch condition, such that physical affection would show an increased buffering effect for those with greater levels of anxious attachment, while there would be a reduced buffering effect for those more avoidantly attached.

The full model did not provide supporting evidence for the proposed hypotheses regarding RSA and regulatory engagement. While there was a lone main effect of touch condition that was marginal in terms of its p value, its meaningfulness is questionable when considered alongside the other results. Taken together, the results suggest a poor fit of the model and a high degree of error.

An APIM was used to look at the degree to which an individual's attachment style predicted this or her partner's stress reactivity, and whether engaging in touch increased any effect of partner attachment. It was specifically hypothesized that those with partners who were more insecurely attached on either dimension would show a greater PEP decrease from baseline in the touch condition, while avoidant attachment would have the strongest effect on a partner's stress response.

The results partially supported these hypotheses, as wives' avoidant attachment significantly predicted their husbands' ΔPEP, independent of their own level of attachment on either dimension. Furthermore, this effect significantly increased in the touch condition. Contrary to what was hypothesized, however, avoidant attachment predicted an *increase* in ΔPEP, demonstrating *decreased* sympathetic activation for those with more avoidantly attached wives. This might suggest that one's avoidance has the most potent effect on a partner's response to touch, though this may be sex-specific and in the opposite direction from what was anticipated. This effect of avoidance is somewhat congruent with the conceptualization that avoidant attachment schemas largely reflect one's attitudes and expectations about a partner's availability, while anxious attachment is more related to one's beliefs about worthiness or likelihood of receiving partner responsiveness and security (Bartholomew & Horowitz, 1991; Brennan, Clark, & Shaver, 1998; Sibley, Fischer, & Liu, 2005). Thus, an individual's avoidant attachment may be more likely to have inter-individual consequences and responsive fluctuations. It is difficult, however, to draw any strong conclusions from the results.

When taking the results of the model as a whole into consideration, individual *p* values alone can be dubious for a few stand-out results within the context of an error-prone model, especially one that does not seem to support the overall theoretical assumptions in the set of hypotheses. Although MLM gives conservative parameter estimates, and some of the null results here seem to trend in a manner expected, there is a general lack of stability, with seemingly random fluctuations in effect direction across variables and gender. For example, husbands showed a significant grand mean decrease in PEP as expected during a stress task, while wives showed a nonsignificant but relatively large increase from baseline—both with large standard errors. Moreover, many coefficients showed opposite effects between touch and talk variables. Overall, the model is not greatly discrepant with regard to the null hypothesis, and these unstable and theoretically inconsistent results may better speak to the degree of measurement error in the data.

Limitations and Considerations for Future Research

One source of such error may be measurement error in the physiological outcome variables used. Not only are there numerous possible sources of error introduced from electrode placement to data cleaning, but RSA is by nature potentially sensitive to intra-individual fluctuations in respiration (Berntson et al., 1997; Butler, Wilhelm, & Gross, 2006; Grossman, Karemaker, & Wieling, 1991). Other cardiac psychophysiologists, however, have asserted that respiratory fluctuations contribute negligible error in healthy populations (Denver, Reed, & Porges, 2007). Additionally, PEP can be sensitive to changes in posture (Berntson, Quigley, & Lozano, 2007; Stern, Ray, & Quigley, 2001), which is difficult to completely prevent. Data processing was carried out over several months using many different personnel, and although they were trained, some inter-rater differences were likely to be introduced into the data. Moreover, initial data quality itself is related to the accuracy of its processing, potentially maintaining or amplifying such error in the final product.

Another consideration about measurement lies in the construct validity of the ECR-R. Adult attachment can be thought of as a hierarchical order of representations that increase in specificity further down the hierarchy. There are more global, pan-relationship representations both across and within relationship domains (e.g. friendships, family, and romantic relationships), as well as more relationship-specific working models within each domain type (Sibley & Overall, 2008). A meta-analysis conducted by Cameron, Finnegan, & Morry (2012) found a significantly greater correlation between attachment dimensions in the ECR-R than in the ECR. This reduced orthogonality also seemed to be partially driven by the degree of relationship-specificity, with a significantly higher correlation when the ECR-R was used among members of a committed relationship compared to an uncommitted relationship. Relationship status, on the other hand, did not moderate orthogonality for the original ECR. This points to the ECR-R being more a measure of relationship-specific attachment compared to the more global ECR, and in turn the dimensionality appears to be altered.

Although it could be reasoned that the hypothesized relationships would be more likely to occur using a more relationship-specific scale, the collinearity between dimensions in this sample was quite high at ($r = .61$) for wives and ($r = .70$) for husbands, which approached the upper bound of the correlations included in Cameron et al. (2012). This makes further sense given that participants in this sample were explicitly instructed to consider their current relationship when filling out the ECR-R. This has implications for the construct validity of the dimensions used, as their oblique relationship suggests they measure far less distinct constructs than originally intended.

Partner effects of attachment considered here were straightforward, though future investigations might take into consideration partner-actor difference and multiplicative interactions, such as difference interactions to account for overall similarity or opposition between partner attachment dimensions at the couple level. The effect of a partner's attachment may also depend on the level of either one of an actor's attachment dimensions. For example, partner avoidance may predict reactivity only for those who are higher on anxious attachment. Inclusion of these contingencies and nuances could tease apart additional partner effects potentiated by physical contact.

A final issue to discuss is the possibility that the regulatory effects of touch simply weren't able to be fully induced in the laboratory setting. Even though participants were instructed to make contact as naturally as they would sitting at home together, instructed and inorganic affectionate touch in an unfamiliar setting may have minimized any true effects. This is of course a classic issue when attempting to balance ecological considerations with experimental rigor and replicability. Overall, these results should help to guide methodological and design considerations in future experimental tests of interpersonal affect regulation theory. Further accumulation of experimental evidence across contexts and designs should work toward building a diverse reservoir of experimental evidence for meta-analysis, from which more robust conclusions regarding effect sizes can be drawn.

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