From Me to You: Stress Spillover and Respiratory Sinus Arrhythmia

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Abstract

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Stress spillover describes how stress in one life domain affects other life domains. For example, parenting stress, defined as stress related to raising a child, tends to affect how romantic partners think about, feel, and behave in their romantic relationship with their spouse. Evidence suggests that, on average, parents of young children experience a decline in romantic relationship quality as they transition into parenthood. However, not all parents experience stress spillover from their child-related stress to their romantic relationship. This study evaluated whether respiratory sinus arrhythmia, a biomarker of emotion regulation capabilities in interpersonal relationships, moderates the effect of child-related stress on marital stress among parents of young children. As part of a dyadic study, 82 cohabiting couples raising preschool-aged children had their resting RSA assessed during a laboratory visit, and independently reported on their daily child-related stress and marital stress for seven consecutive days. Actor-partner interdependence modelling tested the associations between child-related and marital stress for both members of the couple, as well as the moderating role of each partners' RSA. Results indicated significant actor and partner effects of child-related stress on actor marital stress. These results show that one partner's reports of child-related stress were related to their own reports of marital stress and to their partner's reports of marital stress, even after adjusting for their partner's reports of child-related stress, indicating the presence of a stress spillover effect. Furthermore, a significant interaction between partner's reports of child-related stress and partner's RSA when predicting actor's marital stress revealed that this stress spillover effect was larger among individuals with lower RSA. Our findings suggest that RSA influences the extent to which parenting stress impacts one's interpersonal behaviours in their romantic relationship.

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Contribution of Authors

Andrew Switzer: Mr. Switzer contributed to this thesis by participating in data analysis, and writing of all sections in the manuscript.

Warren Caldwell: Mr. Caldwell contributed to this thesis by participating in data collection.

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Jean-Philippe Gouin: Dr. Gouin contributed to this thesis by designing this project, supervising data collection, preparation, and analysis, and by supervising the preparation of the manuscript, including direction and feedback on writing.

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General Introduction

Prior work indicates that stressful experiences outside of a romantic relationship can have deleterious effects on the quality and stability of that relationship (Randall & Bodenmann, 2009; 2017). The process through which stress in one life domain influences other life domains is called stress spillover (Repetti, 1989). The Vulnerability-Stress-Adaptation (VSA) Model of Marriage (Karney & Bradbury, 1995) supposes that stressful conditions impede couples' abilities to engage in adaptive relational processes, in turn, leading to worse marital outcomes. This model also states that some individuals possess enduring vulnerabilities that make them less capable of engaging in adaptive relational processes when experiencing stress. For many parents of young children, the transition into parenthood marks a long-lasting decline in the quality of their romantic relationship (Nomaguchi & Milkie, 2003, 2020). Prior studies indicate that one partner's parenting stress can independently affect both partners' appraisals of their romantic relationship. While these spillover effects have been replicated in several studies, the magnitude of these effects vary, suggesting that some individuals possess enduring vulnerabilities that render them more susceptible to stress spillover effects, as hypothesized by the VSA Model of Marriage (Karney & Bradbury, 1995).

The current study examines the role of respiratory sinus arrhythmia (RSA), a biomarker of vagally-mediated parasympathetic activity on the heart, conceptualized as an index of social-engagement and self-regulatory capabilities, as a potential moderator of stress spillover (Porges, 2007; Thayer & Lane, 2009). Individuals with lower RSA tend to show deficits in self-regulation and social functioning (Smith et al., 2020). Among these findings, there is growing evidence that differences in RSA influence how individuals behave in interpersonal relationships while experiencing stress or negative affect. The goal of the current study is to assess whether RSA moderates the spillover of child-related stress on marital stress among a sample of couples raising young children.

Introduction

Stress spillover describes a process through which stress in one life domain affects an individual's thoughts, feelings, and behaviours in other life domains (Repetti, 1989). Early research on stress spillover documented how stress at work affected marital behaviours at home, showing that high work stress led to more withdrawal from romantic partners, more anger, and greater perceived stress in the family domain (Grzywacz et al., 2002; Repetti, 1989). Since then, research on stress spillover has examined how stress in an array of life domains outside of a romantic relationship, sometimes referred to as extra-marital stress, affects the quality and stability of romantic relationships. Studies have shown that extra-marital stress, including but not limited to work stress, financial stress, physical illness, daily hassles, and parenting stress can negatively affect the quality of a romantic relationship (Brock & Lawrence, 2008; Falconier et al., 2014; Karney et al., 2005; Nomaguchi & Milkie, 2003; Schulz et al., 2004).

The spillover of extra-marital stress on romantic relationship quality can be understood through Karney and Bradbury's (1995) Vulnerability-Stress-Adaptation (VSA) Model of Marriage, which states that stressful experiences outside of a romantic relationship impair individuals' abilities to engage in adaptive relational processes, including fewer positive and more frequent negative interactions with one's partner, which can lead to declines in romantic relationship quality and stability. This model also states that some individuals possess enduring vulnerabilities that make them more sensitive to the effects of stress spillover. In other words, some individuals are less capable of engaging in positive marital interactions, or refraining from engaging in negative marital interactions, when experiencing stress outside of their romantic relationship. In line with the VSA Model of Marriage, many studies have shown that greater extra-marital stress predicts worse romantic relationship quality and stability, both cross-sectionally and longitudinally (Karney & Bradbury, 1995; Randall & Bodenmann, 2009; 2017). Further, a number of dyadic studies, which include both partners' reports of stress and romantic relationship satisfaction, have shown that one partner's extra-marital stress is not only related to their own perceptions of their romantic relationship, but that it can independently predict their spouse's assessment of their romantic relationship as well (Buck & Neff, 2012; Falconier et al. 2014; Fallahchai et al., 2019; Ferguson, 2012; Ledermann et al. 2010; Neff & Karney, 2007; Totenhagen et al., 2013).

Parenting Stress

In understanding how extra-marital stress spills over on romantic relationships, the effects of parenting stress, defined as stress related to raising a child, are of particular interest because parenting-related challenges often occur within the home, potentially affecting both parents simultaneously (Nomaguchi & Milkie, 2003). Systematic reviews indicate that parents tend to report worse romantic relationship quality than non-parents, and that many couples report lasting decreases in marital satisfaction and increases in marital conflict as they transition into parenthood (Nomaguchi & Milkie, 2003; 2020; Kluwer, 2010). Over-time, these declines in romantic relationship quality have been shown to persist for years, at least until the child enters primary school at around 7 years of age (Keizer & Schenk, 2012; Kluwer, 2010).

Similar to the broader stress spillover literature, one parent's child-related stress has been shown to independently predict both parents' romantic relationship satisfaction in dyadic studies. Using a daily diary design to study the day-to-day experiences of parents of children with autism spectrum disorder, Hartley et al. (2018) found that parenting stress on one day predicted fewer positive interactions the following day, but only among mothers. In another daily diary study, Goetz et al. (2019) observed that one parent's parenting stress negatively predicted their spouse's

romantic relationship satisfaction, but only on days when both members reported high parenting stress. Other studies have also shown that one partner's child-related stress negatively predicts both partners' romantic relationship satisfaction, and that this effect was mediated by their partner's communication quality, as observed during a marital interaction task (Zemp et al., 2017). Furthermore, longitudinal studies have shown that one parent's reports of parenting stress when their child is three years of age prospectively negatively predicted both partners' reports of romantic relationship quality two years later (Berryhill et al., 2016). Combined, these studies show how one partner's experiences in raising their child can negatively influence both partners' experiences in their romantic relationship.

Although stress spillover effects have been replicated in numerous studies, the magnitude of these effects vary, suggesting that some individuals possess enduring vulnerabilities that render them more susceptible to stress spillover, as hypothesized by the VSA Model of Marriage. For example, women with higher self-esteem and more secure attachment styles have been shown to be less sensitive to stress spillover (Neff & Karney, 2009). Trait-neuroticism, a personality dimension marked by emotional instability and negative affect, has also been shown to moderate stress spillover among men, such that men higher in neuroticism experience more stress spillover (Wang et al., 2011). Individuals who engage in less constructive and more passive coping strategies may experience stronger stress spillover (Bodenmann et al., 2010). In addition, rumination, the tendency to engage in repetitive, passive, and self-focused thoughts when experiencing stress, has been shown to exacerbate stress spillover (King & DeLongis, 2014). Furthermore, differences in how individuals interact with their partners have also been shown to moderate spillover. For example, worse couple communication and conflict resolution skills have been linked to stronger spillover effects (Kelley et al., 2018; Neff & Karney, 2007). Less positive and more negative dyadic coping, which describe how both members of a couple share in each other's stress and coping processes, may strengthen the spillover of extra-marital stress towards romantic relationship quality (Bodenmann et al., 2010; Falconier et al., 2013; Fallahchai et al., 2019). In sum, these findings suggest that individual differences in intrapersonal and interpersonal processes related to extra-marital stress can moderate stress spillover.

Respiratory Sinus Arrhythmia

Individuals' capacity to inhibit maladaptive cognitive, emotional, and behavioural responses to stress may moderate stress spillover. Respiratory Sinus Arrhythmia (RSA) is a biomarker of vagally-mediated parasympathetic activity on the heart, which has been conceptualized as an index of self-regulation capabilities in interpersonal relationships (Porges, 2007; Thayer & Lane, 2009). RSA represents the variability in time intervals between consecutive heartbeats linked to the respiration cycle (Applehans & Luecken, 2006). Across the breathing cycle, the inhibitory influence of the parasympathetic nervous system through the vagus nerve towards the heart is temporarily gated during inhalation and released upon exhalation, causing the heart to beat faster and slower, respectively (Berntson et al., 1997). Accordingly, changes in heart rate across the breathing cycle reflect the output of parasympathetic inhibition on the heart.

There are two leading theories explaining RSA's associations with the regulation of social and emotional behaviours: Polyvagal Theory, and the Neurovisceral Integration Model. Porges' (2007) Polyvagal Theory describes RSA as an index of a physiologically distinct social-engagement system. Porges notes that the same brain-stem nuclei that modulate parasympathetic inhibition on the heart have evolved to influence muscles of the face involved in social

engagement, like muscles near the eyes, ears, face, and throat, whose functions include controlling facial expressions, listening, and modulation of speech. This social-engagement system allows individuals to engage in social engagement behaviours, rather than fight-or-flight responses, in certain contexts. The vagus nerve, linking the brain with peripheral organs, plays a key role in quickly shifting autonomic states to modulate the repertoire of social and behavioral responses that can be expressed at a given time. According to Polyvagal Theory, RSA is an index of this neurophysiological system supporting social-engagement behaviours, with lower resting RSA indicating lesser social-engagement capabilities.

Thayer and Lane's (2009) Neurovisceral Integration Model emphasizes the top-down inhibition of limbic brain regions by the prefrontal cortex, which underlies the organization of self-regulatory behaviours in response to changing situational demands. This top-down inhibition occurs in tandem with parasympathetic inhibition on the heart. Therefore, the Neurovisceral Integration Model conceptualizes RSA as an index of the strength of top-down inhibition, with lower RSA indexing weaker top-down inhibition, and in turn worse self-regulation, including less adaptive social and emotional functioning. Combined, Polyvagal Theory and the Neurovisceral Integration Model describe how distinct neurophysiological systems converge to support social-engagement and self-regulation capabilities, and that these systems are indexed by RSA.

In support of these theories, empirical studies have linked RSA to different social abilities. Individuals with lower resting RSA are less capable of identifying emotions in images and in conversation (Côté et al., 2011; Lischke et al., 2017; Quintana et al., 2012). They also tend to be less cooperative and empathetic, and perceive themselves as less socially accepted and integrated (Beffara et al., 2016; Geisler et al., 2013; Lischke et al., 2018; Maunder et al., 2011). Individuals with lower resting RSA engage in fewer social interactions, and experience less positive affect from social interactions than individuals with higher RSA (Isgett et al., 2017; Kok, & Fredrickson, 2010). Further, individuals with lower RSA are also less likely to seek social support, and less likely to engage in adaptive coping behaviours when experiencing stress (Geisler et al., 2013). Following immigration, individuals with lower resting RSA experienced smaller increases in acculturation over time than individuals with higher RSA (Doucerain et al., 2016).

Meta-analytic results also support the association between lower RSA and poorer self-regulatory capabilities, including emotion regulation (Holzman & Bridgett, 2017). In their everyday lives, individuals with lower RSA experience more negative affect and cope less constructively when subject to higher than normal stress, compared to individuals with higher RSA (Fabes & Eisenberg, 1997; Visted et al. 2017). Individuals with lower RSA also show stronger associations between stress and psychological distress, including symptoms of anxiety (Gouin et al., 2014; Kogan et al., 2012; Wekenbord et al., 2019). In laboratory studies, individuals lower in RSA are less capable in suppressing intrusive thoughts, in trying to regulate negative emotional expressions, and react with more anger when subject to an anger-inducing stressor (Demaree et al., 2004; Ellis et al., 2016; Gillie et al., 2015).

Studies linking RSA to self-regulation in the context of interpersonal relationships suggest that individuals with lower RSA experience stronger associations between their own stress or negative affect and the quality of their social interactions. For example, individuals with lower resting RSA report lower marital quality (Smith et al., 2011). Men with lower RSA may be more sensitive to the effects of negative dyadic coping (Switzer et al., 2018). In a study on maternal depression and parent-adolescent interaction patterns, Connell et al. (2011) found that

RSA of mothers and teens independently, and in combination, moderated the effect of maternal depression on the quality of their interactions. Specifically, dyad pairs with one or more dyad members with lower RSA showed a stronger effect of maternal depression on the quality of their interactions than dyad pairs with higher RSA. In line with this finding, a study on couples by Diamond et al. (2011) found that men with lower RSA showed a stronger association between their own negative affect and their partners' report of negative spousal interactions. According to a longitudinal study by Ong et al. (2019), individuals with lower RSA showed a stronger association between affective stress reactivity (i.e., a stronger association between an individual's stress and mood) and lower marital satisfaction over 10-years than individuals with higher RSA. These findings suggest that individuals with lower resting RSA may engage in more negative and less positive interpersonal behaviours when undergoing stress, potentially making them more likely to experience stress spillover.

The Current Study

Given the links between RSA and emotion regulation in interpersonal relationships, the aim of the current study was to test whether RSA moderates the spillover of child-related stress on the quality of the romantic relationship between parents of young children. Parents of young children represent a population that may be especially at risk for stress spillover, due to the parenting challenges they experience as they transition into parenthood (Keizer & Schenk, 2012). In this dyadic study, daily reports of both partners' child-related stress and marital stress, as well as both partners' resting RSA were analyzed using an Actor-Partner Interdependence Model (APIM) (Kenny et al., 2006). The APIM estimated both actor and partner effects in a single model. Actor effects refer to the effect of an individual's independent variable on their own dependent variable. Partner effects refer to the effect of an individual's independent variable on their partner's dependent variable, independent of the effect of their partner's independent variable. In the current study, stress spillover was best represented by the partner effect of child-related stress on the actor marital stress - that is, how one dyad member's child-related stress predicted their spouse's marital stress, controlling for their spouse's child-related stress. We hypothesized that individual's with lower RSA would show a stronger spillover effect (i.e., partner effect) from their child-related stress to their partner's perceived marital stress.

Methods

Participants

Participants were 84 cohabiting heterosexual couples rearing preschool age children. Participants were recruited from the community through online ads, schools, and support groups for parents of children with neurodevelopmental disorders to maximize the range of child-related stress within the sample. To participate in the study, both members of the couple had to be currently cohabiting, and be the legal guardian of a child under 7 years of age. Exclusion criteria for the study included pregnancy, breastfeeding, chronic medical conditions, and regular prescribed medication use, as these factors may influence RSA. Two couples completed no daily diary assessments, leading to a final sample of 82 couples.

Procedure

First, both members of the couples independently provided consent before participating in the study. Then, all participants completed online background questionnaires which included demographic and romantic relationship information. Subsequently, both members of each couple attended a 60-minute laboratory visit to assess RSA. Before the laboratory visit, participants were instructed not to consume alcohol, caffeine, or tobacco, or to engage in vigorous physical activity during the two hours before the visit, because these factors have been shown to bias the

estimation of their RSA (Bernston, et al. 1997). During the laboratory visit, participants completed a series of seated tasks as their heart-rates were recorded via electrocardiogram (ECG). Participants completed a 5-minute resting period to assess resting RSA. Subsequently, participants completed a questionnaire about their child's behaviour problems and a 14-minute marital interaction task[1]. Finally, each member of the couple was asked to independently complete daily diaries for seven consecutive days following the laboratory visit. These diaries assessed child-related and marital stress.

Measures

Respiratory Sinus Arrhythmia (RSA). RSA at rest was measured during the 5-minute resting baseline. Participants were seated, and instructed to breathe normally and relax as much as possible for the duration of the task. Electrodes were fitted to participants in a Lead II position by a trained research assistant. Electrocardiograph (ECG) data was acquired using a Mindware BioNex 8-slot chassis (Mindware Technologies Ltd, Gahanna, OH). Participants' heart-rate was recorded continuously at a sampling rate of 1000 Hz throughout the laboratory visit. ECG recordings were visually inspected to identify and correct recording artifacts, and then analyzed using MindWare RSA Analysis software, Version 3.1 (Mindware Technologies). RSA was then calculated using a Fast Fourier Transform applying a .15-.40 Hz frequency band filter. RSA values were calculated in 30-second epochs and averaged to compute a single RSA at rest for each participant (Bernston et al., 1997). A natural log transformation was applied to RSA values to normalize their distribution.

Daily Child-Related and Marital Stress. Daily child-related and marital stress were recorded by single item questions in the daily diaries. Participants reported on their child-related stress in the past day by responding to "Today, to what extent did you experience stress in relation to your children?" Marital stress was assessed by the item "Today, how much stress did you experience from your relationship with your partner?" Responses for both items were scored on a 5-point Likert scale, ranging from "Not at all (1)" to "A great deal (5)". Average child-related and marital stress scores were computed from all days where both dyad members completed the daily diary across the daily diary period. The intraclass correlations for child-related stress and marital stress were .45 and .38, respectively, indicating that 45% and 38% of the variance in daily scores is attributable to between-person differences in participants' average scores[2]. Participants completed an average of 6.54 diaries (SD= 1.50), of which 4.84 diaries (SD=1.44) were completed on the same day by both partners.

Data Analysis

Data were screened and cleaned using IBM SPSS version 23, and analyzed in an Actor Partner Interdependence Model (APIM) framework using Structural Equation Modelling (SEM) in MPlus version 7. The APIM is an analytic approach that accounts for the non-independence of scores between dyad members, which can lead to biased standard errors around effect-size estimates if left unaccounted for (Kenny et al., 2006). By analyzing the APIM in SEM, changes in goodness of fit indices between nested models can be compared to determine whether a more complex model fits the data better than a more parsimonious model. In this study, changes in model fit were used to assess the empirical distinguishability of dyad members, as outlined by Olsen and Kenny (2006). Distinguishability refers to whether or not dyad members can be reliably distinguished by some characteristics (Kenny et al., 2006). In the current study, because all couples included one male and one female, sex is a theoretically distinguishing variable. By comparing a saturated model that freely estimates all model parameters separately for males and females to a model where all model parameters are constrained to equality, changes in model fit

can assess whether or not dyad members are empirically distinguishable. Equality constraints causing misfit can be removed to create a partially indistinguishable model. The fit of these models was assessed using the chi-square statistic (χ^2), Root Mean Square Error of Approximation (RMSEA), the Comparative Fit Index (CFI), and the Tucker-Lewis Index (TLI) (Hu & Bentler, 1999; Marsh et al., 2005). RMSEA values equal to or below .08 indicates adequate fit, whereas values equal to or below .06 indicate excellent fit. Likewise, CFI and TLI values equal to or higher than .90 and .95 respectively support adequate and excellent fit. When comparing goodness of fit between nested models, increases in RMSEA values equal to or greater than .015, and decreases in CFI and TLI greater than or equal .01 indicate a significant decline in model fit (Chen, 2007).

All SEM were estimated using the robust maximum likelihood (MLR) estimator, which is robust to non-normality (Muthén & Muthén, 2012). Prior to these analyses, average scores of child-related stress and resting RSA were grand-mean centered, and interaction terms were computed by multiplying these centered variables. In the case of a significant interaction effect, simple slopes of the effect of child-related stress on marital stress at one standard deviation above and below the mean RSA at rest values were compared (Aiken & West, 1991). The path diagram for the APIM is depicted in Figure 1.

Results

Demographic information, descriptive statistics, and bivariate associations between child-related stress, resting RSA, and marital stress are presented in Table 1. Across the full sample, participants' ages ranged from 21 to 48 years old (M=34.59, SD=4.65). Paired samples T-tests showed that males were significantly older than females, and that a greater proportion of males worked full-time (t(81)=7.474, p<.001; t(81)=3.54, p=.001). Males also reported less child-related stress and had lower RSA than females (t(81)=-2.727, p=.008; t(81)=-2.501, p=.014).

Bivariate associations showed that males' and females' reports of child-related stress were positively correlated, and that males' and females' reports of marital stress were positively correlated, both representing small to medium effect-sizes. The latter association indicates that 7.02% of the variance in females' assessment of marital stress was explained by males' reports. Both males' and females' reports of child-related stress were positively correlated with their own reports of marital stress, also representing small to medium effect-sizes. In addition, females' child-related stress was weakly correlated to males' marital stress, explaining 3.20% of the variance in males' marital stress. Males' child-related stress was not significantly correlated with females' marital stress. Neither dyad member's resting RSA was associated with any other variables in this sample.

Structural Equation Modelling

To test for the empirical distinguishability of our dyads, we compared a saturated model to a model with full equality constraints between males and females. Compared to the saturated (i.e., fully distinguishable) model, which fit the data perfectly, the model with full equality constraints between dyad members provided poor fit to the data (χ^2=44.465, Df=30, p=.043, RMSEA=.077, CFI=.673, TLI=.815), suggesting that dyads were not fully indistinguishable. After removing the equality constraints for the variances of the interaction terms, the variance of child-related stress, and the covariance between actor child-related stress and the interaction between actor child-related stress and partner RSA, model fit improved considerably (χ^2=24.794, Df=26, p=.531, RMSEA=.000, CFI=1.000, TLI=1.000), such that the partly indistinguishable model did not fit significantly worse than the saturated model. Because this partially indistinguishable model provided as good a fit to the data as the saturated model while

estimating fewer parameters, it was considered a better, more parsimonious model. Results from this model are included in Table 2.

In this model, there was a significant actor effect of marital stress on child-related stress, indicating that individuals who reported more child-related stress on average tended to also report more stress in their interactions with their spouse. There was also a significant partner effect of child-related stress on marital stress, indicating that greater partner child-related stress predicted more actor marital stress, independent of actor child-related stress. Stated otherwise, one individual's child-related stress predicted more stress in their marriage, as rated by themselves and their spouse, suggesting the presence of a spillover effect from child-related stress to marital stress.

Partner RSA moderated the partner effect of child-related stress on actor marital stress. Simple-slopes analyses revealed that the partner effect of child-related stress on actor marital stress was larger among individuals whose partner's RSA was one standard deviation below the mean (B=.296, 95%C[.063, .528]), compared to individuals whose partner's RSA was one standard deviation above the mean (B=.073, 95%CI[-.190, .337]). In other words, the spillover effect from one individual's child related stress to their spouse's reports of marital stress was larger among individuals with lower RSA. Figure 2 shows the partner effect of child-related stress on marital stress at one standard deviation above and below the mean value of RSA. None of the other RSA by child stress interactions were significant.

Discussion

This study tested the extent to which resting RSA moderates the spillover of child-related stress on marital stress among parents of young children. Results from the APIM showed that partner's RSA moderated the partner effect of child-related stress on actor marital stress. Stated otherwise, individuals with lower RSA showed a stronger spillover effect of their child-related stress toward their partner's reports of marital stress. This effect did not differ between males and females. These findings contribute to a growing literature indicating that RSA is associated with self-regulation in romantic relationships. Specifically, these findings suggest that individuals with lesser self-regulatory capabilities in close relationships, as indexed by lower RSA, exhibit a stronger stress spillover effect from their child-related stress towards their partner's reports of marital stress.

Consistent with the larger stress-spillover and parenting stress literature, increased child-related stress predicted more marital stress in the current study (Randall & Bodenmann, 2009; 2017; Nomaguchi & Milkie, 2003; 2020). Using a dyadic design, we assessed the effects of one partner's child-related stress on both partners' reports of marital stress. We found that individuals who reported more child-related stress also reported more stress in relation to their spouse (i.e., an actor effect). Moreover, individuals whose partners' reported more child-related stress reported more stress in their romantic relationship themselves, above and beyond the effect their own child-related stress had on their marital stress (i.e., partner effect). Recent studies using the APIM framework have reported similar results. Using a similar cross-sectional dyadic design, Zemp et al. (2017) also identified both actor and partner effects of child-related stress on romantic relationship satisfaction. Berryhill et al. (2016) used a longitudinal dyadic design, and found both actor and partner effects of child-related stress on romantic relationship quality two years later. In contrast, in Goetz et al.'s (2019) daily diary study on parents of children with and without autism, the partner effect of parenting stress on spousal reports of negative interactions was only significant when both partners reported high stress, highlighting variability in the magnitude of the stress spillover effect across studies.

Respiratory Sinus Arrhythmia Moderates Stress Spillover

Consistent with our hypothesis that RSA would moderate stress spillover, there was a significant interaction effect between partners' child-related stress and their RSA on actors' reports of marital stress. Specifically, this interaction indicates that the effect of an individual's child-related stress on their spouse's reports of marital stress was largest among individuals with lesser self-regulatory capabilities, as indexed by lower RSA. These findings are consistent with the VSA Model of Marriage, which argues that individuals possess enduring vulnerabilities that may render them more sensitive to stress spillover (Karney & Bradbury, 1995). Further, these findings are consistent with theories linking RSA to self-regulatory capacity, which suggest that individuals with lower RSA may be less capable of regulating their interpersonal behaviours under conditions of stress (Porges, 2009; Thayer & Lane, 2000). Prior studies have shown that individuals with lower RSA tend to seek social support less frequently when experiencing stress than individuals with higher RSA, which may result in greater emotional and interpersonal consequences of stress (Geisler et al., 2013) Associations between negative dyadic coping strategies and depressive symptoms also appear to be stronger among individuals with lower RSA (Switzer et al., 2018). Connell et al. (2011) observed that both dyad members' RSA moderated the association between maternal depression and social interaction quality between mothers and their adolescent child. Diamond et al. (2011) also reported that men with lower RSA showed a stronger within-person association between their own negative affect and their partner's report of negative marital interactions compared to men with higher RSA. Moreover, they did not observe the same effect when predicting an individual's own reports of their negative spousal interactions with their spouse for men nor for women. Findings from the current study and from Diamond et al. (2011) suggest the association between an individual's stress and how they perceive their relationship does not change as a function of their RSA. In contrast, these findings suggest that RSA moderates the association between an individual's stress and how they behave in their romantic relationship, as reflected by their spouse's assessment of their interactions.

Prior literature suggest some potential mechanisms underlying the stronger stress spillover effect among individuals with lower RSA. For example, previous studies suggest that impaired communication mediates stress spillover (Ledermann et al., 2010; Zemp et al., 2017). Individuals with lower RSA have more difficulty identifying emotions in others and in themselves, which may impede couple communication when one or both partners are experiencing stress or negative affect (Beffara et al., 2016; Côté et al., 2011; Lischke et al., 2017; 2018; Quintana et al., 2012). Individuals with lower RSA may be less cooperative, and less likely to seek social support or social interactions with their spouse when experiencing stress, preventing them from engaging in adaptive relational processes (Geisler et al., 2013; Isgett et al., 2017; Kok, & Fredrickson, 2010). They might also benefit less from these adaptive relational processes (Isgett et al., 2017; Kok & Fredrickson, 2010). Emotional reactivity, such as proneness to anger or negative emotions, have also been shown to mediate stress spillover (Bodenmann et al., 2010; Lavee & Ben-Ari, 2007). Deficits in emotion-regulation associated with RSA, including greater psychological reactivity to stress, and difficulties with suppressing intrusive thoughts or emotional expressions, may also contribute to greater expressions of anger or negative emotions during spousal interactions, in turn, impacting the quality of spousal interactions (Demaree et al., 2004; Ellis et al., 2016; Gillie et al., 2015; Gouin et al., 2014; Kogan et al., 2012; Visted et al. 2017). Partners who are more negative in their attributions of their spouses' behaviours, and who perceive their spouse to be less understanding have also been

shown to experience stronger spillover (Graham & Conoley, 2006; Gordon & Chen, 2016). Future researchers may explore the associations between RSA and attributions of spousal behaviours.

Interpersonal emotion regulation framework suggests that some individuals regulate their own emotions or their partners' emotions through social interaction (Zaki & Williams, 2013). Through this framework, individual differences in RSA may explain differences in how individuals regulate their own emotions or their spouses' emotions through social interactions. In the current study, only the partner child-related stress by partner RSA interaction was significant when predicting actor marital stress. There was no significant actor child-related stress by partner RSA interaction when predicting actor marital stress, nor was there a significant partner child-related stress by actor RSA interaction when predicting actor marital stress. This pattern of results may suggest that individuals with lower RSA exhibit deficits in social-engagement and self-regulatory processes that impede their ability to regulate their own child-related stress through social interaction, but not their partner's child-related stress. These results contrast findings from Connell et al. (2011), who found that both mothers' and adolescents' RSA moderated the effect of maternal depression on the quality of their interaction. In contrast to the dyadic daily diary protocol employed in the current study, Connell et al. (2011) coded behaviours between mothers and their adolescent child during a semi-structured interaction task. Differences in methodological approaches between these studies may explain differences in their results. Future research should explore in which contexts actor RSA may moderate partner's stress spillover.

Sex differences

In the present study, actor and partner child-related stress effects were not significantly different between males and females. Some studies in the stress spillover literature have found the spillover of womens' stress towards males' perceptions of their romantic relationships may be larger than the reverse (Buck & Neff, 2012; Falconier et al., 2014; Keizer & Schenk, 2012; Neff & Karney, 2007). In contrast, Wang et al. (2011) highlight men with high neuroticism as the most likely to experience stress spillover. Other studies have reported spillover effects to be similar between men and women (Ferguson, 2012; Fallahchai et al., 2019; Goetz et al., 2019; Grzywacz et al., 2002; Lederman et al., 2010; Totenhagen et al., 2013; Zemp et al., 2017). Furthermore, there are few studies on how men and women's RSA may differ in its relation to social and emotional regulation, and these studies do not yet provide a clear consensus. For example, Diamond et al. (2011) found that RSA moderated the effect of negative affect on spouses' reports of interaction quality for men, but not for women. Similarly, Switzer et al. (2018) found that men with low RSA benefitted less from their partner's delegated dyadic coping to men with higher RSA, but that the same effect was not significant for women. In contrast, the moderating role of RSA on the association between rumination and marital conflict may not differ between males and females (Caldwell et al., 2019). Given these inconsistent findings across studies, differences between males and females in how RSA relates to social capabilities and self-regulation are likely small in magnitude.

Strengths, Limitations, & Implications

Key strengths of the study include the dyadic design combined with the APIM analytic approach. By having both dyad members independently report on their child-related stress and their marital stress, we could assess how one partner's child-related stress differentially affected their own reports of marital stress, in addition to their partner's reports of marital stress. Moreover, partners' reports of marital stress indirectly assess actors' behaviours during marital

interactions. A key limitation of this study is that it used a cross-sectional design, so it could not assess the causality or the directionality of the relationship between child-related stress and marital stress. While this study examined the spillover of extra-marital stress towards the romantic relationship, the VSA Model of Marriage also predicts that poor marital quality can lead to an increase in the experience of stress outside of one's marriage. Previous studies have shown that parents who report better marital quality engage in more adaptive parenting behaviours, and report less parenting stress (Lafontaine et al., 2009; Colpin et al, 2000; Karney & Bradbury, 1995). Future studies can build from these findings in several significant ways. Researchers may use longitudinal designs to assess the causality of the associations between these variables over time. In addition, future researchers may use a longer daily diary period to assess how between-person differences in RSA interact with within-person differences in child-related stress to influence changes in marital stress, and vice-versa. Despite using a daily diary design, supplemental analyses revealed no significant within-person effects in the current study, possibly due to the brevity of the daily diary period. Lastly, while the use of daily diary questionnaires may provide a more accurate assessment of the daily experiences of participants, our single-item measures may be limited in their ability to capture different aspects of participants' interactions with their child or their spouse. Future researchers may build from these results by using multi-item measures that assess positive and negative parenting experiences and marital interactions. Researchers can use these multi-item measures to examine whether RSA moderates positive spillover, or how positive experiences with one's child influences their relationship with their spouse.

Nonetheless, the current study provides useful findings that can inform support programs for parents of young children. While many couples experience a decline in the quality of their romantic relationship as they transition into parenthood, as many as half experience no change, or even a positive change in the quality of their romantic relationship (Kluwer, 2010). Our findings can help identify individuals and families who are at greater risk of experiencing spillover from parenting stress towards their romantic relationship. Practitioners can also capitalize on these results by recognizing how both partners' stress and self-regulatory capabilities can influence both parents' experiences in their romantic relationship. Specifically, given the presence of both actor and partner effects found in our study, successful support programs for parents will likely benefit from including both parents.

In conclusion, our findings contribute to the stress spillover literature by replicating previous studies, showing that one partner's parenting stress predicted more marital stress for both partners. Our findings add to this literature by showing that individuals with lower RSA experienced a stronger spillover of their parenting stress towards their partners' reports of marital stress. These findings also add to a growing literature of RSA as a biomarker of emotion regulation, especially in the context of interpersonal relationships.

References

Aiken, L. S., West, S. G., & Reno, R. R. (1991). Multiple regression: Testing and interpreting interactions. London, England: Sage.

Appelhans, B. M., & Luecken, L. J. (2006). Heart rate variability as an index of regulated emotional responding. *Review of General Psychology, 10*(3), 229–240. https://doi.org/10.1037/1089-2680.10.3.229

Beffara Bret, B., Beffara-Bret, A., Vermeulen, N., & Mermillod, M. (2016). Resting high frequency heart rate variability selectively predicts cooperative behavior. *Physiology & Behavior, 164*, 417–428. https://doi.org/10.1016/j.physbeh.2016.06.011

Berntson, G., Thomas Bigger, J., L. Eckberg, D., Grossman, P., Kaufmann, P., Malik, M., Nagaraja, H., Porges, S., Saul, P., H. Stone, P., & van der Molen, M. (1997). Heart rate variability: Origins, methods, and interpretive caveats. *Psychophysiology, 34*, 623-648. https://doi.org/10.1111/j.1469-8986.1997.tb02140.x

Berryhill, M. B., Soloski, K. L., Durtschi, J. A., & Adams, R. R. (2016). Family process: Early child emotionality, parenting stress, and couple relationship quality. *Personal Relationships, 23*(1), 23–41. https://doi.org/10.1111/pere.12109

Bodenmann, G., Meuwly, N., Bradbury, T. N., Gmelch, S., & Ledermann, T. (2010). Stress, anger, and verbal aggression in intimate relationships: Moderating effects of individual and dyadic coping. *Journal of Social and Personal Relationships, 27*(3), 408–424. https://doi.org/10.1177/0265407510361616

Brock, R. L., & Lawrence, E. (2008). A longitudinal investigation of stress spillover in marriage: Does spousal support adequacy buffer the effects? *Journal of Family Psychology, 22*(1), 11–20. https://doi.org/10.1037/0893-3200.22.1.11

Buck, A., & Neff, L. (2012). Stress spillover in early marriage: The role of self-regulatory depletion. *Journal of Family Psychology, 26,* 698–708. https://doi.org/10.1037/a0029260

Caldwell, W., da Estrela, C., MacNeil, S., & Gouin, J.-P. (2019). Association between romantic partners' rumination and couples' conflict is moderated by respiratory sinus arrhythmia. *Journal of Family Psychology, 33*(6), 640–648. https://doi.org/10.1037/fam0000544

Chen, F. F. (2007). Sensitivity of goodness of fit indexes to lack of measurement invariance. *Structural Equation Modeling, 14*(3), 464–504. https://doi.org/10.1080/10705510701301834

Connell, A. M., Hughes-Scalise, A., Klostermann, S., & Azem, T. (2011). Maternal depression and the heart of parenting: respiratory sinus arrhythmia and affective dynamics during parent-adolescent interactions. *Journal of Family Psychology, 25*(5), 653–662. https://doi.org/10.1037/a0025225

Côté, S., DeCelles, K. A., McCarthy, J. M., Van Kleef, G. A., & Hideg, I. (2011). The Jekyll and Hyde of emotional intelligence: Emotion-regulation knowledge facilitates both prosocial and interpersonally deviant behavior. *Psychological Science, 22*(8), 1073–1080. https://doi.org/10.1177/0956797611416251

Demaree, H. A., Robinson, J. L., Erik Everhart, D., & Schmeichel, B. J. (2004). Resting RSA is associated with natural and self-regulated responses to negative emotional stimuli. *Brain and Cognition, 56*(1), 14–23. https://doi.org/https://doi.org/10.1016/j.bandc.2004.05.001

Diamond, L. M., Hicks, A. M., & Otter-Henderson, K. D. (2011). Individual differences in vagal regulation moderate associations between daily affect and daily couple interactions. *Personality and Social Psychology Bulletin, 37*(6), 731–744.

https://doi.org/10.1177/0146167211400620
Doucerain, M. M., Deschênes, S. S., Aubé, K., Ryder, A. G., & Gouin, J.-P. (2016). Respiratory sinus arrhythmia is prospectively associated with early trajectories of acculturation among new international students. *Journal of Cross-Cultural Psychology, 47*(3), 421–440. https://doi.org/10.1177/0022022115624015
Ellis, A. J., Shumake, J., & Beevers, C. G. (2016). The effects of respiratory sinus arrhythmia on anger reactivity and persistence in major depression. *Psychophysiology, 53*(10), 1587–1599. https://doi.org/10.1111/psyp.12722
Fabes, R. A., & Eisenberg, N. (1997). Regulatory control and adults' stress-related responses to daily life events. *Journal of Personality and Social Psychology, 73*(5), 1107-1117. https://doi.org/10.1037/0022-3514.73.5.1107
Falconier, M., Nussbeck, F., & Bodenmann, G. (2013). Immigration stress and relationship satisfaction in Latino couples: The role of dyadic coping. *Journal of Social and Clinical Psychology, 32,* 813-843. https://doi.org/10.1521/jscp.2013.32.8.813
Falconier, M., Nussbeck, F., Bodenmann, G., Schneider, H., & Bradbury, T. (2014). Stress from daily hassles in couples: Its effects on intradyadic stress, relationship satisfaction, and physical and psychological well-being. *Journal of Marital and Family Therapy, 41*, 221-235. https://doi.org/10.1111/jmft.12073
Fallahchai, R., Fallahi, M., & Randall, A. K. (2019). A dyadic approach to understanding associations between job stress, marital quality, and dyadic coping for dual-career couples in Iran. *Frontiers in Psychology, 10*, 487. https://doi.org/10.3389/fpsyg.2019.00487
Ferguson, M. (2012). You cannot leave it at the office: Spillover and crossover of coworker incivility. *Journal of Organizational Behavior, 33*(4), 571–588. https://doi.org/10.1002/job.774
Geisler, F., Kubiak, T., Siewert, K., & Weber, H. (2013). Cardiac vagal tone is associated with social engagement and self-regulation. *Biological Psychology, 93*, 279-286. https://doi.org/10.1016/j.biopsycho.2013.02.013
Gillie, B. L., Vasey, M. W., & Thayer, J. F. (2015). Individual differences in resting heart rate variability moderate thought suppression success. *Psychophysiology, 52*(9), 1149–1160. https://doi.org/10.1111/psyp.12443
Gistelinck, F., & Loeys, T. (2019). The Actor–Partner Interdependence Model for Longitudinal Dyadic Data: An implementation in the SEM framework. *Structural Equation Modeling, 26*, 329–347. https://doi.org/10.1080/10705511.2018.1527223
Goetz, G. L., Rodriguez, G., & Hartley, S. L. (2019). Actor-partner examination of daily parenting stress and couple interactions in the context of child autism. *Journal of Family Psychology, 33*(5), 554–564. https://doi.org/10.1037/fam0000527
Gordon, A. M., & Chen, S. (2016). Do you get where I'm coming from?: Perceived understanding buffers against the negative impact of conflict on relationship satisfaction. *Journal of Personality and Social Psychology, 110*(2), 239–260. https://doi.org/10.1037/pspi0000039
Gouin, J.-P., Deschênes, S., & Dugas, M. (2014). Respiratory sinus arrhythmia during worry forecasts stress-related increases in psychological distress. *Stress, 17*, 1–26. https://doi.org/10.3109/10253890.2014.949666
Graham, J., & Conoley, C. (2006). The role of marital attributions in the relationship between life stressors and marital quality. *Personal Relationships, 13*, 231–241.

https://doi.org/10.1111/j.1475-6811.2006.00115.x
Grzywacz, J. G., Almeida, D. M., & McDonald, D. A. (2002). Work–family spillover and daily reports of work and family stress in the adult labor force. *Family Relations, 51*(1), 28–36. https://doi.org/doi:10.1111/j.1741-3729.2002.00028.x
Hu, L., & Bentler, P.M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*, 1-55.
Hartley, S., Papp, L., & Bolt, D. (2016). Spillover of marital interactions and parenting stress in families of children with Autism Spectrum Disorder. *Journal of Clinical Child & Adolescent Psychology, 47*, 1–12. https://doi.org/10.1080/15374416.2016.1152552
Holzman, J. B., & Bridgett, D. J. (2017). Heart rate variability indices as bio-markers of top-down self-regulatory mechanisms: A meta-analytic review. *Neuroscience and Biobehavioral Reviews, 74*, 233–255. https://doi.org/10.1016/j.neubiorev.2016.12.032
Isgett, S. F., Kok, B. E., Baczkowski, B. M., Algoe, S. B., Grewen, K. M., & Fredrickson, B. L. (2017). Influences of oxytocin and respiratory sinus arrhythmia on emotions and social behavior in daily life. *Emotion, 17*(8), 1156–1165. https://doi.org/10.1037/emo0000301
Karney, B. R., & Bradbury, T. N. (1995). The longitudinal course of marital quality and stability: A review of theory, methods, and research. *Psychological Bulletin, 118*(1), 3-34. https://doi.org/10.1037/0033-2909.118.1.3
Karney, B. R., Story, L. B., & Bradbury, T. N. (2005). Marriages in context: Interactions between chronic and acute stress among newlyweds. In T. A. Revenson, K. Kayser, & G. Bodenmann (Eds.), Decade of behavior. Couples coping with stress: Emerging perspectives on dyadic coping (p. 13–32). Washington, DC: American Psychological Association. https://doi.org/10.1037/11031-001
Keizer, R., & Schenk, N. (2012). Becoming a parent and relationship satisfaction: A longitudinal dyadic perspective. *Journal of Marriage and Family, 74*(4), 759–773. https://doi.org/10.1111/j.1741-3737.2012.00991.x
Kelley, H., LeBaron, A., & Hill, E. (2018). Financial stress and marital quality: The moderating influence of couple communication. *Journal of Financial Therapy, 9*, 3. https://doi.org/10.4148/1944-9771.1176
Kenny, D. A., Kashy, D. A., & Cook, W. L. (2006). Dyadic data analysis. New York, NY: Guilford.
King, D. B., & DeLongis, A. (2014). When couples disconnect: Rumination and withdrawal as maladaptive responses to everyday stress. *Journal of Family Psychology, 28*(4), 460–469. https://doi.org/10.1037/a0037160
Kluwer, E. S. (2010). From partnership to parenthood: A review of marital change across the transition to parenthood. *Journal of Family Theory & Review, 2*(2), 105–125. https://doi.org/10.1111/j.1756-2589.2010.00045.x
Kogan, A. V, Allen, J. J. B., & Weihs, K. L. (2012). Cardiac vagal control as a prospective predictor of anxiety in women diagnosed with breast cancer. *Biological Psychology, 90*(1), 105–111. https://doi.org/10.1016/j.biopsycho.2012.02.019
Kok, B. E., & Fredrickson, B. L. (2010). Upward spirals of the heart: autonomic flexibility, as indexed by vagal tone, reciprocally and prospectively predicts positive emotions and social connectedness. *Biological Psychology, 85*(3), 432–436. https://doi.org/10.1016/j.biopsycho.2010.09.005
Lavee, Y., & Ben-Ari, A. (2007). Relationship of dyadic closeness with work-related stress: A daily diary study. *Journal of Marriage and Family, 69*, 1021–1035.

https://doi.org/10.1111/j.1741-3737.2007.00428.x
Ledermann, T., Bodenmann, G., Rudaz, M., & Bradbury, T. N. (2010). Stress, communication, and marital quality in couples. *Family Relations, 59*(2), 195–206. https://doi.org/10.1111/j.1741-3729.2010.00595.x
Lischke, A., Lemke, D., Neubert, J., Hamm, A. O., & Lotze, M. (2017). Inter-individual differences in heart rate variability are associated with inter-individual differences in mind-reading. *Scientific Reports, 7*, 11557. https://doi.org/10.1038/s41598-017-11290-1
Lischke, A., Pahnke, R., Mau-Moeller, A., Behrens, M., Grabe, H. J., Freyberger, H. J., Hamm, A. O., & Weippert, M. (2018). Inter-individual differences in heart rate variability are associated with inter-individual differences in empathy and alexithymia. *Frontiers in Psychology, 9*, 229. https://doi.org/10.3389/fpsyg.2018.00229
Marsh, H.W., Hau, K.-T., & Grayson, D. (2005). Goodness of fit evaluation in structural equation modeling. In A. Maydeu-Olivares & J. McArdle (Eds.), Contemporary psychometrics. Mahwah, NJ: Erlbaum.
Maunder, R. G., Nolan, R. P., Hunter, J. J., Lancee, W. J., Steinhart, A. H., & Greenberg, G. R. (2011). Relationship between social support and autonomic function during a stress protocol in ulcerative colitis patients in remission. *Inflammatory Bowel Diseases*, 18(4), 737–742. https://doi.org/10.1002/ibd.21794
Muthén, L., & Muthén, B. (2012). Mplus user's guide, version 7. Los Angeles, CA: Muthén & Muthén.
Neff, L. A., & Karney, B. R. (2007). Stress crossover in newlywed marriage: A longitudinal and dyadic perspective. *Journal of Marriage and Family, 69*(3), 594–607. https://doi.org/10.1111/j.1741-3737.2007.00394.x
Neff, L. A., & Karney, B. R. (2009). Stress and reactivity to daily relationship experiences: How stress hinders adaptive processes in marriage. *Journal of Personality and Social Psychology, 97*(3), 435–450. https://doi.org/10.1037/a0015663
Nomaguchi, K. M., & Milkie, M. A. (2003). Costs and rewards of children: The effects of becoming a parent on adults' lives. *Journal of Marriage and Family, 65*(2), 356–374. https://doi.org/10.1111/j.1741-3737.2003.00356.x
Nomaguchi, K., & Milkie, M. A. (2020). Parenthood and well-being: A decade in review. *Journal of Marriage and Family, 82*(1), 198–223. https://doi.org/10.1111/jomf.12646
Olsen, J., & Kenny, D. (2006). Structural equation modeling with interchangeable dyads. *Psychological Methods, 11*, 127–141. https://doi.org/10.1037/1082-989X.11.2.127
Ong, A. D., Gardner, S., Urganci, B., Gunaydin, G., & Selcuk, E. (2020). Affective reactivity, resting heart rate variability, and marital quality: A 10-year longitudinal study of U.S. adults. *Journal of Family Psychology, 34*(3), 375–382. https://doi.org/10.1037/fam0000591
Porges, S. W. (2007). The polyvagal perspective. *Biological Psychology, 74*(2), 116–143. https://doi.org/10.1016/j.biopsycho.2006.06.009
Quintana, D. S., Guastella, A. J., Outhred, T., Hickie, I. B., & Kemp, A. H. (2012). Heart rate variability is associated with emotion recognition: Direct evidence for a relationship between the autonomic nervous system and social cognition. *International Journal of Psychophysiology, 86*(2), 168–172. https://doi.org/10.1016/j.ijpsycho.2012.08.012
Randall, A. K., & Bodenmann, G. (2017). Stress and its associations with relationship satisfaction. *Current Opinion in Psychology, 13,* 96–106. https://doi.org/10.1016/j.copsyc.2016.05.010

Randall, A. K., & Bodenmann, G. (2009). The role of stress on close relationships and marital satisfaction. *Clinical Psychology Review, 29*(2), 105–115. https://doi.org/10.1016/j.cpr.2008.10.004

Repetti, R. L. (1989). Effects of daily workload on subsequent behavior during marital interaction: The roles of social withdrawal and spouse support. *Journal of Personality and Social Psychology, 57*(4), 651–659. https://doi.org/10.1037/0022-3514.57.4.651

Schulz, M. S., Cowan, P. A., Cowan, C. P., & Brennan, R. T. (2004). Coming home upset: Gender, marital satisfaction, and the daily spillover of workday experience into couple interactions. *Journal of Family Psychology, 18*(1), 250–263. https://doi.org/10.1037/0893-3200.18.1.250

Smith, T. W., Cribbet, M. R., Nealey-Moore, J. B., Uchino, B. N., Williams, P. G., MacKenzie, J., & Thayer, J. F. (2011). Matters of the variable heart: Respiratory sinus arrhythmia response to marital interaction and associations with marital quality. *Journal of Personality and Social Psychology, 100*(1), 103–119. https://doi.org/10.1037/a0021136

Smith, T. W., Deits-Lebehn, C., Williams, P. G., Baucom, B. R. W., & Uchino, B. N. (2020). Toward a social psychophysiology of vagally mediated heart rate variability: Concepts and methods in self-regulation, emotion, and interpersonal processes. *Social and Personality Psychology Compass, 14*(3), 12516. https://doi.org/10.1111/spc3.12516

Switzer, A., Caldwell, W., da Estrela, C., Barker, E. T., & Gouin, J.-P. (2018). Dyadic coping, respiratory sinus arrhythmia, and depressive symptoms among parents of preschool children. *Frontiers in Psychology, 9*, 1959. https://www.frontiersin.org/article/10.3389/fpsyg.2018.01959

Thayer, J. F., & Lane, R. D. (2009). Claude Bernard and the heart–brain connection: Further elaboration of a model of neurovisceral integration. *Neuroscience & Biobehavioral Reviews, 33*(2), 81–88. https://doi.org/10.1016/j.neubiorev.2008.08.004

Totenhagen, C. J., Curran, M. A., Serido, J., & Butler, E. A. (2013). Good days, bad days: Do sacrifices improve relationship quality? *Journal of Social and Personal Relationships, 30*(7), 881–900. https://doi.org/10.1177/0265407512472475

Visted, E., Sørensen, L., Osnes, B., Svendsen, J. L., Binder, P.-E., & Schanche, E. (2017). The association between self-reported difficulties in emotion regulation and heart rate variability: The salient role of not accepting negative emotions. *Frontiers in Psychology, 8*, 328. https://doi.org/10.3389/fpsyg.2017.00328

Wang, S., Repetti, R., & Campos, B. (2011). Job stress and family social behavior: The moderating role of neuroticism. *Journal of Occupational Health Psychology, 16*, 441–456. https://doi.org/10.1037/a0025100

Wekenborg, M. K., Hill, L. K., Thayer, J. F., Penz, M., Wittling, R. A., & Kirschbaum, C. (2019). The longitudinal association of reduced vagal tone with burnout. *Psychosomatic Medicine, 81*(9), 791–798. https://doi.org/10.1097/PSY.0000000000000750

Zaki, J., & Williams, W. C. (2013). Interpersonal emotion regulation. *Emotion, 13*, 803–810. https://doi.org/10.1037/a0033839

Zemp, M., Nussbeck, F. W., Cummings, E. M., & Bodenmann, G. (2017). The spillover of child-related stress into parents' relationship mediated by couple communication. *Family Relations, 66*(2), 317–330. https://doi.org/10.1111/fare.12244

Footnotes

[1] Our primary analyses tested the moderating role of resting RSA, which is conceptualized as a marker of self-regulatory and social-engagement capabilities. We also tested the moderating role of RSA calculated from the entire visit, which may reflect a combination of individual differences in resting RSA, in addition to differences in RSA reactivity to the CBCL and marital interaction task, which can be conceptualized as an index of self-regulatory effort (Smith et al., 2020). These secondary analyses found no significant interaction effects between child-related stress and RSA throughout the entire visit.

[2] We first tested for within-person effects using Gistelinck & Loeys' (2019) online application to fit a longitudinal APIM in SEM, but these models provided poor fit to the data. As an alternative, we used mixed modelling in SPSS to test for within-person effects separately for actor- and partner-rated outcomes. Note that in these models, we did not account for the non-independence of scores between dyad members; as such standard errors around effect-size estimates and their associated p-values may be biased (Kenny, Kashy, & Cook, 2006).

When predicting actor's reports of marital stress, there were significant effects of between-person and within-person differences in actor child-related on marital stress (B=.340, 95%CI=[.206,.475], p<.001; B=.173, 95%CI=[.088,.259], p<.001), but no significant interactions between actor RSA and between-person or within-person differences in actor child-related stress (B=-.054, 95%CI=[-.195,.086], p=.446; B=-.058, 95%CI=[-.134,.017], p=.125). In this model, random effects indicated that there was significant variability in the model intercept (B=.312, 95%CI=[.214,.453], p<.001).

In the model predicting partners' marital stress, we found significant effects of between-person differences in actor child-related stress on marital stress, but no effect of within-person differences in actor child-related stress (B=.171, 95%CI=[.043,.299], p=.009; B=-.009, 95%CI=[-.105,.087], p=.854). The interaction between actor RSA and between-person differences in actor child-related stress was significant when predicting partners' marital stress (B=-.152, 95%CI=[-.287,-.016], p=.028). The interaction between actor RSA and within-person differences in actor child-related stress was not significant when predicting partner marital stress (B=-.076, 95%CI=[-.161, .009], p=.078). Random effects also indicated significant variability in the model intercept (.262, 95%CI=[.178,.386], p<.001).

Figure 1.

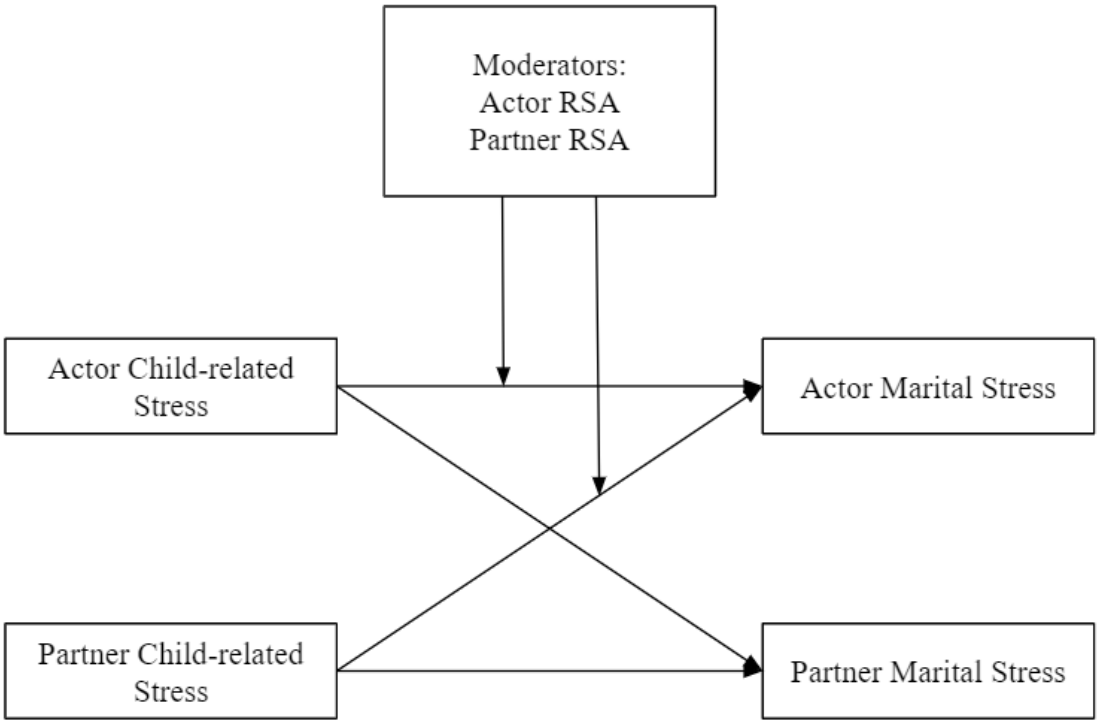

Figure 1. APIM depicting actor and partner effects of child-related stress on marital stress, as moderated by actor and partner RSA.

Figure 2.

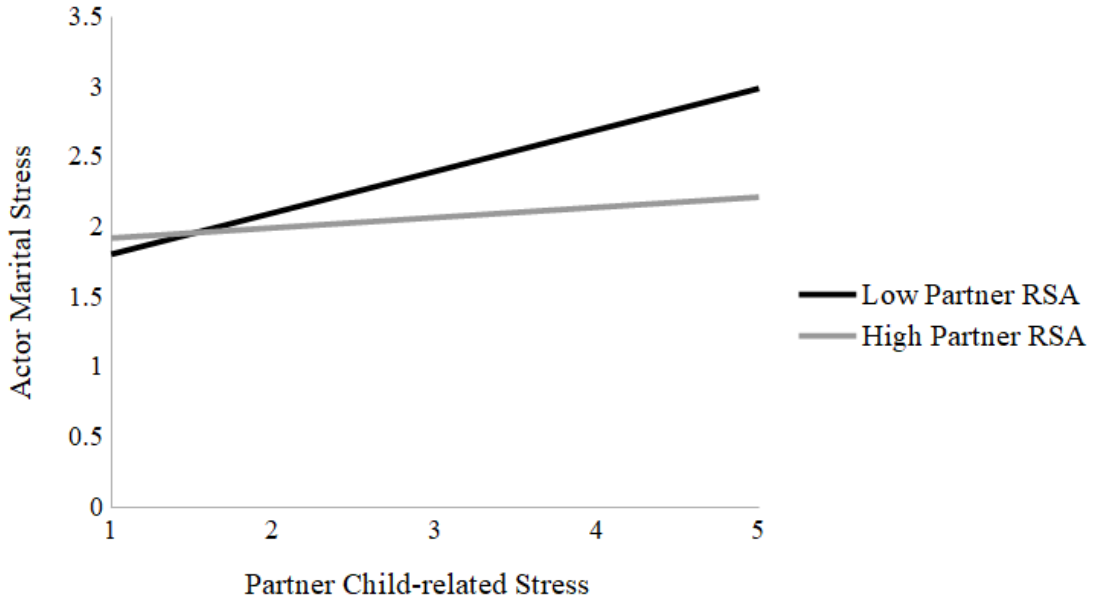

Figure 2. The partner effect of child-related stress on actor marital stress among individuals whose partners have low RSA (1 SD below the mean) and high RSA (1 SD above the men).

Table 1.

Participants' Demographic & Descriptive Data

		Dyad	Males	Females
Age (years)		-	35.91 (4.72)	33.27 (4.20)
Ethnicity (% of sample white)		-	52.44%	59.76%
Education	High School Degree or Less	-	41.46%	31.71%
	College	-	36.59%	46.34%
	University	-	21.95%	21.95%
Employment Status	Not currently employed	-	21.95%	29.27%
	Part-time or Temporary	-	7.31%	28.05%
	Full-time	-	70.73%	42.68%
Born Outside of Canada		-	47.56%	46.34%
Relationship Length (years)		10.01 (4.33)	-	-
Number of Children	1	43.90%	-	-
	2	50.00%	-	-
	3 or more	6.10%	-	-
Household Income	$0-$19,999	14.63%	-	-
	$20,000-$39,999	18.29%	-	-
	$40,000-$59,999	20.12%	-	-
	$60,000-$79,999	15.85%	-	-
	$80,000-$99,999	10.98%	-	-
	+$100,000	20.12%	-	-
Average Child-related Stress		-	2.13 (.72)	2.41(.88)
Average Marital Stress		-	1.82 (.80)	1.88 (.74)
Resting RSA		-	6.22 (1.13)	6.67 (1.04)

Note. RSA = Respiratory sinus arrhythmia.

Table 2.

Bivariate Associations Between Study Variables.

	1	2	3	4	5	6
1. Actor Child-Related Stress	-	.213*	-.014	.149*	.147	-.058
2. Actor Marital Stress	.249*	-	.037	.179*	.265*	-.020
3. Actor RSA	.058	-.010	-	-.081	.019	.081
4. Partner Child-Related Stress	.149*	.147	-.058	-	.249*	.058
5. Partner Marital Stress	.179*	.265*	-.020	.213*	-	-.010
6. Partner RSA	-.081	.019	.081	-.014	.037	-

Note. Correlations for men are included above the diagonal and correlations for women are below the diagonal. Actor effects represent the individual's own score, and the partner effects represent the individual's partner's score. RSA = Respiratory sinus arrhythmia.
*$p < .05$

Table 3.

Actor and Partner Effects of Study Variables on Actor Marital Stress in the Partially Indistinguishable Model

	B (SE)	t	p	LL95%CI	UL95%CI
Actor Child-Related Stress	.309 (.069)	4.495	<.001	.174	.444
Partner Child-Related Stress	.182 (.074)	2.439	.015	.036	.328
Actor RSA	.023 (.047)	.494	.622	-.068	.115
Partner RSA	.030 (.052)	.737	.461	-.050	.110
Actor Child-Related Stress * Actor RSA	-.025 (.052)	-.482	.630	-.127	.077
Partner Child-Related Stress * Actor RSA	.080 (.076)	1.053	.292	-.069	.230
Actor Child-Related Stress * Partner RSA	.013 (.063)	.198	.843	-.111	.136
Partner Child-Related Stress * Partner RSA	-.185 (.064)	-2.892	.004	-.310	-.060

Note. Actor and partner effects are fixed to equality between males and females. SE = Standard error; RSA = Respiratory sinus arrhythmia.