INTERDEPENDENCE, MENTAL WORKING MODELS, AND STRESS BUFFERING IN COUPLES: TOWARD THEORETICAL SPECIFICITY

by

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A Dissertation Submitted to the Faculty of the

DEPARTMENT OF PSYCHOLOGY

In Partial Fulfillment of the Requirements

For the Degree of

DOCTOR OF PHILOSOPHY

In the Graduate College

THE UNIVERSITY OF ARIZONA

2019

THE UNIVERSITY OF ARIZONA
GRADUATE COLLEGE

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SIGNED: Kyle J. Bourassa

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Abstract

Close relationships play a key role in affecting wellbeing across the lifespan. Romantic relationships in particular are an essential social context that impacts physical and mental health. Couples operate interdependently, impacting (and being impacted by) their partner's thoughts, feelings, and behavior. Although the importance of romantic relationships is well established, less research examines the mechanisms that might explain precisely why and how close relationships exert their salubrious effects on health. This dissertation includes three empirical papers that examine (a) what individual characteristics in one person might impact partners' wellbeing and whether these effects might continue even when partners are no longer physically present, and (b) the possible mechanisms that might explain how partners might impact each other. The first study showed that spouses' physical health and cognition predict their partners' wellbeing, and that there is a high degree of interdependence in couples' quality of life. The second study then provided evidence that interdependence within couples' quality of life is maintained, even when one partner passes away. Finally, the third study showed that drawing on the mental image of a romantic partner reduced cardiovascular reactivity to a stressful task in a manner similar to having a partner physically present, suggesting that mental working models may explains interdependence within couples they are not physically interacting. This series of papers provides evidence for how partners affect each other's mental and physical wellbeing over time, and suggest one mechanism that might account for interdependence within couples beyond physical presence.

Chapter 1: Introduction

The importance of close relationships is a consistent thread that weaves through popular modern culture in the form of film, books, and social media posts. This is not surprising—a large scientific literature suggests our close relationships are connected directly to mental and physical health (Holt-Lunstad, 2018; Sbarra & Coan, 2017). Across the life span, psychological and physical wellbeing is intricately tied to the quality of our relationships. The loss of these relationships—in the form of bereavement after years of marriage or a separation following years of discord—are rated as life's most difficult challenges (Holmes & Rahe, 1967). A consistent finding in the literature is that close relationships can buffer people against the negative consequences of stress (Butler & Randall, 2012; Cohen, 2004; Holt-Lunstad, Smith, & Layton, 2010). The current dissertation contributes to the research in this area by focusing on three questions that shed light on how people affect (and are affected by) their romantic partners. First, how do spouses' characteristics, such as their mental or physical wellbeing, contribute to their partners' quality of life? Second, do these interdependent processes persist after one person passes away? Finally, what mechanisms might explain how romantic relationships impact physical health? Whereas the first and second question focus on the nature of interdependence and its boundary conditions, the third question focuses more squarely on the physiological benefits that may be conferred by this interdependence and how these effects are likely to unfold.

Theoretical Framework

One way to conceptualize impact of close relationships on wellbeing is through the lens of Interdependence Theory (Kelley & Thibaut, 1978). This theory serves as a broad framework that outlines the dyadic level at which behavior impacts (and is impacted by) close others. Rewards and punishments influence people's interactions, which in turn affect how they behave

over time. This theory gives rise to the concept of *interdependence* within close relationships. In short, interdependence captures the idea that the people who spend a great deal of time with each other, such as romantic partners, affect each other's thoughts, feelings, and behavior over time (Aron & Nardone, 2012). This basic tenant has guided how subsequent theories have envisioned partner effects within close relationships, including both Attachment Theory and Social Baseline Theory.

Attachment Theory (Ainsworth, 1970; Bowlby, 1982) outlines a model of development in which caregiver support figures play a central role in young children's development. Caregivers occupy essential roles that allow children to explore their environment and regulate their emotions. The theory suggests that children develop attachment styles that impact the characteristics ways they respond their environment in the context of support from their caregivers. Attachment styles formed in childhood are carried forward and continue to impact adult attachment and behavior in later romantic relationships (Shaver & Hazan, 1993; Simpson & Rholes, 1998). In both childhood and adulthood, attachment figures are thought to provide psychological resources for romantic partners to drawn on in stressful situations in the form of mental representations. These mental representations of their attachment relationships are called *working models* (Bretherton & Munholland, 1999) and inform how people respond to external stressors. People in secure relationships are better able to regulate their emotions and seek support from their romantic partners (Mikulincer & Shaver, 2008b).

Notably, the ability to call on a working model of an attachment figure (Collins & Read, 1994) can enhance feelings of social support and self-regulatory capacity even when partners are not physically present (Collins & Feeney, 2004). For example, in the case of widowhood, the death of a spouse involves a reorganization of internal working models of attachment to

accommodate the loss (Shear & Shair, 2005). Called a *continuing bond*, this link can serve as an ongoing source of symbolic support after a spouses' death (Mikulincer & Shaver, 2008a). The activation of a mental representation of a romantic partner might promote ongoing interdependence within couples, even when romantic partners are not present.

Social Baseline Theory (Beckes & Coan, 2011) complements Attachment Theory, and explores the role of social relationships in shaping basic cognitive process, including perception of task demands. According to Social Baseline Theory, proximity to and interaction with others—particularly people we have close relationships with—help conserve biological resources by both allowing people to distribute environmental risk and reducing the use of costly bioenergetic resources to respond to threats. When people are in close proximity to relational partners, such as spouses or family members, they can respond efficiently to environmental stressors with fewer physiological and neural resources, sharing the need to respond among the group. (Beckes & Coan, 2011). In one example of this effect, Coan et al. (2006) used three conditions to explore the association of neural response as assessed by fMRI to threat of electric shock among married women. Participants who held the hand of their spouse had less neural response to threat in areas are implicated in response to threat cues, emotional regulation, and stress response systems. This response was also moderated by relationship satisfaction, such that the women who reported the highest quality marriages also had the most reduction in neural response to the electric shocks. It was not just the physical proximity of a romantic partner, but the quality of the relationship that was associated with diminished neural threat responding.

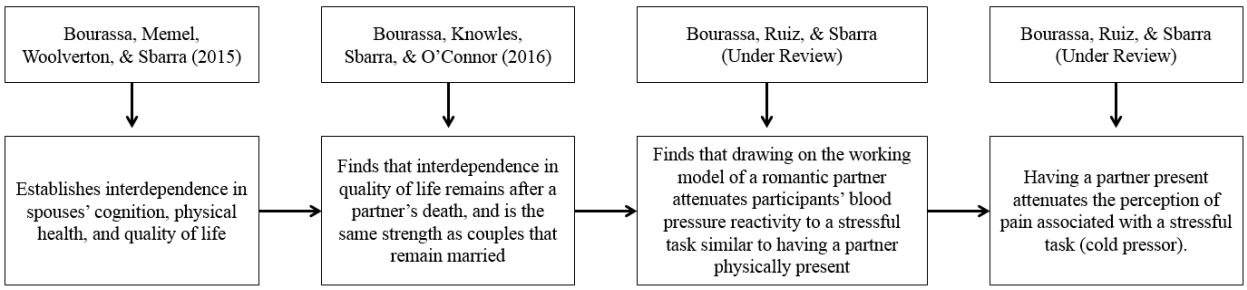
One important difference between Attachment Theory and Social Baseline Theory is the emphasis on physical proximity. In general, studies of Social Baseline Theory have used the physical presence of other people, such as the aforementioned handholding paradigm (Coan et

al., 2006) to explore the biological conservation of resources in response to a threat. Attachment Theory, in contrast, suggests that romantic partners impact each other's psychological and physiological functioning via mental representations of their partners. These mental representations may act as a psychosocial resource for people to draw on when confronted with stressful situations, even when a romantic partner isn't physically present. For example, when primed with threatening words, people's working models of their romantic partners were more accessible to participants than working models of other close relationships (Mikulincer, Gillath, & Shaver, 2002). The current work seeks to examine how interdependence within couples might operate as suggested by Attachment Theory and Social Baseline Theory, and the mechanisms that might explain this interdependence within couples over time.

Present Study Outline

This current investigation explores the impact interdependence within romantic relationships has on physical and mental health over time. The specific contributions of each paper are illustrated in Figure 1.

Figure 1.



In the first paper, I establish interdependence in romantic partners in one specific psychological outcome, quality of life; in the second paper, I extend this work to examine whether ongoing interaction is necessary for romantic partners to affect each other over time. Finally, my third study tested how physical and psychological closeness among romantic

partners affected physiological and psychological outcomes during a stressful laboratory task. In this way, these studies test theoretical assumptions about physical interactions and psychological closeness in Attachment Theory and Social Baseline Theory. The central questions for this dissertation center on how romantic relationships impact wellbeing, and what mechanisms might explain these effects.

To answer these questions, I first explore the association of married spouses' physical and cognitive health with their romantic partners' quality of life. The results show that a spouses' cognition and self-reported levels physical health predict their partners' quality of life, above and beyond that partners' own physical health and cognition. In addition, I show that these spouses' quality of life is highly interdependent over time, accounting for approximately 45% and 51% of spouses' initial quality of life and change in their quality of life over time, respectively. Next, I use a subsample of married couples in which one partner passes away from the same dataset to explore whether the characteristics of deceased romantic partners predict their surviving spouses' outcomes. The results show that the interdependence in quality of life empirically tested in Bourassa et al. (2015) persists, even after one partner passes away. More specifically, deceased spouses' quality of life prior to their death predicts their surviving spouses' quality of life, even years after their passing. This effect is illustrated in Figure 2. Importantly, the strength of this partner effect of quality of life is equivalent between married and widowed participants. In these cases, physical interaction among the couples is impossible, suggesting that intra-individual psychological processes, impact people's outcomes after interactions between spouses cease.

Evidence that ongoing psychological attachment to a deceased partner might impact outcomes after widowhood comports well with Attachment Theory broadly, but the mechanisms that might explain this effect haven't been empirically tested. Is it having a romantic partner

physically present responsible for attenuating responses to threat—as suggested by Social Baseline Theory—or might psychological salience of a romantic partner suffice? The third paper seeks to answer this question by testing how the physical presence or psychological closeness of a romantic partner impacts physiological and psychological outcomes during a stressful laboratory task.

Figure 2.

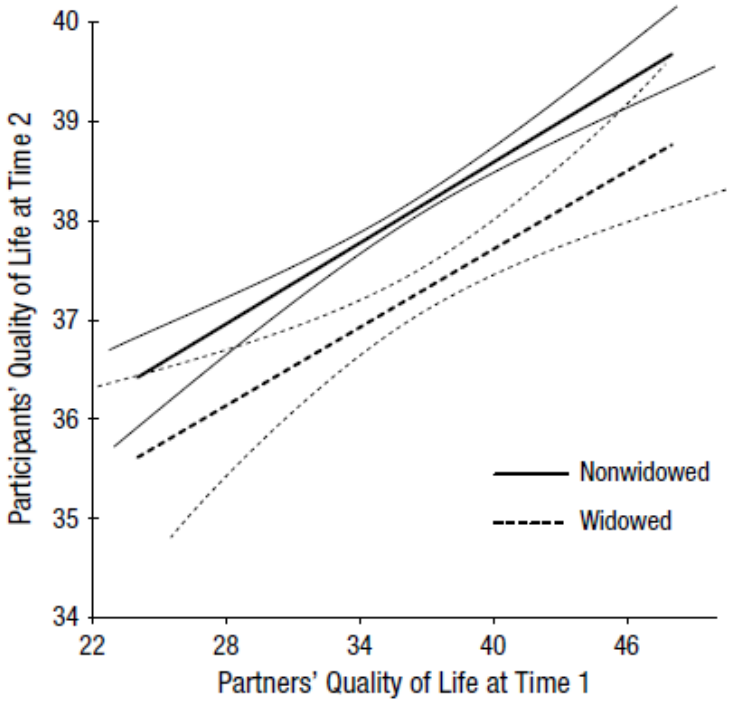


Fig. 3. Participants' predicted quality of life at Time 2 as a function of partners' quality of life at Time 1, separately for the widowed and non-widowed subsamples. This analysis accounted for Time 1 age, gender, education, income, depressive symptoms, and partner age. The thin lines flanking each regression line indicate 95% confidence intervals.

These three papers contribute to the current literature of interdependence in romantic relationships by exploring how social relationships impact wellbeing outcomes and how these relationships might attenuate psychological and physiological responses to stressful situations. How does activating the working model of a romantic partner modify psychological and

physiological response to threat, even when one's partner is not present? And does this activation compare to the attenuation of threat and response observed when romantic partners are physically present? In the following section, I summarize the series of three papers in more detail.

Chapter 2: Bourassa, Memel, Woolverton, & Sbarra (2015)

Bourassa, K. J., Memel, M., Woolverton, C., & Sbarra, D. A. (2015). A dyadic approach to health, cognition, and quality of life in aging adults. *Psychology and Aging*, *30*(2), 449-461.

Summary

The first step to explore interdependence in couple's outcomes is to establish that such effects exist and explore what outcomes show interdependence among romantic partners over time. Although there are previous studies examining the interpersonal context of cognition, physical health, and quality of life, few studies test these associations in an integrated, longitudinal, dyadic model. Prior work found interdependent effects of quality of life (Bookwala & Schulz, 1996), for example, however the results were mixed in regards to the exact pattern of these associations (Walker, Luszcz, Gerstorf, & Hoppmann, 2010). Using an integrated, dyadic model and a representative, multinational, longitudinal sample best allows for the estimation of these partner effects and the determination if spouse's psychological and physical health might predict their partner's psychological and physical health outcomes over time.

To explore this question, my co-authors and I used secondary data from the Survey of Health, Ageing, and Retirement in Europe (SHARE) study. At the time of analysis, the SHARE dataset had four waves of data collection collected every 2 years; three panel waves and one dealing with retrospective life histories (Wave 3). Participants were drawn from 13 European

Union countries (Austria, Belgium, Czech Republic, Denmark, France, Germany, Greece, Italy, Netherlands, Poland, Sweden, Spain, Switzerland). All told, the data contained over 150,000 completed interviews with about 86,000 unique participants, including a subset of romantic couples. We included couples who were assessed at least two of the three possible panel assessments in the current study, resulting in a final sample of 8,187 couples.

Using these data, we specified bivariate latent curve growth models (LCGM; McArdle & Anderson, 1990) to examine interdependent partner effects on quality of life from cognition and physical health, as well as the intercept-intercept and slope-slope covariation of quality of life among husbands and wives. We also included the focal predictors of husbands' and wives' health and cognition at the initial time point to examine their associations with the latent curve parameters for quality of life. Finally, we added covariates predicting our outcomes of interest to account for possible alternative predictors, including participant age, depressive symptoms, caregiving status, and education, as well as couples' income percentile, and years married. The final conceptual model is presented in Figure 3.

In this study, we found that husbands' and wives' levels of physical health and cognition were predictive of their partners' baseline levels of quality of life, but not change in their quality of life. As shown in Figure 4, partner effects of both physical health and cognition were smaller than actor effects of physical health, but more similar to actor effects of cognition. The results suggest that spouses' physical health and cognition may affect their partners' quality of life, potentially through activating partner's stress management and coping resources, or by affecting individual's emotions and behaviors, which affect their partner's quality of life in turn.

Figure 3.

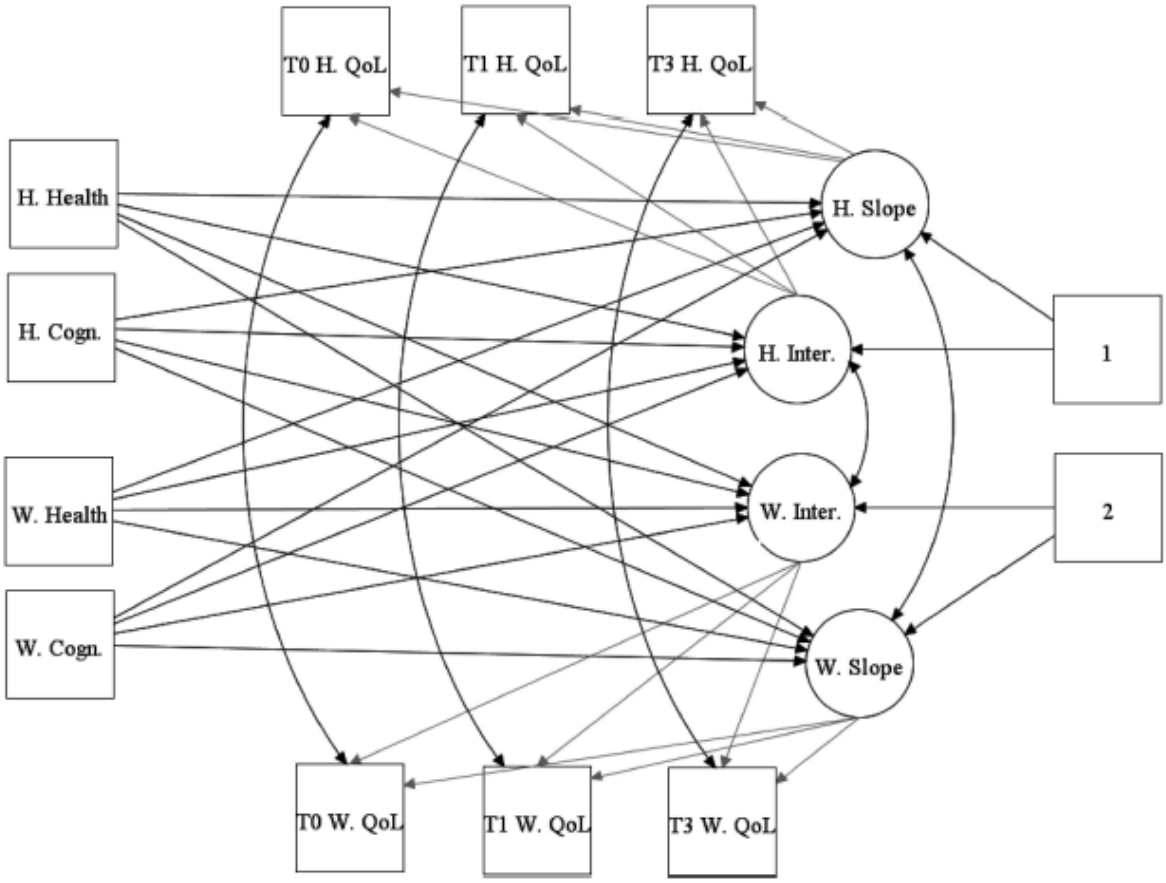


Figure 2. The final conceptual model for the current study, including the bivariate latent curve growth model and all relevant predictors for the latent curve parameters for QoL for husbands and wives, is presented above. The variables numbered 1 and 2 represent the relevant covariates included for (1) husbands and (2) wives (years married, income, education level, age, and depressive symptoms at T0). Health and cognition for husbands and wives were assessed at T0. H. = husbands, W. = wives, inter. = intercept, cogn. = cognition, QoL = quality of life. The estimates for all pathways in the model are included Table 2, Model 3.

In addition to the partner effects of cognition and physical health on quality of life, husbands' and wives' baseline quality of life was positively correlated, suggesting that husbands and wives have similar quality of life levels. Further, spouses' individual quality of life slopes were positively correlated, suggesting that as wives' quality of life increased/decreased so did their husbands' quality (and vice versa), accounting for over half of the variance in spouses quality of life (51%). These findings replicated previous research that found similarities among husbands' and wives' wellbeing (Bookwala & Schulz, 1996, Walker et al., 2011). The present

study also extended these findings to LCGM parameters (correlated change) and presents a compelling case for interdependence of quality of life among older couples.

Figure 4.

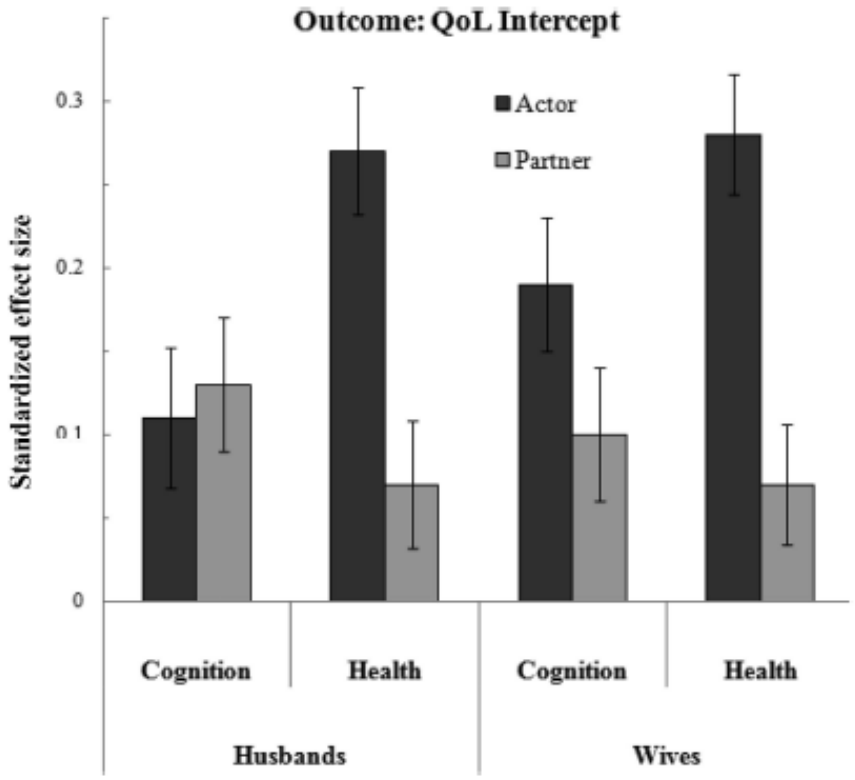


Figure 3. The standardized actor and partner effects of health and cognition predicting the intercept of husband and wives' QoL from the full model, including all covariates (years married, income, education level, age, and depressive symptoms at T0). All actor and partner effects displayed were significant at the $p < .001$ level. There were no significant differences in partner effects between men and women for cognition or physical health's prediction of husbands' or wives' QoL intercept. Error bars represent 95% confidence intervals.

These results suggest that it is important to examine the interpersonal context of health, cognition, and quality of life. This study also helps establish the importance of interdependence among couples, and aging adults specifically, but is agnostic as to what might be responsible for these effects. Typically, transactional interactions are thought to explain interdependence in close relationships over time, but were not explicitly tested in this case. Although it is important to

determine that such effects exist, it is also essential to understand what might be responsible for such effects. Further research could examine the pathways responsible for these partner effects.

Contributions

As the first-author of this manuscript, my contributions were extensive. I developed the idea to test interdependence in married spouses' cognition, physical health, and quality of life and discovered the SHARE study as a dataset with which to test these ideas. I established the analytic plan to test these associations and, with help from my advisor and co-authors, I drafted and submitted the resulting manuscript to *Psychology and Aging*, which included implementing substantial conceptual and analytic changes to the manuscript during the revision process.

Chapter 3: Paper 2 – Bourassa, Knowles, Sbarra, & O'Connor (2016)

Bourassa, K. J., Knowles, L. M., Sbarra, D. A., & O'Connor, M. F. (2016). Absent but Not Gone Interdependence in Couples' Quality of Life Persists after a Partner's Death. *Psychological Science*, *27*(2), 270-281.

Summary

As established in Bourassa et al., (2015) older adults' quality of life is dependent not only on their own psychological functioning, but also on that of their spouse. One unexplored question is whether this interdependence can continue if one of the partners in a marriage passes away. Attachment Theory suggests that internal working models of a deceased partner are reorganized to accommodate the loss (Mikulincer & Shaver, 2008a; Shear & Shair, 2005). These internal models appear to predict people's outcomes following bereavement and might vary based on the prior characteristics of the deceased spouse. If so, it is possible that characteristics of the deceased spouses' prior to their death continue to influence their spouses after their death?

This possibility would represent an intra-individual cognitive process that might influence couples' interdependent outcomes without relying on physical interactions.

To test this possibility, we again used the SHARE dataset, this time using data from full couples who were available at one wave, and where one spouse passed away between that assessment and the next wave of data collection. In this way, we were able to create two independent subsamples (*n*s = 225 and 325) in which full couple data was available at an initial time point (T1), and after one spouse passed away prior to a second time point (T2), at which we had outcome data for the surviving spouse. In addition, we included 2,566 couples that remained intact during this same period for use as a comparison group. Using these participants' data, we were able to explore whether interdependence in quality of life continued when physical interactions was no longer possible. We expected partners' pre-death quality of life would predict the spouse's quality of life after the partner's death among widowed participants, and we also expected the association of partners' pre-death quality of life and the surviving spouses' later quality of life would be weaker among widowed couples than non-widowed, continuously married couples.

We evaluated our first hypothesis by testing whether deceased partners' quality of life predicted surviving spouses' later quality of life, while controlling for surviving spouses' prior quality of life. We first used only the hypothesized variables of interest in our models, and then integrated a number of covariates as alternative predictors that might explain the associations. In addition, we examined whether membership in a specific subsample was predictive, which tested whether effects replicated across the independent subsamples. To test our second hypothesis, we evaluated whether there were differences between the widowed and non-widowed samples in the strength of the association between partners' prior quality of life and their spouses' later quality

of life. Our models included participant and partner quality of life as a predictor of later quality of life, with widowed status moderating of the relationship between partner quality of life and later participant quality of life. We tested the models with additional alternative variables as covariates of interest in additional models for this hypothesis as well.

The results of our regression models found that deceased partners' quality of life prior to their death predicted their widowed spouses' later quality of life. This effect is visualized in Figure 5. In addition, the strength of independence in couples' quality of life was equivalent between widowed and nonwidowed participants, and is visualized in Figure 2.

Theories predicting dyadic effects in couples' psychology and physiology (Lewis et al., 2006; Rholes & Simpson, 2004; Sbarra & Hazan, 2008) generally focusing on ongoing interactions to explain these effects. These findings suggest that interdependent effects of quality of life among married spouses continue after one partner *cannot* be present for ongoing interactions. Although their marriages had ended, the distal effects of the deceased partner's characteristics continued to predict their surviving spouse's wellbeing. The results of this study suggest that the presumed ongoing physical interaction used to explain the partner effects found in Bourassa et al. (2015) are not the only possible mechanisms for these effects, as they could not explain interdependence in quality of life without ongoing interactions. Some intra-individual processes must maintain interdependence in quality of life, and it is possible that these effects might be meaningful for people whose partner is living, but not physically present.

Contributions

As the first-author of this manuscript, my contributions were extensive. I developed the idea to test whether interdependence in married spouses' quality of life continued even when one spouse has passed away. I used the SHARE study in a unique way test these ideas by finding a

Figure 5.

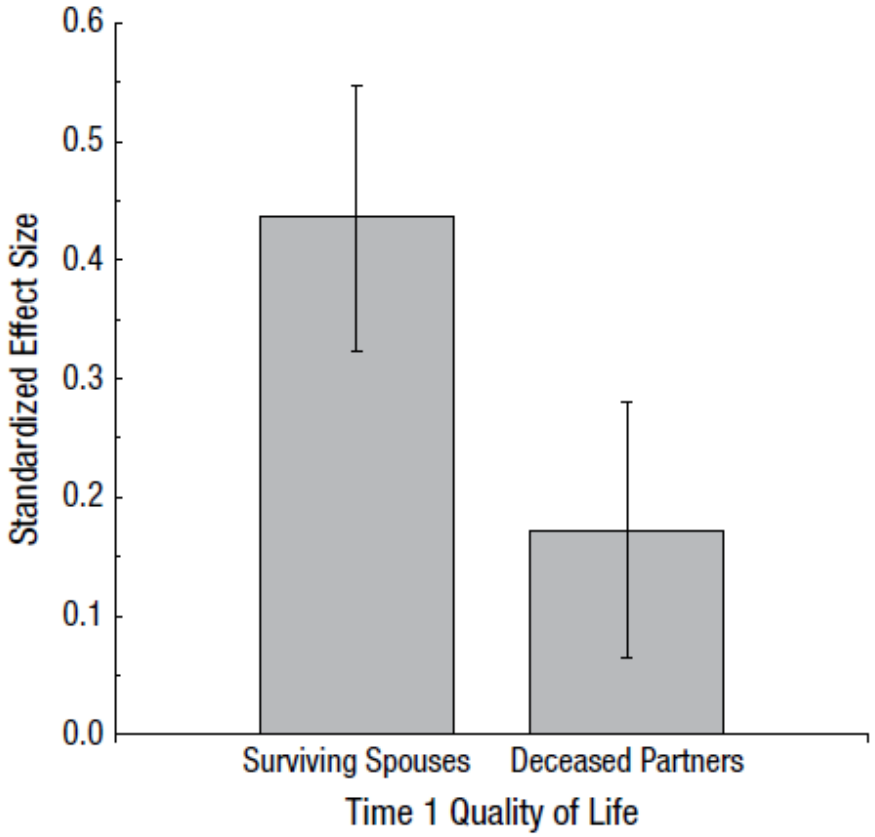


Fig. 1. Standardized mean effect size from Model 2 for surviving spouses' and partners' Time 1 quality of life as a predictor of participants' Time 2 quality of life for the widowed subsample. Values shown are from Model 2, which included surviving spouses' Time 1 age, gender, education, and depressive symptoms; years of marriage; partners' age and self-rated health; daily hours devoted to partner care prior to death; time the partner was ill prior to death; length of time since the surviving spouse was assessed prior to the partner's death; and length of time the surviving spouse was assessed after the partner's death, as well as Time 2 social engagement. Error bars represent 95% confidence intervals.

subsample of widowed participants with full couple-level data at an early assessment. I proposed this idea to my co-authors and organized the process of taking this data through the analysis and writing process. With my co-authors, I established the analytic plan to test our research questions, and drafted then submitted the resulting manuscript to *Psychological Science*, including responding to changes to the manuscript during the peer review process.

Chapter 4: Paper 3 – Bourassa, Ruiz, & Sbarra, (Under Review)

Bourassa, K. J., Ruiz, J. M., & Sbarra, D. A. (Under Review). The Impact of Physical Proximity and Attachment Working Models on Cardiovascular Reactivity: Comparing Mental Activation and Partner Presence. *Psychophysiology*.

Summary

Romantic partners can affect each other's health by attenuating responses to stressful stimuli (Butler & Randall, 2012; Cohen, 2004). Close others, including romantic partners, can act as a psychological resource when facing threatening or stressful situations, and these resources can in turn modulate stress responses and buffer against exaggerated physiological reactivity (Bloor, Uchino, Hicks, & Smith, 2004; Coan et al., 2006; Cohen & Wills, 1985; Smith, Ruiz, & Uchino, 2004). Attachment Theory (Bowlby, 1982) and Social Baseline Theory (Beckes & Coan, 2011) provide complementary, but distinct explanations for how romantic partners might buffer stress and promote improved health. Attachment Theory suggests that drawing on working models—the internalized cognitive schema of a romantic partner (Collins & Read, 1994)—is one method to potentially reduce physiological reactivity by buffering against stress (Cohen & Wills, 1985). Social Baseline Theory complements Attachment Theory and proposes that social proximity and interaction helps people conserve biological resources by allowing for sharing the burden associated with environmental risk and threat, which has the potential to improve health over the long term (Beckes & Coan, 2011).

Attachment Theory and Social Baseline Theory suggest separate mechanisms through which romantic partners impact each other's physiological and affective responses to external stressors. Social Baseline Theory emphasizes the role of physical proximity in shaping the perception of threat (Coan & Maresh, 2014), whereas Attachment Theory proposes that calling

on the *working models* of attachment figures enhance feelings self-regulatory capacity (Collins & Feeney, 2004). In comparing and contrasting these theories, two primary questions arise. First, does calling on the mental representation of a romantic partner differentially predict stress responses compared to having a partner physically present? Second, to the extent that the presence of a partner and calling on a representation of a partner both attenuate stress responses, do these effects operate through different appraisal processes?

To test these questions, my co-authors and I used a sample of undergraduate students in a romantic relationship (N = 102) recruited to complete a cardiovascular reactivity laboratory study. Participants were randomized to either have a romantic partner present, access the mental representation of their partner, or think about their day as an active control during a cold pressor task (Menkes et al., 1989). Our preregistered procedure, hypotheses, and analysis plan for this investigation were made available online (https://osf.io/kdt9s) prior to the completion of the study data collection. We predicted that accessing the mental representation of a romantic partner and a partner's presence would both reduce participants' physiological reactivity. In exploratory analyses, we also examined whether the physical presence of a romantic partner affected participants' self-reported pain during the stressful task. The analytic framework followed the preregistered analytic plan to assess the primary outcomes of interest—systolic and diastolic blood pressure (SBP, DBP), heart rate (HR), and HR variability (HRV)—using multiple regression models. We ran each model independently and controlled for baseline cardiovascular activity levels. In cases of HRV, we also included respiration rate as a covariate.

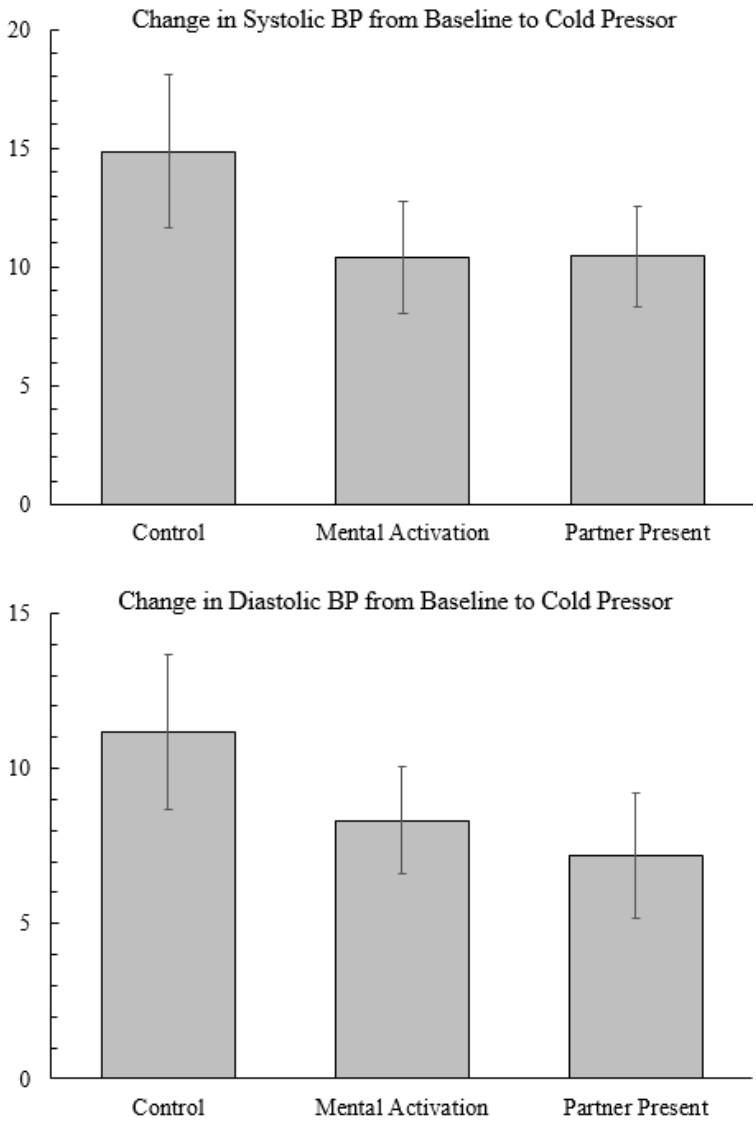
Our results for our main hypotheses showed no significant differences between the Partner Present and Mental Activation conditions for SBP or DBP. As predicted, however, Partner Present and Mental Activation participants had significantly lower BP reactivity

compared to Control participants for both SBP and DBP. Participants assigned to the Partner Present and Mental Activation conditions increased 4.41 mmHg SBP and 3.38 mmHg DBP less from baseline to the cold pressor task compared to Control, effect sizes of d = -0.54 and -0.53, respectively. Figure 6 illustrates the raw reactivity for each condition.

Having established condition differences in BP (but not HR or HRV) under the preregistered analytic plan, we conducted a series of exploratory analyses to better understand the overall pattern of results. These analyses revealed that participants in the Partner Present condition had significantly lower pain ratings after the cold pressor compared to participants in the Mental Activation and Control conditions. The effect was medium in size, d = -0.57, representing a 12.1% difference in pain on the 11-point scale. These effects point to a dissociation in self-report and physiology across conditions: Participants in the Partner Present condition perceived the cold pressor task to be less painful than the Mental Activation and Control participants, but evidenced attenuated BP reactivity similar to Mental Activation participants.

These results replicated previous findings that drawing on a close other can reduce cardiovascular reactivity during a stressful task (Bloor et al., 2004; Smith et al., 2004) and extended these findings by directly comparing them to having a romantic partner physically present. Evidence that drawing on the mental representation of a romantic partner or having a partner physically present attenuates BP reactivity during stressful task to a similar degree provides support for the basic premises of both Attachment Theory and SBT. BP reactivity to a cold pressor predicts the development of preclinical disease states (Treiber et al., 2003), and if the current findings were maintained outside the laboratory, it would suggest that CVR is a critical, health-relevant pathway linking romantic relationships to distal health outcomes.

Figure 6.



Contributions

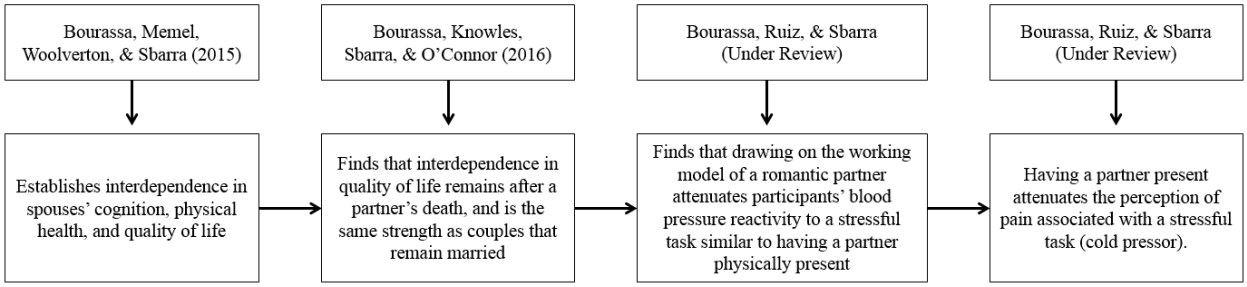
As the primary researcher in charge of the study design and data collection, as well as the first-author of this manuscript, my contributions were extensive. In concert with my co-authors, I developed the idea to test whether cardiovascular responses to stressful stimuli can be attenuated by accessing the internal mental representation of one's partner or a partner's physical proximity in a similar way, as well as how perceptions of a stressful task might differ by condition. I led a

team of undergraduate research assistants to collect data from 102 participants using a cardiovascular reactivity paradigm and physiological data collection equipment. This included all aspects of recruitment, training, and data cleaning. I was present when running every participant and cleaned all physiological data. Once the data was collected, I then organized the process of taking the collected data through the analysis and writing process. With my co-authors, I drafted then submitted the resulting manuscript for peer review.

Chapter 5: General Discussion

The three manuscripts presented here outline a research program examining the impact of interdependent romantic relationship processes on a diverse range of outcomes, including quality of life (Bourassa et al., 2016, Bourassa et al., 2016) and cardiovascular reactivity (Bourassa et al., Under Review). Taken together, the studies examined the inter- and intra-personal psychological variables that can help explain how interdependent effects in romantic relationships are maintained over time, even when partners are not physically present with each other. The conceptual linkage between these manuscripts is visualized in Figure 1 (repeated below).

Figure 1.



In summary, Bourassa and colleagues (2015) first established interdependence in couples' quality of life, and proposed that ongoing interactions might mediate this effect, in line

with the broad conceptual framework presented by Interdependence Theory (Kelley & Thibaut, 1978). It should be noted, however, that this study did not explicitly test any potential mechanisms that might explain interdependence. The suggestion that ongoing interactions fully explained interdependence among couples in this study was then challenged by the findings from Bourassa and colleagues 2016 study; deceased spouses quality of life prior to their death continues to predict their surviving spouses' quality of life, even years after their death. Said differently, interdependence in quality of life remained even when ongoing physical interactions among married couples were no longer possible. The findings suggested that it was not possible that the physical proximity of a romantic partner or interactions between spouses fully explained interdependence among couples. Rather than ongoing physical interactions, some intra-individual cognitive or behavioral process must also explain how deceased spouses' characteristics could predict their surviving spouses' outcomes, even years later. This possibility makes intuitive sense. People who are married or in romantic relationships would be unlikely to say their partner only impacts their reactions to external stimuli or internal thoughts and feelings when they are physically interacting with them. Although physical interaction is undoubtedly important, it likely only one method through which our romantic partners impact our ongoing psychological and physical wellbeing.

Bourassa and colleagues (2016) suggested that the ongoing association in couples' quality of life after a partner's death might be due to continuing bonds to the deceased partner, in which people continue to draw on the internal working model of their deceased partner after their death (Mikulincer & Shaver, 2008a; Shear & Shair, 2005). Even though they are no longer physically present, the surviving spouse can remain psychologically close to the surviving spouse by accessing the working model of their romantic partner. In this way, the importance of

the people we love does not simply fade away when they die. The findings from Bourassa and colleagues (2016) support the idea that impacts from spouses remain when they are not physically present, perhaps through intra-individual cognitive processes. As with the Bourassa et al. (2015) study, however, this analysis did not explicitly test potential mechanisms that might explain the association. Both studies used large publically available datasets, which allowed for samples of couples' pre-widowhood partner data, sophisticated statistical models with high levels of power, and the ability to include a variety of important covariates. The tradeoff for these types of data, however, is the lack of specific, mechanistically-focused psychological measurement that might be found in smaller, more targeted studies.

Although psychological closeness to an absent partner was a plausible explanation for how interdependence might result when spouses cannot physically interact, there was little research examining this possibility within ongoing romantic relationships. It was essential at this point to conduct a more targeted study that might test the effect of mentally drawing on the working model of a romantic partner when faced with external stressors. Prior work in the broader social support literature found that mentally drawing on the image of a close friend attenuated cardiovascular reactivity to a social stressor when compared to mentally activating an acquaintance (Bloor et al., 2004; Smith et al., 2004). Using a similar laboratory paradigm, Bourassa and colleagues' most recent study (Under Review) directly tested one possible cognitive process that might explain how romantic partners might affect each other, even when not physically present. They examined whether drawing on the mental working model of a romantic partner—as suggested by Bourassa et al. (2016)—may be similar or different from the physical presence of a romantic partner in terms of cardiovascular responses to stress. By using an experimental design to compare how physical presence or mental activation of a romantic

partner might affect people's physiological or affective outcomes to an active control, this study provided initial *casual evidence* that accessing a working attachment model of a romantic partner or spouse attenuates blood pressure reactivity during a stressful task in a way that is similar to having a partner present. Furthermore, this study also showed that a partner's presence reduced the perception of pain during the stressful task. Having a partner present reduced cardiovascular reactivity while also reducing the pain associated with a cold pressor task, whereas mentally drawing on the working model of romantic partner buffered against cardiovascular reactivity, but the pain experienced during the task was not reduced.

Attachment and Social Baseline theories propose independent mechanisms for how romantic partners might impact each other's health over time. A primary implication of the results of these three studies is that both of the assumed mechanisms of action for how romantic partner might influence each other—mental working models and physical proximity—appear to create and maintain interdependence within couples. Attachment Theory focuses how the mental working model of a romantic partner people carry with them might buffer against stress response (Cohen & Wills; 1985) and promote positive outcomes, whereas Social Baseline Theory focuses on the impact that load-sharing and reduction in the perception of threat has on subsequent stress responses when people are physically present with others they are close to. Importantly, these mechanisms are not mutually exclusive, and instead point toward a multifaceted way that close relationships can operate to impact psychological and physiological reactions to stressful stimuli. It seems reasonable to assume that when romantic partners are physically present that the load-sharing suggested by Social Baseline Theory would be the least taxing way to respond to potential threats, conserving biologically resources in turn. It is equally reasonable to assume that when romantic partners are not physically present, they may still influence reactions to threat via

intra-individual cognitive processes, including drawing on the working model of that partner, as suggested by Attachment Theory. The evidence from Bourassa and colleagues (Under Review) seems to suggest that these mechanisms work independently and translate to similar effects on blood pressure reactivity.

Perhaps as interesting as the main effects on physiology was that the task was rated as less painful for those whose partner was present, which lends some support for the claim from Social Baseline Theory that having a partner present might make facing stressful situations less difficult. It is possible, for example, that the people whose romantic partner was present during the cold pressor were better able to "share the load" of the physical pain during the task. Participants drawing on the working model of their partner were able to use that working model as a psychological resource, but this process was more effortful. This said, these results were exploratory, and we observed no differences in self-reported appraisals of the cold pressor task (Bourassa et al., Under Review). Future studies should attempt to measure what might vary between these two groups that could provide insight into the different mechanisms of action between Attachment Theory and Social Baseline Theory. For example, it would be helpful to use more refined measurements of primary and secondary appraisals in the moment, such as using ongoing self-report of effort required for a given task.

An additional implication of this work is the proposed potential mechanisms that might explain how romantic relationships and marriage affect health. Romantic relationships and marriage are consistently associated with improved psychological and physical health (Sbarra & Coan, 2017). A variety of plausible mechanisms of action may explain this effect, including stress buffering and differential impacts on health behaviors (Bourassa, Ruiz, & Sbarra, In Press). This series of papers, particularly the work by Bourassa and colleagues (Under Review),

provide evidence that people involved in romantic relationships may be protected against potentially harmful cardiovascular reactivity. Although the study was conducted in a laboratory environment, controlled laboratory responses to a cold pressor predict the development of preclinical disease states (Chida & Steptoe, 2010; Treiber et al., 2003). If reductions in blood pressure reactivity in the lab can be replicated in the daily, lived experiences on people in romantic relationships (for preliminary evidence, see Kamarck, Schwartz, Janicki, Shiffman, & Rayno, 2003), it would suggest that reductions in wear-and-tear from exaggerated blood pressure responses to daily stressors by having a partner present or drawing on the mental working model of a partner would translate to better downstream, long-term health (Robles, Slatcher, Trombello, & McGinn, 2014; Uchino, 2006). To determine if such an effect might exist, however, it would be essential to undertake future studies that examine ambulatory blood pressure reactivity to daily stressors, particularly when a partner might be present or someone may draw on the working model of their romantic partner.

Limitations

This series of studies should be understood in the context of its limitations. First, the studies by Bourassa et al. (2015; 2016) used correlational methods to examine associations in aging couples. Although the samples were large and representative—and the second paper included an internal replication—it is possible these findings are not causal. Second, the final study by Bourassa et al. (Under Review) found that attenuation of physiological reactivity can occur from drawing on the working model of a partner, but the maintained interdependence in the second study (Bourassa et al., 2016) was in quality of life, not physiological reactivity. Although an important finding and suggestive of a possible mechanisms of action for physiological reactivity, further study would be needed to examine if drawing on the working

model of a romantic partner with higher quality of life might maintain interdependence in quality of life even when physical interaction does not occur. Third, although the final study by Bourassa et al. (Under Review) assessed primary and secondary appraisals of the cold pressor task, the results did not indicate any association of pre- or post-task appraisals with condition or BP reactivity. Without understanding the specific mechanisms of action for how mentally drawing on the working model of a romantic partner might impact physiological reactivity, the specific BP reactivity finding are more difficult to interpret. Fourth, the three studies presented here were drawn from varying populations, including European aging and adults (Study 1 and 2) and young adults at a state university in the US (Study 3). Although we might hope that these results would replicate and extend to different populations, it is certainly important to note that the samples varied in this way.

Future Directions

The current series of studies suggest important future directions for additional research. First, it would be important examine partner outcomes following interventions to test the effects of interest found in the first two studies by Bourassa et al. (2015; 2016). For example, it would be possible to examine how aging couples' quality of life changes when medical intervention results in improved physical health for one spouse. Second, the lack of findings related to changes in appraisals by condition or on BP reactivity suggests that additional research is needed to examine how drawing on a working model of a romantic partner might be similar or different to having a partner physically present. Although both attenuate physiological reactivity, it seems unlikely that this effect operates the same way for both conditions. Future research could use either more proximal self-report measurement during the task to try to better assess self-reported appraisals or use a larger sample to try to overcome some of the random variability present in

self-report. It might also be useful to use alternative types of assessment to try to measure how drawing on the working model of a partner might impact physiology. For example, combining cardiovascular physiological assessment and fMRI could allow future research to examine the specific brain regions associated with threat examined by Coan et al. (2016) to determine whether mentally calling on a partner's working model affects threat response in a similar or different way compared to holding a partners hand. A third, potentially fruitful future direction would be to extend the final study (Bourassa et al., Under Review) to include a condition in which partners physically touch each other. Studies examining Social Baseline Theory have traditionally used a handholding paradigm (Coan et al., 2006), which may differ in meaningful ways from having a partner present, but without physical contact. Such a replication and extension of the current work would both provide an independent test of the BP reactivity findings reported here, and test an additional important condition that affect physiological reactivity.

Conclusion

The current study sought to examine interdependence in romantic relationships to test how close relationships, and specifically romantic relationships, might operate to impact couples' psychological and physiological outcomes. In the first manuscript, Bourassa and colleagues (2015) provided evidence that married couples' health and cognition predicted each other's psychological wellbeing. This study also showed that couples' quality of life was correlated initially and over time, providing initial evidence for couples' interdependence in quality of life outcomes. The second manuscript from Bourassa and colleagues (2016) then extended this work, finding that deceased spouses' quality of life continues to be linked with their surviving spouse's quality of life, even years after their death. This work suggested that

interdependence is maintained, even when physical presence of a romantic partner is not possible. Some type of intra-individual process must be at least partially responsible for maintaining couples' interdependence in couples, leading Bourassa and colleagues (Under Review) to use an experimental study to test people's cardiovascular reactivity to a stressful laboratory task. The results showed that mentally drawing on the working model of a romantic partner could attenuate cardiovascular reactivity to a stressful task in a similar way to having a partner physically present, though people whose partner was present reported experiencing less pain as a result of the task. These results provide support for both Attachment Theory and Social Baseline Theory's mechanisms proposed to attenuate people's physiological reactivity to stress. In short, the current collection of studies provided evidence for interdependence in couple's outcomes, and that this interdependence did not require physical presence. The final study then showed that mentally drawing on the attachment working model of a romantic partner might be one possible mechanism for how people might be impacted by their romantic partner, even when they aren't physically present.

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Appendix A

Note: This appendix is included as a post-print manuscript and is published in full form elsewhere: Bourassa, K. J., Memel, M., Woolverton, C., & Sbarra, D. A. (2015). A dyadic approach to health, cognition, and quality of life in aging adults. *Psychology and Aging*, *30*(2), 449-461.

A Dyadic Approach to Health, Cognition, and Quality of Life in Aging Adults

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Author Note: This paper uses data from SHARE wave 4 release 1.1.1, as of March 28th 2013, and SHARE wave 1 and 2 release 2.6.0 as of November 29th 2013. The SHARE data collection has been primarily funded by the European Commission through the 5th Framework Programme (project QLK6-CT-2001-00360 in the thematic programme Quality of Life) through the 6th Framework Programme (projects SHARE-I3, RII-CT-2006-062193, COMPARE, CIT5-CT-2005-028857, and SHARELIFE CIT4-CT-2006-028812) and through the 7th Framework Programme (SHARE-PREP, N° 211909, SHARE-LEAP, N° 227822 and SHARE M4, N° 261982). SHARE data collection was also provided additional funding from the U.S. National Institute on Aging (U01 AG09740-13S2, P01 AG005842, P01 AG08291, P30 AG12815, R21 AG025169, Y1-AG-4553-01, IAG BSR06-11 and OGHA 04-064) and the German Ministry of Education and Research as well as from various national resources whose support is gratefully acknowledged (see www.share-project.org for a full list of funding institutions). The authors did not directly receive support from any agencies for this article. Correspondence concerning this manuscript can be directed to Kyle Bourassa, 1503 E. University Blvd., Bldg #68., Rm. 312. Tucson, AZ 85721-0068, kylebourassa@email.arizona.edu, or (520) 626-6426.

Abstract

Married couples evidence interdependence in their psychological and physical wellbeing across the lifespan. This is particularly true in aging populations that experience declines in physical health and cognitive ability. This study investigated the effects of partners' physical health and cognition on quality of life (QoL) in a series of bivariate latent curve growth models (LCGM). The sample included aging married couples (N = 8,187) who participated in the Survey of Health, Ageing, and Retirement in Europe (SHARE) study and provided data across six years. Results indicated that husbands' and wives' baseline levels and rates of change in QoL covaried significantly over time. In addition, husbands' and wives' physical health and cognition predicted their partners' baseline level of QoL above and beyond their own health and cognition, and these effects were of equivalent size for both men and women. The findings suggest that as couples age, husbands' and wives' QoL, cognition, and health are predictive of their partners' QoL.

Key words: Marriage; aging; cognition; health; quality of life

Abbreviations: QoL = Quality of life; LCGM = Latent curve growth model; SHARE = Survey of Health, Ageing, and Retirement in Europe

A Dyadic Approach to Health, Cognition, and Quality of Life in Aging Adults

Close relationships provide a vital context for human wellbeing (Reis, Collins, & Bersheid, 2000). As married or partnered couples age together, changes in one person's functioning can affect their partner's wellbeing. Physical health and cognitive ability are two important areas of functioning for aging adults, and both have important impacts on elements of wellbeing (Hillerås, Jorm, Herlitz, & Winblad, 1999; Okun & Stock, 1987), including quality of life (QoL; Netuveli, Wiggins, Hildon, Montomery & Blane, 2006; Wiggins, Higgs, Hyde, & Blane, 2004). Although the predictive power of health and cognitive ability on individuals' QoL is firmly established, fewer studies have explored the association of physical health and cognitive abilities with later QoL within a dyadic context. Furthermore, those studies that have examined dyadic effects focus primarily on clinical conditions, such as cancer or dementia, rather than on how normative variations in physical health and cognition are associated with older adults' QoL. As levels of partner functioning have important impacts on both members of a marriage (Walker & Luszcz, 2009), aging adults' physical health and cognition may have unique effects on their partners' QoL. The current study seeks to identify if older husbands' and wives' health and cognitive ability are predictive of their partners' later wellbeing, as indexed by QoL, in a large multinational sample of married adults.

QoL in Aging Populations. People are increasingly living longer, and aging adults are a growing proportion of developed countries' populations (Restrepo & Rozental, 1994). As the population of aging adults grows, so too does the need to understand successful aging, a term encompassing low levels of disability, high cognitive and physical functioning, and "active engagement with life" (Depp & Jeste, 2005; Rowe & Kahn, 1997). Increasing attention has been

focused on successful aging, including a recent special issue devoted to its implications and concerns (cf. Pruchno, 2015), suggesting a continuing interest in understanding successful aging. QoL is a broad but important aspect of successful aging, typically describing a positive subjective perception of the aging process (Bowling, 2007; Strawbridge, Wallhagen, & Cohen, 2002) in aging populations. For example, higher QoL scores correspond with lower levels of plasma triglycerides and is linked to better cardiovascular health, and lung function (Steptoe, Demakakos, De Oliveira, & Wardle, 2012), better sleep (Steptoe, O'Donnell, Marmot, & Wardle, 2008), and a reduction in all-cause mortality (Netuveli, Pikhart, Bobak, Blane & 2012; Steptoe & Wardle, 2012). Although several studies have identified the importance of physical health and cognition on individual QoL in older adults, fewer studies have examined these topics from a dyadic perspective. Variations in the physical health or cognition of a partner could interfere with the shared emotion long-term romantic partners may enjoy or rely on for their QoL.

Physical health and cognition predicting individual QoL. Health and cognition play an understandably central role in successful aging. In terms of physical health, people face increased risk for a variety of impairments in health as they age, including chronic diseases, decreased mobility, and immune function for example, and these difficulties are associated with decreases in aging adults' QoL. Life satisfaction is associated with elevated risk for early mortality (Gerstorf, Ram, Röcke, Lindenberger, & Smith, 2008). In contrast, better physical health is linked to improved QoL (Netuveli et al. 2006; Wiggins et al., 2004)

Cognition is a second, but equally essential factor that contributes to successful aging. Aging is associated with an overall cognitive decline (Park, O'Connell, & Thomson, 2003), which can range from a normative, gradual change in cognitive ability to the onset of clinical

conditions. Debilitating disorders, such as Alzheimer's disease (AD), dementia (Bäckman, Jones, Berger, & Laukka, 2005), and mild cognitive impairment (MCI; Gauthier et al., 2006) have large effects on aging adults' QoL, increasing healthcare needs (Gaugler, Kane, Kane, & Newcomer, 2005) and mortality (Mölsä, Marttila, & Rinne, 1995). Normative changes in cognitive ability also have important effects on aging adults. Lower levels of cognitive functioning increase the likelihood of later disability and death (McGuire, Ford, & Ajani, 2006). In addition, cognitive decline predicts later wellbeing, disability, and use of healthcare (Comijs, Dik, Aartsen, Deeg, & Jonker, 2005), and correlates with psychological wellbeing (Okun & Stock, 1987; Wiggins et al., 2004) and life satisfaction (Jones, Rapport, Hanks, Lichtenberg, & Telmet, 2003).

Interpersonal effects of health, cognition, and QoL. Individual levels of physical health and cognition are embedded in a social context. Relationships with friends and family can be either salubrious or harmful for older adults' physical health (Ashida & Heaney, 2008), cognition (Dixon, 2011; Seeman, Lusignolo, Albert, & Berkman, 2001), and wellbeing (Berg, Wiebe, Butner, 2011). Personal relationships become especially important to aging adults as they begin to appraise that the time in their life is more limited and assume a more present-focused orientation that maximizes subjective emotional states (Carstensen, Issacowitz, & Charles, 1999; Carstensen & Mikels, 2005). In this orientation, aging adults are more selective and put more effort into emotionally meaningful relationships and activities compared to those in earlier life stages (Carstensen, Fung, & Charles, 2003). By the same token, a smaller social network may also mean members have a more meaningful impact on aging adults' wellbeing. As such, it is important to explore the impact of close partners on aging adults' QoL

Marriage plays a central role in affecting the course of successful aging (Hoppmann, Gerstorf, & Luszcz, 2011). Interdependence theory posits that married people's patterns of

behavior – whether positive or negative – can affect their partners due to non-independent nature of their relationship (Cook & Kenney, 2005; Kelly & Thibault, 1978). These dyadic effects are conceptualized in several ways. *Crossover* or *spillover effects* occur when aspects of individuals negative experiences affect their partner via activation of both partners stress management and coping resources, particularly when one partner faces health issues (Berg & Upchurch, 2007; Westman, Keinan, Roziner, & Benyamini, 2008; Yorgason, Roper, Sandberg, & Berg, 2012). For example, older adults become physiologically aroused when thinking about or viewing their partner's simulated suffering (Monin et al, 2010). In addition, *emotional transmission* occurs when individual's non-shared experiences affect their emotions and behaviors, which in turn affect their partners' future emotions and behaviors through interpersonal interactions (Larson & Almeida, 1999).

There is some broad support in the literature for dyadic effects of physical health, cognition and QoL specifically. For instance, husbands' and wives' wellbeing predicts their partner's wellbeing (Bookwala & Schulz, 1996), though subsequent research found only husbands' subjective wellbeing (SWB) predicts wives' SWB over time (Walker, Luszcz, Gerstorf, & Hoppmann, 2011).

In the case of physical health, dyadic effects can be both positive and negative. For example, there is a direct crossover effect of husbands' and wives' perceived health (Westman et al., 2008), and observing a partner suffering from pain can result in heightened individual distress, particularly among people who perceive their partner to be in greater pain (Monin, Schulz, Feeney, & Cook, 2010). Couples coping with chronic illness also covary in their daily affect, suggesting that the negative effect of illnesses in later life are shared among marital partners (Berg, Wiebe, & Butner, 2011). In addition, among the oldest-old, individuals with

chronic illnesses report more negative experiences when they are with their spouses, suggesting that health has contextual impacts on interpersonal experiences (Chui, Hoppmann, Gerstorf, Walker, & Luszcz, 2014). Couple dynamics can also positively influence health habits that reduce risk as a result of a shift from self-focused to relationship-centered thinking (Lewis et al., 2006). Communal coping, in which both members of a couple view one partner's health problems as a shared issue (Lyons, Mickelson, Sullivan, & Coyne, 1998), is associated with lowered mortality from heart failure (Rohrbaugh, Mehl, Shoham, Reilly, & Ewy, 2008).

Similar to physical health, cognition shows important dyadic associations in couples. For example, marital partners are generally concordant in cognitive measures (Dufouil & Alpérovitch, 2000). Much dyadic research focuses on the effect of acting as a caregiver to a romantic partner or family member. Caregivers generally report qualitative increases in frustration, resentment, and grief when beginning to care for those with clinical cognitive conditions, such as early dementia or MCI (Adams, 2006). More normative cognitive declines also are associated with dyadic quality. For example, husbands' earlier cognition predicts wives' later cognitive functioning among couples with marital problems (Strawbridge, Wallhagen, & Shema, 2011). In addition, husbands' perceptual speed predicts their wives' lagged scores on the same measure a year later, though this effect does not hold for wives' scores (Gerstorf, Hoppmann, Anstey, and Luszcz, 2009).

Gender differences in partner effects. The broad dyadic effects of partners' physical health and cognition show meaningful gender differences. In general, wives' outcomes are more highly associated with their husbands' functioning than vice versa. For example, husbands' experience of stroke and high blood pressure is associated with wives' depression, but there is no association in the opposite direction (Ayotte, Yang, & Jones, 2010). This same effect occurred in

the aforementioned work by Gerstorf et al. (2009) and Strawbridge et al. (2011), in which wives had greater sensitivity to their husbands' cognition, as well as work by Walker et al. (2011) examining wellbeing. In addition, among couples dealing with a chronic illness, women's wellbeing is generally more affected than men's (Northouse, Mood, Templin, Mellon, & George, 2000). These findings may reflect differences in how men and women experience variability in their partners' physical health and cognition due to a general pattern of gender expectations for caregiving relationships in old age, where women are more often expected to act as caregivers. For instance, wives with husbands with an illness report providing more support to their husbands than husbands with ill wives (Revenson, Abraido-Lanza, Majerovitz, & Jordan, 2005). Alternatively, different cultural expectations for men and women results in more women assuming interdependent self-construals (Cross & Madson, 1997; Impett & Peplau, 2006) than men. These construals could result in greater sensitivity for wives to their husbands' health and cognition, particularly in situations where a partner is experiencing age-related decline. Testing potential gender differences is essential to explore the possibility of these differences in how men and women experience aspects of their partners' levels of health and cognition.

The Present Study

QoL is a central outcome for aging adults. Although research points to important interpersonal effects on QoL from partners' QoL, physical health and cognitive ability among older married couples, few studies address these topics in an integrated, longitudinal, dyadic model. There are a number of reasons why such an approach would be useful. First, physical health and cognition are correlated, both within and over time, resulting in shared variance that separate models cannot account for. An integrated model allows for an analysis of unique variance for both predictors of interest. Second, dyadic functioning may have important effects

on a couple above and beyond individual QoL, health, and cognition alone. A dyadic model would allow for a better estimation of these interpersonal effects. Finally, using longitudinal data also allows for an examination of longitudinal partner effects of a couples' QoL over time.

To address these gaps in the literature, we examined the possible effects of partner's QoL, physical health and cognitive ability on QoL within a marital dyad using data from the Survey of Health, Ageing, and Retirement in Europe (SHARE) study. The large sample of married couples (n = 8,187) with full data collected over six years of data collection (with four waves of data collected every two years), including aspects of cognition, physical health, and QoL, presents a unique and rich opportunity to explore these associations over time in a dyadic model. Based on prior work by Bookwala and Schulz (1996) and Walker et al. (2011), we predict strong positive associations between husbands' and wives' baseline levels and rates of change in QoL. Further, we predict that husbands' and wives' health and cognition levels will predict their partner's QoL above and beyond their own health and cognition. Finally, we predict that these associations will be stronger for women than for men.

Method

Participants

As described in more detail by Börsh-Supan et al (2013), the SHARE dataset currently has four waves of data collection (2004-2005; 2006-2007; 2008-2009; 2011-2012); three panel waves (2004, 2006, and 2010) and one dealing with retrospective life histories (2008), with six planned additional waves of data. Participants were interviewed and were selected from 19 European Union countries (Austria, Belgium, Czech Republic, Denmark, Estonia, France, Germany, Greece, Hungary, Ireland, Italy, Netherlands, Poland, Portugal, Sweden, Slovenia, Spain, Switzerland) and Israel, with over 150,000 completed interviews with about 86,000

unique participants ages 50 or older, including a subset of interviews with both partners of romantic couples (of which, some were younger than 50). Participants from earlier waves were contacted for participation in subsequent waves and the average retention rate of the study for the first four waves was 81%. All non-incarcerated, non-hospitalized individuals in the countries being surveyed were eligible, and population registries were used for those countries in which such use was allowed. Interviewers made use of computer-assisted personal interviewing (CAPI) for the data collection, along with self-administered questionnaires that were dropped off to participants. The data collection incorporated a variety of variables capturing psychological, physical health, and cognitive aspects of participants. Six countries, however, (Ireland, Israel, Hungary, Portugal, Slovenia, and Estonia) did not participate in more than a single wave and are not included in the study sample.

Figure 1 outlines the inclusion and exclusion criteria that resulted in the final sample for the study. The original SHARE data contains 86,290 people (44% male), of whom 29,555 participated during at least two assessments among waves 1, 2 and 4[1]. Of these 29,555 participants, 21,194 reported being continuously married across all completed waves of data. Participants with same-sex partners (n =50) were excluded to maintain dyads distinguishable by gender. Of the remaining 29,555 people, 16,374 had data from the same partner available; resulting in 8,187 married couples. The selected participants were as a whole significantly younger (Cohen's d = -0.31), had more education (d = 0.07), higher income (d = 0.37), worse T0

[1] The number who did not complete the necessary waves is due to the large additions of the dataset to include new participation from countries not originally involved in SHARE, who will have multiple assessments once additional waves are collected.

physical health (*d* = -0.17), better T0 cognitive functioning (*d* = 0.23), higher T0 (*d* = 0.10), T1 (*d* = 0.19), and T3 QoL (*d* = 0.18), and fewer T0 depressive symptoms (*d* = -0.19), though in all cases besides age and income, the effect size of the differences in samples were small. Table 1 displays the descriptive statistics for the men and women included in the study on all variables used in the current study (*N* = 16,374).

Measures

Demographic variables. The SHARE study assessed a variety of demographic variables, including age, gender, household income percentile (out of 10), education, and year in which a marriage began. Household income percentile and marriage length differed for respondents, but were held constant across married partners in the analyses. A dichotomous measure of caregiver status, which asked participants whether they cared for a sick or disabled adult, was also included.

Physical health. Physical health was measured using participants' response to a five point likert-scale read out to them asking "Would you say your health is…" with responses ranging from "very poor" to "excellent." Participants were randomized to receive the question either at the beginning or end of the broader physical health questionnaire to account for response biasing. Scores were reverse coded so that higher scores denoted higher self-perceived physical health. In general, self-perceived health is considered a valid measure of physical health among aged adults, showing convergent validity (Liang, 1986), and is predictive of future health problems and mortality (Idler & Benyamini, 1997). Some caution, however, must accompany judgments of self-rated health, as it is relative and is affected by the culture and country of the respondents (Jürges, 2007).

Cognitive ability. Cognitive ability was measured using an arithmetic mean of the scores of participants on three cognitive tasks: verbal fluency, immediate word recall, and delayed word recall. Score were standardized against the larger sample with data at all four waves (*n* = 9773, 43.5% male) to account for differences in scaling of the measures. Verbal fluency was assessed using a task where participants were asked to name as many animals correctly as possible during a one-minute period. The measure is designed as an assessment of semantic fluency and is sensitive to alterations in brain function and has been used widely as a component of neuropsychological batteries to differentiate between healthy age-related memory change and clinically significant impairments (Haugrud, Crossley, & Vrbancic, 2011). Immediate and delayed word recall were measured using the Ten-Word Delayed Recall Test. Ten common words were presented and participants were asked to recall the words immediately and then again five minutes later. This assessment was constructed based on similar computerized word recall tasks that have been used extensively to assess immediate and delayed memory performance (Green, Montijo, & Brockhaus, 2011; Hoskins, Binder, Chaytor, Williamson, & Drane, 2010). The three item scale showed adequate internal reliability in the current sample (α = .79).

Quality of Life. QoL was measured using 12 items of the CASP-19 (Hyde et al., 2003), a scale developed specifically for use in assessing quality of life, life satisfaction, and wellbeing in aging populations, which shows concurrent validity with similar measures. The scale seeks to assess the domains of "control," "autonomy," "self-realization," and "pleasure," with four to five likert-scale agreement items across the four domains for a total of 19 items (e.g. "I look forward to each day). These items scores', ranging from zero to three, are then summed for a final score that can range from 0 to 57, with higher scores representing higher QoL. The CASP-19 shows

predictive power based on contextual factors that impact wellbeing, such as health and marital problems (Blane, Higgs, Hyde, & Wiggings, 2004), has shown adequate internal reliability, and all four sub-domains load on a single latent factor of QoL (Wiggins, Higgs, Hyde, & Blane, 2004). The SHARE dataset uses a subset of 12 of these items that show more robust statistical measurement properties as determined through exploratory and confirmatory factor analyses (Wiggins, Netuveli, Hyde, Higgs, & Blane, 2008). Response choices were coded from one to four and resulted in a final shorted scale with a range from 12-48, with higher score representing higher QoL. The measure shows adequate internal reliability in the current sample in the fourth wave of SHARE data collection ($\alpha = .76$).

Depressive symptoms. Depressive symptoms were measured using the EURO-D, a measure designed to assess the self-reported presence of depressive symptoms within the European Union (Castro-Costa et al., 2007; Prince et al., 1999a). The scale uses 12 binary yes-no items (1, 0; e.g. “Have you been sad recently” and “Have you cried recently”) from the Geriatric Mental State (GMS), a scale designed for assessing depression in the elderly (Gurland et al, 1976). The EURO-D shows associations with age, gender, and marital status typical of other such scales, as well as concurrent validity with those same scales (Prince et al, 1999b). The EURO-D showed adequate internal reliability in the current sample in both the first and fourth wave of data collection ($\alpha = .69$).

Data Analysis

In the current study, we specified a series of bivariate latent curve growth models (LCGM; McArdle & Anderson, 1990) that assess changed in QoL over the three study assessments, while accounting for unique actor and partner effects on the outcomes of interest. To test the primary hypotheses of interest, we first specified separate latent curve models for

husbands and wives. Once the basic change models were created, we specified a bivariate LCGM (Model 1) to examine the intercept-intercept and slope-slope covariation of QoL among husbands and wives, including within occasion covariation (between the partners) of the manifest variables of QoL at T0, T1 and, T4. We then specified a second model (Model 2) where we added the focal predictors of husbands' and wives' health and cognition at T0 to examine their associations with the latent curve parameters for QoL. Finally, we specified a third model (Model 3) where we added covariates to account for possible alternative predictors, including participant's age, depressive symptoms, caregiving status, and education, as well as couples' income percentile, and years married. The final conceptual model is presented in Figure 2.

In specifying the models, we identified the best-fitting LGCMs by comparing nested model specifications using a chi-square difference tests [$\chi^2_{\text{Model 2}} - \chi^2_{\text{Model 1}} (df_{\text{Model 2}} - df_{\text{Model 1}})$]. Elements of the original model were constrained and estimated a second time in the nested model; if constraining different change parameters did not adversely affect model fit, we retained the more parsimonious model. Three main indexes of model fit are the standardized root-mean-squared residual (SRMR), root-mean-squared error of approximation (RMSEA) and comparative fit index (CFI). Hu and Bentler (1999) suggested that a combination of examining SRMR, supplemented with RMSEA and CFI, is a robust method to assess model fit. Models were considered to have relatively good fit if SRMR values < .08, RMSEA values < .06 and CFI values > .95.

Finally, we conducted additional post hoc comparisons within Model 3 to test the difference in the strength of association between husbands' and wives' partner effects. In each case where a significant partner effects on QoL existed, we constrained husbands' parameter estimates within the model to be equal to their wives' estimate and calculated the chi-squared

difference in model fit. Significant differences indicated a sex difference between men and women in the strength of partner effects of cognitive ability and physical health predicting QoL.

We conducted all analyses in Mplus version 7.2 (Muthén & Muthén, 2011) using full information maximum likelihood (FIML) estimation and simultaneous regression for all path models. Estimates included standardized regression weights to allow for comparison between differently scaled predictors. The values represent the amount of a SD change in the outcome variable predicted by a 1 SD change in the predictor. The standardized values are calculated using the formula $\beta = b*SD(x)/SD(y)$ for continuous predictors, and $\beta = b/SD(y)$ for dichotomous variables, which is described in further detail in Muthén & Muthén (2011).

Missing Data. Our treatment of missing data reflected a balance between inclusion and exclusion of participants to best approach the assumptions of FIML estimation for missing data, namely data that is missing at random (MAR; Graham, 2009), while also including as many participants in the sample as possible. Both concerns can produce results that do not reflect the associations in the population a sample is collected from. In the case of the former, if a sample contains data that is not missing at random (NMAR), it can produce biased parameter estimates for SEMs (Graham, 2009, Schafer & Graham, 2002). In the case of the latter, excluding participants from representative samples can act to create samples that are no longer representative, but are biased due to the nature of exclusionary criteria. For these reasons, we elected to include all continuously married couples with partner data who completed at least two of the three time points in our models. This approach balances the importance of including as many participants as possible while also maintaining the likelihood that the sample data is MAR. Despite this balanced approach, concerns may remain that the data may still be NMAR;

therefore, we specified our final model using a smaller subsample of couples (n = 2,566) with data at all time points (T0, T1, and T3) to confirm results found in the larger sample.

Results

Table 1 displays the descriptive statistics of the variables used in the models. In comparison to the women in the sample, men reported significantly higher QoL at T0 (d = 0.05), T1 (d = 0.05), and T3 (d = 0.05), age (d = 0.37), and education in years (d = 0.12). They also reported significantly lower levels of T1 cognitive ability (d = -0.23), caregiver status (d = -0.06) and depressive symptoms at T0 (d = -0.39). All significant differences were in the small to moderate range for effect size. In addition, men and women's reports of physical health and cognition at T0 were significantly correlated in the sample, at the level r = 0.37, p < .001, and r = 0.48, p < .001 respectively.

Model 1: Bivariate LCGM

Before examining the bivariate specification, we first tested the basic LCGMs for husbands and wives separately to identify the best fitting univariate models. These models suggested that a simple linear change model fit the data well for both husbands and wives. Allowing the final time point to vary freely (while also setting the covariation between the slope and intercept of QoL to zero to maintain one model df) improved model fit for both husbands, χ^2 (1, n = 8,187) = 10.69, p < .001, and wives, χ^2 (1, n = 8,187) = 9.16, p < .001. The model for husbands, χ^2 (1, n = 8,187) = 1.18, p = .227, SRMR = .010, CFI = 1.00, RMSEA = .005, and wives, χ^2 (1, n = 8,187) = 0.35, p = .554, SRMR = .005, CFI = 1.00, RMSEA = .000, both had good fit.

Model 1 integrated these two LCGMs into a single bivariate specification that included covariation among the latent curve parameters for husbands and wives, while also allowing the

manifest variables of QoL to covary over time. (Constraining the intercept-slope partner effects – i.e., husbands' slope covarying with wives' intercept – to zero was necessary to produce a positive definite PSI matrix). Once constrained, the final model fit the data adequately, χ^2 (6, n = 8,187) = 20.61, p = .002, SRMR = .017, CFI = 1.00, RMSEA = .017. The results evidenced a significant positive covariation between husbands' and wives' intercepts (i.e., their initial QoL levels at the start of the study), β = 0.74, p < .001, and slopes, β = 0.85, p < .001, for QoL[2]. The final results for the model are presented in Table 2.

Model 2: Bivariate LCGM Including Focal Predictors

In Model 2, we then added husbands' and wives' physical health and cognition at T0 as predictors of the slope and intercept of QoL. The model, including physical health and cognition as predictors, fit the data well, χ^2 (14, n = 8,187) = 21.26, p = .095, SRMR = .009, CFI = 1.00, RMSEA = .008. Husbands' intercept of QoL was significantly predicted by their partner's physical health, β = 0.06, p = .003, at T0, and cognition, β = 0.15, p < .001. Wives' intercept of QoL was also predicted by their husbands' physical health, β = 0.09, p < .001 at T0, and cognition, β = 0.13, p < .001. In addition, husbands' slope of QoL was significantly predicted by wives' physical health, β = 0.13, p = .005, however, there were no other significant partner effects on QoL's slope for men or women. The covariation between the intercepts, β = 0.69, p < .001, and slopes, β = 0.72, p < .001, for QoL remained significant with the addition of these predictors. The final results for Model 2 are presented in Tables 2 and 3.

Model 3: Bivariate LCGM Including Focal Predictors and Covariates

[2] In the case of covariations, standardized effect sizes (β) represent the correlation coefficient between the two latent curve parameters (r).

Model 3 included the addition of competing predictors (age, education level, income, years married, caregiving status, and depressive symptoms) to the bivariate specification examined in Model 2. In this final model, the slopes and intercepts of QoL for men and women were regressed on all couple level covariates (years married, income level), whereas individual level covariates (age, caregiving status, education level, and depressive symptoms) were only included for each individual. The resulting model fit the data adequately, χ^2 (14, n = 8,187) = 281.57, p < .001, SRMR = .016, CFI = 0.99, RMSEA = .024. The model results are presented in Table 2. The partner effects of wives' health, β = 0.07, p < .001, and cognition β = 0.14, p < .001 on husband's QoL intercept, and the partner effects of husbands' health, β = 0.10, p = .005 cognition, β = 0.07, p = .005, and, on wives' QoL intercept remained significant. These results are displayed in Figure 3. With the addition of the covariates, there were no significant partner effects on the slope of QoL, suggesting the association of wives' physical health predicting husbands' slope in QoL is better explained by husbands' covariates included in Model 3. The results for all predictors are presented in Table 3. In addition, the covariation between the intercepts, β = 0.67, p < .001, and slopes, β = 0.72, p < .001, for QoL remained significant with the addition of these covariates.

Partner Effects by Gender

We next compared partner effects of health and cognition on the intercepts of QoL for men and women using a single degree of freedom chi-squared difference test to test our hypothesis that men's health and cognition would be more predictive of wives' QoL than vice versa in Model 3. Men and women did not significantly differ on the strength of partner effects for physical health, X^2 (1, N = 2204) = 0.10, p = .752, or cognition, X^2 (1, N = 2204) = 2.02, p =

.155. The results suggest there are not significant gender differences in the observed partner effects on QoL.

Additional Effects of Interest

Beyond the hypothesized effects of interest, the results of the LCGM also presented additional findings of interest. First, both husbands' and wives' had a positive slope of QoL (0.20, p = .002 and 0.27, p < .001, respectively), suggesting that QoL increased over the course of the study for both spouses, even when accounting for relevant covariates. Wives' slope of QoL was significantly higher than husbands' slope (p = .009) suggesting that aging wives gain more QoL over time, though the size of this effect was very small (*cohen's d* = 0.04) and significant primarily due to the large size of the sample.

In addition, the covariates included in Model 3 evidenced actor effects on baseline levels of QoL for husbands and wives. In particular, husbands and wives who reported higher age, education, and income, and lower depressive symptoms, predicted higher baseline levels of QoL. Model 3 also revealed effects on QoL's slope from husbands' and wives' depressive levels and age, such that people who were older and those with lower levels of depressive symptoms evidenced lower slopes, and thus lower levels of QoL over time compared to those with higher levels of depressive symptoms or age at T0.

Confirmatory Analyses

Finally, as a confirmation that the use of couples with two assessments and FIML was not biasing our parameter estimates, we specified the models described including only participants with all three assessments available (n = 2,566). The final model, including the focal predictors and covariates, fit the data adequately, χ^2 (14, n = 2,566) = 138.48, p < .001, SRMR = .020, CFI = 0.99, RMSEA = .026, and replicated the significant positive covariation between husbands'

and wives' QoL intercept, β = 0.60, p < .001, and slope, β = 0.79, p < .001. In addition, the result replicated partner effects on both husband's QoL intercept from wives' health, β = 0.14, p < .001, and cognition, β = 0.10, p < .001, and wives' QoL intercept from husbands' health, β = 0.07, p = .003, and cognition, β = 0.14, p < .001. Finally, in this smaller sample, partner effects for physical health were significantly stronger for men, χ^2 (1, *n* = 2,566) = 23.39, p < .001, whereas the partner effects for cognition were significantly stronger for women, χ^2 (1, *n* = 2,566) = 4.79, p = .029[3].

Discussion

Using a representative multinational sample of European couples in later life, we explored dyadic associations, including the partner effect of physical health and cognition, on QoL. Spouse's QoL covaried, both at baseline and over time, and husbands' and wives' variations in cognition and health predicted their partners' QoL at baseline, but not over time. Finally, the strength of these partner effects did not differ for men compared to women.

Partner concordance in QoL. In the current study, husbands' and wives' baseline QoL were positively correlated, suggesting that husbands and wives entered the study with similar

[3] The models described here were also run with depressive symptoms as the outcome of interest in a LCGM with covariates. Although the model fit the data adequately, χ^2 (46, *n* = 2,566) = 104.13, p < .000, SRMR = .010, CFI = 0.99, RMSEA = .022, there were no significant partner effects of physical health or cognition levels predicting depressive symptoms at baseline (the intercept) or change in depressive symptoms over time (slope). Participant's own physical health and cognition predicted baseline QoL, but not QoL's slope, except in the case of women's cognition predicting their own depression at baseline (which was non-significant).

QoL scores. Further, their QoL slopes also were positively correlated, suggesting that as wives' QoL increased/decreased so did their husbands' QoL (and vice versa). These findings replicate previous research that has found similarities among husbands' and wives' wellbeing (Bookwala & Schulz, 1996, Walker et al., 2011). The present study also extended these findings to LCGM parameters (namely intercept-intercept and slope-slope covariation) and presents a compelling case for interdependence of QoL among older couples, though in the current model specification, directionality of these associations could not be determined. Further, the sizes of the effects are large, accounting for 45.4% and 51.2% of the variance in baseline and change in QoL, respectively.

Partner effects of physical health and cognition on QoL. We also found that husbands' and wives' levels of physical health and cognition were predictive of their partners' baseline levels of QoL, but not their slope. A one *SD* change in a husbands' physical health corresponded to a 0.07 *SD* change in wives' QoL, and a one *SD* change in husbands' cognition corresponded to a 0.11 *SD* change in wives' QoL, representing a change of approximately 0.30 and 0.47 points in husbands' baseline CASP-12 subscale. Similarly, a one *SD* change in a wives' physical health corresponded to a 0.07 *SD* change in husbands' QoL, and a one *SD* wives' cognition corresponded to a 0.10 *SD* change in husbands' QoL, representing a change of approximately 0.33 and 0.47 points in wives' baseline CASP-12 subscale respectively. As shown in Figure 3, partner effects of both physical health and cognition are smaller than actor effects of physical health, but are more similar to actor effects of cognition. These findings extend prior literature regarding the interdependent effects of physical health (Berg et al., 2011; Rohrbaugh et al., 2004; Rohrbaugh et al., 2008; Westman et al., 2008) and cognition (Gerstorf et al., 2009; Strawbridge et al., 2011) among couples to the prediction of QoL, an important outcome for aging adults. The

results suggest that variations in physical health and cognition may affect partners' QoL, possibly by activating partner's stress management and coping resources, or by affecting individual's emotions and behaviors, which then affects their partner's QoL.

Spouse's physical health and cognition levels did not predict *change in* their partner's QoL over time. This null finding should be understood in the context of the actor effects of both physical health and cognition. Only wives' own physical health level predicted lower QoL overtime, whereas cognition did not. Neither husbands' own physical health nor cognition predicted their change in QoL over time. The lack of actor effects (the effect of people's own health and cognition predicting their change in QoL) suggests that variation in levels of physical health and cognition are not predictive of change over time for individuals or their partners. Future research should test the possibility that change may better predict change over time, as *changes in* physical health and cognition may predict *changes in* QoL over time.

Gender differences in partner effects on QoL. There were no significant gender differences between husbands' and wives' effects on their partners' QoL. These results contrast with prior research that found stronger effects of husbands' variables on wives' outcomes (Gerstorf et al., 2009; Northouse et al., 2000; Strawbridge et al., 2011; Walker et al., 2011). This similarity (of effects for husbands and wives) for physical health is more surprising given the literature that find women are more affected by their partners' physical illnesses or clinical cognitive disorders than men (Ayotte et al, 2010; Northouse et al, 2000). The current study examined self-reported physical health and cognition across the full normative spectrum, rather than in the presence of a clinical cognitive disorder or chronic illness, as was typically the case in prior research. It is possible that gender differences exist in more severe caregiving scenarios involving clinical illness, but not across normative levels of physical health and cognition. Future

research is necessary to replicate this before firm conclusions can be drawn regarding gender differences in partner effects for physical health and cognition on QoL.

Additional effects of interest. Beyond our hypothesized dyadic effects, our models revealed additional associations that interest more broadly. First, the mean QoL slope for the study was positive, indicating that people's QoL increased over time in this sample. In addition, wives' slope was significantly higher than husbands', though the size of this effect was very small ($d = 0.04$). The finding that husbands' and wives' mean slops are positive may provide support for the idea that people are aging successfully over time in the domain of subjective wellbeing. This result matches well with prior findings regarding the positivity effect of aging (Cartensen, 2006), which suggests that as people age and approach the end of life, they generally view prior events more positively, which could affect QoL Alternatively, it is possible that increased attention to successful aging and improving standards of medical care could result in increased QoL. These possibilities are not mutually exclusive, however, and further research should attempt to identify and test additional mechanisms action that result in increasing QoL among aging adults.

Also of interest is the finding that people who are older have higher QoL at the start of the study, but their QoL is more likely to decrease over time. It is possible that those who are older may have experienced the aforementioned benefits of the positivity effect on QoL already, but also may be more likely to face age-related issues that reduce QoL, such as decreased physical health or cognition. In comparison, people with higher depressive symptoms had lower QoL initially, but higher depressive symptoms also predicted improvement in QoL over time. It is possible that people would likely experience gains in QoL if their depressive symptoms are treated or spontaneously remit. Finally, higher levels of education and income were associated

with higher baseline levels of QoL. It is likely that having more education and wealth allows aging adults to have more control over their living situations and job prospects as they age, which could lead to higher levels of QoL. Alternatively, it is possible those with higher incomes are still working, which may affect subjective QoL.

The results of this study have implications for both treatment and research that involves aging couples. QoL is an important predictor of long-term health outcomes (Netuveli et al., 2012; Steptoe et al., 2012). The results of this study suggest that treatments focused solely on *the aging individual*, rather than both members of a couple, can miss an important avenue for improving these outcomes. This is consistent with prior work that has found dyadic interventions to be more effective than patient-only treatments in cases when one member of the couple faces a chronic illness (Matire, Schulz, Helgeson, Small, & Saghafi, 2010). These results suggest that partner differences in more normative levels of physical health may affect QoL, and future interventions could provide resources to couples to address possible decreases in QoL when one partner has lower levels of self-reported physical health. Fewer studies have examined the impact of interventions that improve retention of cognition, such as those focused on social engagement (Fried et al., 2004; Hertzog, Kramer, Wilson, & Lindenberger, 2008). It is possible that the same benefits that have been shown in using dyadic interventions in the case of physical health problems may extend to QoL outcomes as a result of partner effects of cognition.

These results also suggest that examining partners' health and cognition in the context of QoL is an important consideration. Further research can shed light on the pathways responsible for partner effects of physical health and cognition on QoL. Although much work has examined the effect associated with neurological disorders such as Alzheimer's disease or dementia that result in a partner needing to serve as a primary caregiver, fewer have explored how more age-

typical cognitive levels may impact QoL. It is possible that lower levels of cognition could interfere with husbands' and wives' pattern of emotional and practical support to their partner, leading to losses in QoL. Alternatively, lower levels of cognition, particularly if lower levels of cognition are due to age-related decline, could result in emotions or behaviors that affect interpersonal interactions within couples (via emotional transmission). Aging adults generally invest more resources into emotionally meaningful relationships and activities, interacting with close social partners rather than broader social networks (Carstensen, Fung, & Charles, 2003; Carstensen, Issacowitz, & Charles, 1999). For those people whose partners have experienced lower levels of cognition or health, interactions with a spouse may not meet their expectations, resulting in lower satisfaction.

The results of this study should be understood in light of its limitations. First, the neurocognitive measures used to assess cognition in the present study are not ideal for analyzing specific elements of cognition. Although prior studies have used this group of measures as an index of cognition and each measure has been independently validated (Green et al., 2011; Haugrud et al., 2011; Hoskins et al., 2010), it is possible more refined measures of cognition may result in different findings or more reliable measurement. Second, it is unclear from the current study if the pattern of covariation among husbands' and wives' baseline levels and change over time in QoL is bidirectional or unidirectional. Future research could incorporate specific directional associations to test the nature of this relationship. Third, the models used in the current study imply some type of partner effect, but do not explicitly test different types of proposed mechanisms. Additional models are necessary before firm conclusions can be drawn about *how* people's physical health and cognition affect their partner's QoL. Fourth, although the results evidenced partner effects for physical health and cognition predicting baseline QoL, these

effects are time-ordered and directionality cannot be determined by the current model. Future research should use models with lagged associations or change in physical health and cognition to explicitly test the directionality of these effects. Finally, same-sex couples were excluded from this study to maintain distinguishable dyads to test the presence of gender differences in partner effects. The existence of partner effects among same-sex couples is an important scientific question, however, and future research could use indistinguishable dyadic designs and explicitly test partner effects of physical health and cognition on QoL in same sex-couples.

Conclusion

By examining the association of physical health and cognition with QoL in a dyadic model, the current study replicates and extends prior findings on the interdependence of aging married couples. Husbands' and wives' baselines and slopes for QoL significantly covaried, further supporting prior research that husbands' and wives' QoL are interdependent. In addition higher levels of husbands' and wives' physical health and cognition predicted higher levels of baseline QoL for their partners, and these associations were similar in size for husbands and wives. As couples age, they face a variety of challenges, including age-related cognitive decline and physical health concerns. The current findings suggest that variations in physical health and cognition have meaningful effects on not only individual's own QoL, but their partner's QoL as well. As a result, future treatment and research on aging couples should address the possible interdependent effect of physical health and cognition on QoL outcomes.

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Table 1

Demographic Characteristics Across Relevant Variables for Husbands and Wives

N = 16,374	Husbands	Wives	Effect size (*d)*
Physical Health	3.18 ± 1.05	3.15 ± 1.04	0.03
Cognition	0.03 ± 0.78	0.21 ± 0.81	-0.23**
QoL	37.36 ± 5.73	37.09 ± 6.15	0.05*
QoL at T1	37.72 ± 5.94	37.44 ± 6.03	0.05*
QoL at T3	37.69 ± 6.04	37.40 ± 6.18	0.05*
Depressive symptoms	1.70 ± 1.86	2.49 ± 2.22	-0.39**
Age	63.77 ± 8.89	60.48 ± 9.01	0.37**
Education	10.88 ± 4.46	10.35 ± 4.20	0.12**
Caregiving Status	0.05 ± 0.22	0.09 ± 0.88	-0.06**
Years Married	35.57 ± 11.33		
Income Percentile	6.19 ± 2.64		

Note: Data are means ± standard deviations. The effect size (*d*) represents the effect size of significant differences between husbands and wives. All variables are measured at T0 unless otherwise noted. QoL = quality of life, education is defined by self-reported years of education, income percentile ranges from 1 to 10. Income percentile and years married were equal for each dyad. Significant differences between husbands' and wives' are indicated with a * ($p < .05$) or ** ($p < .001$). All means and SDs were calculated using full information maximum likelihood estimation (FIML).

Table 2
Husbands' and Wives' QoL LCGM Parameters and Covariations

	Model 1		Model 2		Model 3	
Parameter	Mean	Variance	Mean	Variance	Mean	Variance
Husbands' Inter.	37.41**	4.24**	37.36**	4.22**	37.43**	4.29**
Husbands' Slope	0.36**	1.93**	0.38**	2.05**	0.20**	1.64**
Wives' Inter.	37.15**	4.58**	37.07**	4.66**	37.12**	4.69**
Wives' Slope	0.30**	1.73**	0.37**	1.91**	0.27**	1.75**
Fit Statistics						
H1 log-likelihood	-99473.53		-128422.91		-285613.11	
No. of parameters	21		51		180	
Model *df*	6		14		50	
χ^2	20.61		21.26		281.57	
SRMR	0.017		0.009		0.016	
RMSEA	0.017		0.008		0.024	
CFI	1.00		1.00		0.99	
Covariations	β	95% CI	β	95% CI	β	95% CI
Inter. – Inter.	0.74**	[0.72, 0.76]	0.69**	[0.65, 0.72]	0.67**	[0.63, 0.71]
Slope – Slope	0.85**	[0.68, 1.02]	0.72**	[0.57, 0.87]	0.72**	[0.58, 0.85]
T0 QoL – T0 QoL	0.34**	[0.29, 0.39]	0.37**	[0.32, 0.41]	0.35**	[0.31, 0.40]
T1 QoL – T1 QoL	0.29**	[0.22, 0.36]	0.29**	[0.23, 0.34]	0.34**	[0.30, 0.37]
T3 QoL – T3 QoL	0.37**	[0.32, 0.42]	0.37**	[0.33, 0.41]	0.31**	[0.25, 0.38]

Note: * $p < .05$; ** $p < .001$. Model 1 is the bivariate latent curve growth model (LCGM), Model 2 is the bivariate LCGM including the focal predictors, and Model 3 includes covariates as well. QoL = quality of life. Inter. = Intercept

Table 3
Standardized Regression Coefficients Predicting Husbands' and Wives' QoL Slopes and Intercepts

	Model 2		Model 3	
Husbands' QoL Intercept	β	95% CI	β	95% CI
Husbands' Health	0.41**	[0.37, 0.45]	0.28**	[0.23, 0.31]
Husbands' Cognition	0.19**	[0.15, 0.23]	0.11**	[0.07, 0.16]
Wives' Health	0.06*	[0.02, 0.10]	0.07**	[0.03, 0.11]
Wives' Cognition	0.15**	[0.11, 0.19]	0.14**	[0.10, 0.18]
Husbands' Age			0.08**	[0.04, 0.13]
Husbands' Education			0.12**	[0.09, 0.15]
Husbands' Depression			-0.35**	[-0.38,-0.32]
Husbands' Caregiving			0.04*	[0.01, 0.07]
Years of Marriage			0.05*	[0.00, 0.10]
Income Percentile			0.11**	[0.07, 0.15]
Husbands' QoL Slope	β	95% CI	β	95% CI
Husbands' Health	-0.10*	[-0.20,-0.01]	-0.03	[-0.12, 0.05]
Husbands' Cognition	0.02	[-0.09, 0.12]	0.04	[-0.06, 0.13]
Wives' Health	0.13**	[0.04, 0.22]	0.03	[-0.04, 0.13]
Wives' Cognition	0.09	[-0.01, 0.19]	0.05	[-0.04, 0.14]
Husbands' Age			-0.34**	[-0.43,-0.24]
Husbands' Education			-0.08*	[-0.15,-0.01]
Husbands' Depression			0.19**	[0.11, 0.27]
Husbands' Caregiving			-0.03	[-0.09, 0.04]
Years of Marriage			0.08	[-0.01, 0.17]
Income Percentile			-0.05	[-0.13, 0.03]
Wives' QoL Intercept	β	95% CI	β	95% CI
Husbands' Health	0.09**	[0.05, 0.13]	0.07**	[0.03, 0.11]
Husbands' Cognition	0.13**	[0.09, 0.18]	0.10**	[0.06, 0.14]
Wives' Health	0.40**	[0.37, 0.44]	0.28**	[0.25, 0.32]
Wives' Cognition	0.25**	[0.21, 0.29]	0.19**	[0.15, 0.23]
Wives' Age			0.10**	[0.05, 0.15]
Wives' Education			0.13**	[0.10, 0.17]
Wives' Depression			-0.35**	[-0.38,-0.31]
Wives' Caregiving			0.01	[-0.02, 0.04]
Years of Marriage			0.02	[-0.03, 0.04]
Income Percentile			0.08**	[0.05, 0.12]
Wives' QoL Slope	β	95% CI	β	95% CI
Husbands' Health	0.06	[-0.04, 0.16]	0.06	[-0.03, 0.15]
Husbands' Cognition	0.01	[-0.10, 0.12]	0.04	[-0.07, 0.14]
Wives' Health	-0.16*	[-0.26,-0.06]	-0.12*	[-0.22,-0.02]

Wives' Cognition	0.00	[-0.11, 0.11]	-0.02	[-0.12, 0.08]
Wives' Age			-0.30**	[-0.42,-0.17]
Wives' Education			-0.03	[-0.12, 0.07]
Wives' Depression			0.18**	[0.09, 0.27]
Wives' Caregiving			0.03	[-0.05, 0.10]
Years of Marriage			0.12	[-0.01, 0.25]
Income Percentile			-0.06	[-0.16, 0.04]

Note: * $p < .05$; ** $p < .001$. Model 2 is the bivariate LCGM including the focal predictors (health and cognition), whereas Model 3 includes covariates (age, education, depressive symptoms, caregiving status, years of marriage, and income). QoL = quality of life, education is defined by self-reported years of education, income percentile ranges from 1 to 10.

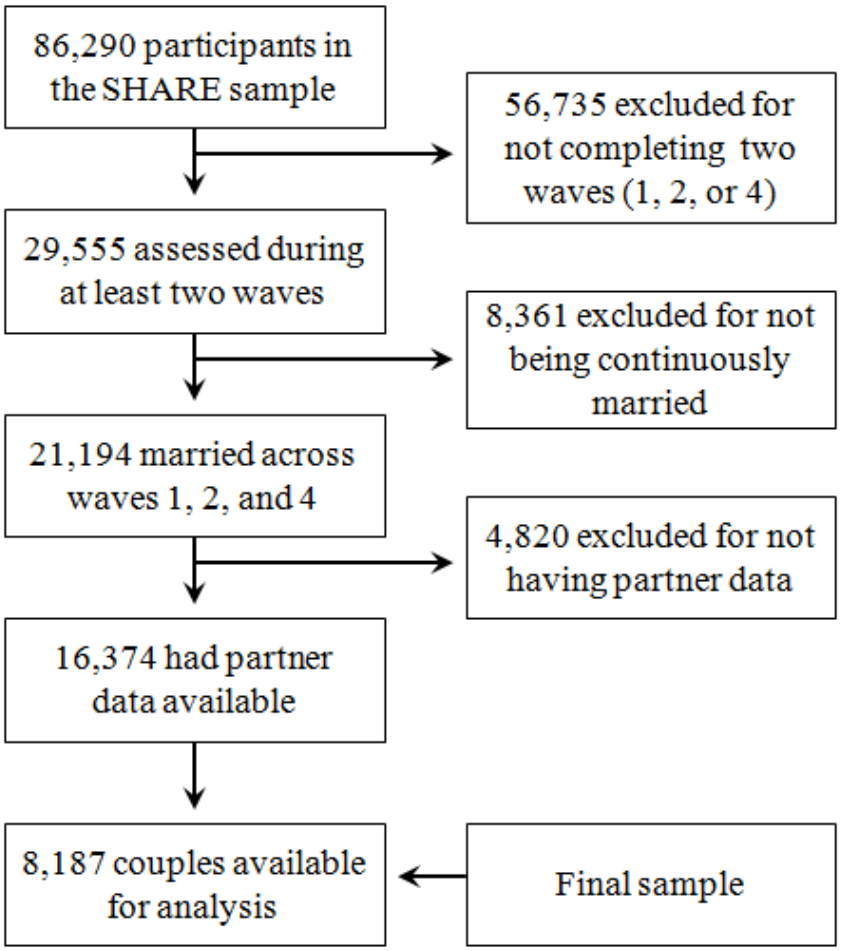

Figure 1. Selection and exclusion criteria for the final sample used in the present study.

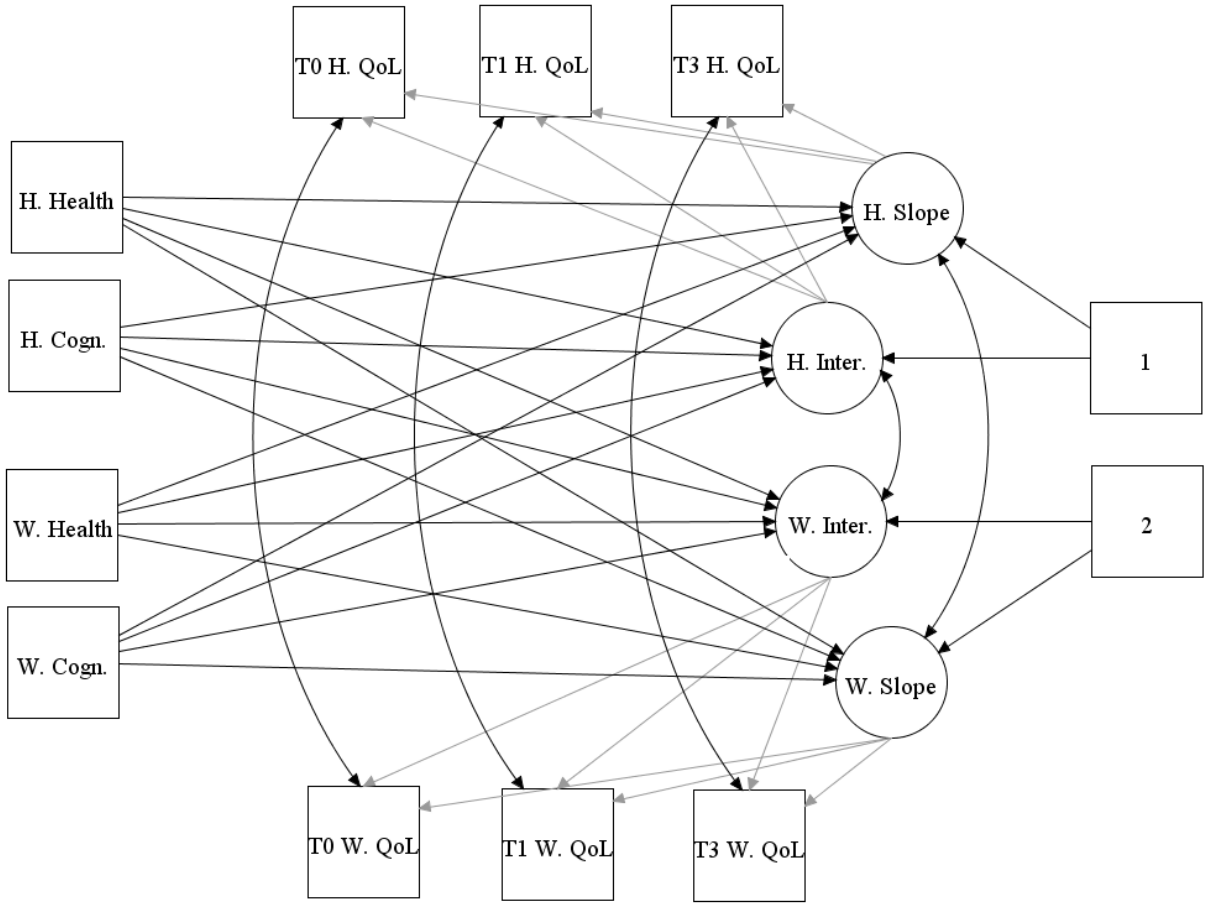

Figure 2. The final conceptual model for the current study, including the bivariate latent curve growth model and all relevant predictors for the latent curve parameters for QoL for husbands and wives, is presented above. The variables numbered 1 and 2 represent the relevant covariates included for (1) husbands and (2) wives (years married, income, education level, age, and depressive symptoms at T0). Health and cognition for husbands and wives are the values assessed at T0. H. = husbands, W. = wives, inter. = intercept, cogn. = cognition, QoL = quality of life. The estimates for all pathways in the model are included Table 2, Model 3.

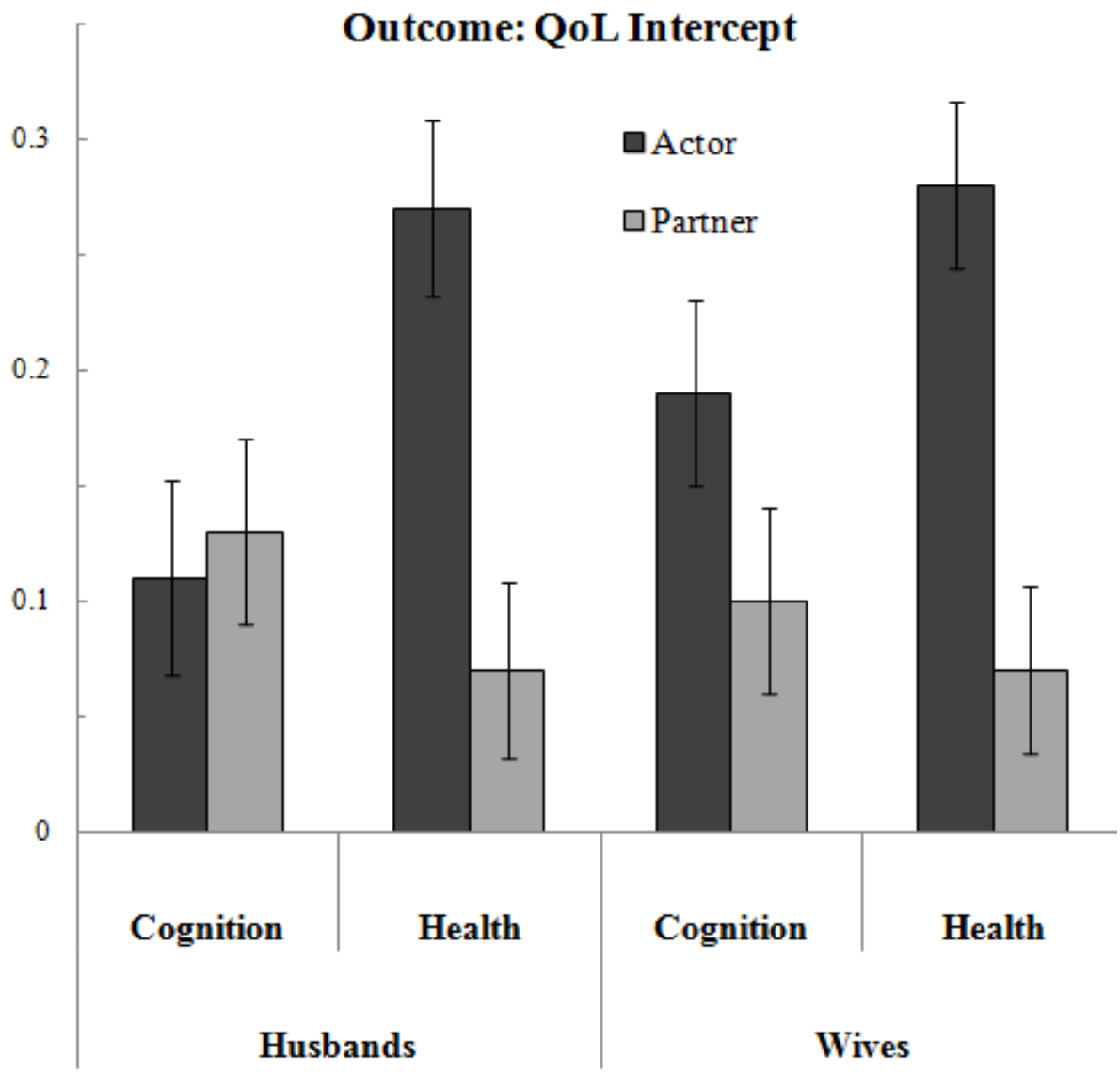

Figure 3. The standardized actor and partner effects of health and cognition predicting the intercept of husband and wives' QoL from the full model, including all covariates (years married, income, education level, age, and depressive symptoms at T0). All actor and partner effects displayed were significant at the $p < .001$ level. There were no significant differences in partner effects between men and women for cognition or physical health's prediction of husbands' or wives' QoL intercept.

Appendix B

Note: This appendix is included as a post-print manuscript and is published in full form elsewhere: Bourassa, K. J., Knowles, L. M., Sbarra, D. A., & O'Connor, M. F. (2016). Absent but Not Gone Interdependence in Couples' Quality of Life Persists after a Partner's Death. *Psychological Science*, *27*(2), 270-281.

Absent but Not Gone: Interdependence in Couples' Quality of Life Persists After a Partner's Death

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Abstract

Spouses influence each other's psychological functioning and quality of life. To explore whether this interdependence continues after a person becomes widowed, we tested whether deceased spouses' characteristics were associated with their widowed partners' later quality of life using couples drawn from a multinational sample of aging adults. Independent subsamples (*n*s = 221 and 325) were assessed before and after a spouse's death. Regressions revealed that deceased partners' quality of life prior to their death positively predicted their spouses' quality of life after the partners' death, even when we controlled for spouses' prior quality of life to account for environmental factors shared within couples. Further, widowed participants' quality of life was lower than nonwidowed couples' 2 years before and after their partners' death, but was equivalent 4 years prior. Finally, the strength of the association between partners' earlier quality of life and participants' later quality of life did not differ between widowed and nonwidowed participants. These findings suggest that interdependence in quality of life continues after one's partner has passed away.

Keywords: Quality of life, widowhood, interdependence, continuing bonds, attachment

Absent but Not Gone: Interdependence in Couples' Quality of Life Persists After a Partner's Death

Death ends a life, but it does not end a relationship, which struggles on in the survivor's mind toward some resolution.

—Robert Anderson (1968, p. 5)

A key tenet of both attachment and interdependence theories is that adults' psychological and physiological functioning affects (and is affected by) their partners' psychology and physiology (Lewis et al., 2006; Rholes & Simpson, 2004; Sbarra & Hazan, 2008). Older adults' quality of life, for example, is dependent not only on their own psychological functioning and physical health, but also on that of their spouse (Bourassa, Memel, Woolverton, & Sbarra, 2015a; Walker, Luszcz, Gerstorf, & Hoppmann, 2011). One interesting but unexplored question is whether interdependence continues once one of the partners in a marriage passes away. Bereavement involves a reorganization of internal working models of attachment to accommodate the loss (Shear & Shair, 2005). This reorganization could involve the deceased partner, who may serve as a source of symbolic support after his or her death (Mikulincer & Shaver, 2008). The characteristics of deceased spouses could affect the reorganization of attachment during the grieving process, affecting surviving spouses' wellbeing as a result. Critically, do characteristics of the deceased *prior* to their death continue to influence their spouses *after* their death?

Quality of Life and Widowhood

Bereavement is associated with a variety of poor psychological and health outcomes, including increased risk for early death (Moon, Kondo, Glymour, & Subramanian, 2011), increased systemic inflammation and hypothalamic-pituitary-adrenal dysregulation (O'Connor,

Wellisch, Stanton, Olmstead, & Irwin, 2012; Schultze-Florey et al., 2012), depression (Sasson & Umberson, 2014), and decreased quality of life (Grimby, 1993). These negative effects, however, can precede the death of a partner. Vable, Subramanian, Rist, and Glymour (2015) found that people near widowhood had higher levels of depression and less mobility than those who did not become widowed, even when they accounted for widows and widowers' demographics and physical health.

Examining the impact of stressful events, such as the loss of a spouse, on quality of life is an important public-health concern. Higher quality of life corresponds with better health (Steptoe, Demakakos, De Oliveira, & Wardle, 2012), better sleep (Steptoe, O'Donnell, Marmot, & Wardle, 2008), and lower mortality (Netuveli, Pikhart, Bobak, & Blane, 2012; Steptoe & Wardle, 2012). Quality of life is a particularly important outcome for widows and widowers, as they have faced a profound stressor and have often lost a significant source of coping and support. There are well-established dyadic effects in couples' quality of life over time (Bookwala & Schulz, 1996; Bourassa et al., 2015a; Walker et al., 2011). Positive emotions—one aspect of quality of life—are linked to lower distress in bereavement (Shear & Shair, 2005), which makes quality of life a promising construct for exploring whether characteristics of deceased partners affect surviving spouses after the partners' death.

One way surviving spouses can reorganize their attachment to a lost partner is through continuing bonds with their partner and updating cognitive representations of their partner's characteristics (Field, 2006; Klass, Silverman, & Nickman, 1996). Continuing bonds can be adaptive, such as when surviving spouses recreate a secure psychological attachment to their partner's memory, or can be maladaptive, such as when the bereaved cannot find meaning in the loss (Field, Gao, & Paderna, 2005). The psychological characteristics of the deceased, such as

their quality of life, may affect whether ongoing attachment might act as a psychological resource for surviving spouses to call on. For example, the positive affect a deceased partner formerly displayed in stressful situations might serve as a source of symbolic support for the surviving spouse.

Finally, if interdependence in quality of life persists despite the loss of a partner, questions remain as to how this effect might compare with interdependence among people who do not lose their spouse (Vable et al., 2015). Do near-widowhood effects extend to quality of life? Are the dyadic effects observed among the bereaved as strong as the established concordance in quality of life among couples in which both partners are still alive?

The Present Study

We used data from the multinational, representative Study of Health, Ageing and Retirement in Europe (SHARE) to explore dyadic effects of quality of life among married couples as a predictor of later quality of life after one of the partners is widowed. Three primary hypotheses guided this investigation. First, among married couples in which one person subsequently died, we expected both partners' predeath quality of life would predict the spouse's quality of life after the partner's death (Hypothesis 1). Second, we expected that the near-widowhood effect (Vable et al., 2015) would be conceptually replicated in our widowed sample, such that the quality of life of widowed participants before their spouse's death would be lower than the quality of life of nonwidowed participants (Hypothesis 2). Finally, we expected the association of partners' predeath quality of life and the surviving spouses' later quality of life would be weaker among widowed couples, compared with nonwidowed couples whose quality of life was measured at the same two time points (Hypothesis 3).

Method

Participants

The SHARE data set that we used for this study currently contains data from four waves: three panel waves (2004, 2006, and 2010) and one dealing with retrospective life histories (2008; Börsch-Supan et al., 2013). Participants were selected from 18 European Union countries (Austria, Belgium, Czech Republic, Denmark, Estonia, France, Germany, Greece, Hungary, Ireland, Italy, The Netherlands, Poland, Portugal, Sweden, Slovenia, Spain, Switzerland) and Israel, with 152,871 completed interviews and 86,290 unique participants primarily 50 years of age or older. Participants from earlier waves were contacted for participation in subsequent waves, and the average retention rate of the study for the first four waves was 81%. For participants who passed away, a proxy respondent completed an end-of-life questionnaire regarding their death and retrospective measures of their health-care use.

From the original SHARE sample of 86,290 people, we excluded 53,985 because they participated in only a single wave of data collection. Of those excluded, 70.43% were newly recruited into the study and assessed only at Time 4. Of the remaining 29,555 participants who had data from two waves, 20,449 completed assessments at Wave 1 and Wave 2, whereas 18,289 completed assessments at Wave 2 and Wave 4. Of the 20,449 participants who completed Waves 1 and 2, 10,830 had complete married-partner data, which equated to 5,415 couples. Of these married couples, 221 experienced the death of their spouse between Waves 1 and 2 (the *Waves 1-2 subsample*). Of the 18,289 participants who completed assessments at Wave 2 and Wave 4, 9,936 had complete married-partner data, which equated to 4,968 couples. Of these married couples, 325 experienced the death of their spouse between Waves 2 and 4 (the *Waves 2-4 subsample*). Both subsamples of couples completed initial (Time 1) assessments, after which one member of the couple passed away before the next assessment. The surviving member of the

dyad then completed a second assessment (Time 2; i.e., after the spouse's death). The widowed participants thus consisted of 546 couples in which one partner died between Time 1 and Time 2 drawn from the two subsamples. The selection and exclusion criteria ensured that the two widowed subsamples were independent.

Finally, to compare the widowed subsample with couples in which both members of the dyad remained alive, we selected 10,697 participants who had completed the Wave 1, Wave 2, and Wave 4 assessments. Of these 10,697 participants, 5,132 had complete data across the assessments, which resulted in a final sample of 2,566 married couples, with participants designated randomly as the partner or the surviving participant. Table 1 displays the descriptive statistics for all participants.

Measures

Demographic variables. SHARE assessed a variety of demographic variables, including both partners' age, gender, and years of education; years the couple was married; and household income percentile. Years of marriage and household income percentile were equal within couples.

End-of-life variables. When members of SHARE passed away, a proxy respondent was contacted to conduct an end-of-life assessment. In the current study, we used several proxy responses, including the hours of help needed in daily activities per day (0 to 24), the length of time the participant was ill before death (coded from 1, *less than 1 month*, to 4, *1 year or more*), and the month and year of participants' death. Two variables measured the time between (a) the widowed partners' Time 1 interview date and the spouse's death and (b) the spouse's death and the widowed partners' Time 2 interview date. Both variables were calculated using the month

and years of death to account for the fact that surviving spouses were widowed for different lengths of time between assessments.

Quality of life. Quality of life was measured at each time point using 12 items of the CASP-19 (Hyde, Wiggins, Higgs, & Blane, 2003), a scale developed specifically for use in assessing quality of life, life satisfaction, and wellbeing in aging populations, which shows concurrent validity with similar measures. The scale assesses the domains of control, autonomy, self-realization, and pleasure (hence the initials CASP) with four to five Likert-scale items in each of the four domains, for a total of 19 items (e.g., "I look forward to each day"). The CASP-19 shows predictive power based on contextual factors that impact wellbeing, such as health and marital problems (Blane, Higgs, Hyde, & Wiggins, 2004), and has shown adequate internal reliability. All four subdomains load on a single latent factor of quality of life (Wiggins, Higgs, Hyde, & Blane, 2004). The SHARE data set uses a subset of 12 of these items that show more robust statistical-measurement properties, as determined through exploratory and confirmatory factor analyses (Wiggins, Netuveli, Hyde, Higgs, & Blane, 2008). Response choices were coded from 1 to 4 and resulted in a final shorted scale with a range from 12 to 48, with higher scores representing higher quality of life. The subscale showed adequate internal consistency across the entire sample at both Time 1 ($\alpha = .75$) and Time 2 ($\alpha = .77$).

Physical health. Deceased partners' physical health prior to their passing was measured at Time 1 using a 5-point Likert-scale item that asked how they would rate their health on a scale from *excellent* to *very poor*. Participants were randomly assigned to receive the question either at the beginning or end of the broader physical-health questionnaire to account for response biasing. Scores were coded such that higher scores denoted lower self-perceived physical health.

In general, self-perceived health is considered a valid measure of physical health among aged adults and is predictive of future health problems and mortality (Idler & Benyamini, 1997).

Depressive symptoms. Depressive symptoms were measured using the EURO-D, a self-report measure originally designed to assess the presence of depressive symptoms in participants from the European Union (Castro-Costa et al., 2007; Prince et al., 1999). The scale uses 12 binary yes/no items (e.g., "Have you been sad recently?" and "Have you cried recently?"). The scale has an established clinical cutoff (≥ 4) and had acceptable internal reliability in the current sample ($\alpha = .69$). We accounted for depressive symptoms in the current study because depression is linked to quality-of-life outcomes in medical populations, such as people with diabetes (Goldney, Philips, Fisher, & Wilson, 2004) and cancer (Visser & Smets, 1998).

Social engagement. Social engagement was measured using a sum score of participants' self-reported participation across four domains of social activities over the month previous to the assessment. The categories were how often they had participated in (a) voluntary or charity work, (b) sports or a social or other kind of club, (c) activities of a religious organization, and (d) activities involving a political or community organization. Scores in each domain ranged from 0, *no participation*, to 3, *participation every week or more*. Scores at Wave 4 consisted of participants' self-reported social participation over the previous year, rather than the previous month, and were recoded to match the monthly frequencies used in Wave 1 and Wave 2, as discussed in further detail in Bourassa, Memel, Woolverton, and Sbarra (2015b).

Data analysis

The four waves of SHARE assessments allowed for two independent subsamples: (a) couples married at Wave 1 with one partner passing away between Waves 1 and 2 (Waves 1-2 subsample), and (b) couples married at Wave 2 with one partner passing away between Waves 2

and 4 (Waves 2-4 subsample). In addition, the nonwidowed subsample consisted of participants who did not lose their partner from Wave 1 to Wave 4. It is important to note that the overall time between the assessments in the two widowed samples was 2 years and 4 years, respectively. Membership in either the Wave 1 or Wave 2 sample was statistically controlled for in all analyses.

We evaluated our first hypothesis by testing whether deceased partners' Time 1 quality of life predicted surviving spouses' Time 2 quality of life. We first conducted analyses using only the hypothesized variables of interest (deceased partner quality of life at Time 1 as a predictor of surviving spouse's quality of life at Time 2, controlling for the surviving spouse's quality of life at Time 1) and subsample membership, and then integrated a number of possible covariates as alternative predictors: surviving spouses' Time 1 age, gender, education, and depressive symptoms; years of marriage; partners' age and self-rated health; daily hours devoted to partner care prior to death; time the partner was ill prior to death; length of time since the surviving spouse was assessed prior to the partner's death; and length of time the surviving spouse was assessed after the partner's death, as well as Time 2 social engagement. In addition, we examined whether membership in a specific subsample was predictive by testing either for moderation by sample membership and quality of life or for a main effect of subsample membership, as appropriate. If the effect of subsample membership was nonsignificant and small in size, this provided evidence that any results in the combined sample replicated across both independent subsamples.

For the second hypothesis, we used regression to examine the mean difference between widowed and nonwidowed participants' Time 1 and Time 2 quality of life to determine whether the groups differed on their absolute quality of life. Time 1 age, gender, education, income,

depressive symptoms, and partner age were included as potential alternative predictors. In addition, we used Wave 1 quality-of-life scores (Time 0) for participants in the Waves 2-4 subsample to test whether differences existed approximately 2 years prior to Wave 2. Because of the timing of the assessments, this was not possible with the Waves 1-2 subsample.

For the third hypothesis, we evaluated whether there were differences between widowed and nonwidowed samples in the strength of the association between Time 1 quality of life and Time 2 quality of life. We conducted a regression analysis using the hypothesized variables of interest (participant and partner quality of life as a predictor of later quality of life) and widowed status (widowed or not widowed) as a moderator of the relationship between partner quality of life and later participant quality of life. We added Time 1 age, gender, education, income, depressive symptoms, and partner age as covariates.

For all regressions, values were standardized to represent the within-occasion change in dependent variables, in standard-deviation units, predicted by a 1 standard-deviation change in the independent variables. The values were calculated using the formula $\beta = b \times SD(x)/SD(y)$ for continuous predictors, and $\beta = b/SD(y)$ for dichotomous predictors, which is described in further detail in Muthén and Muthén (2012). All models were run in MPlus (Version 7.2; Muthén & Muthén, 2012) using simultaneous regression and full-information maximum-likelihood (FIML) estimation for missing data. FIML is a missing-data technique that produces result similar to those yielded by multiple imputation (Graham, 2009). FIML produces less biased estimates compared with listwise and pairwise deletion, similar response-pattern imputation in Monte Carlo simulations, and unbiased estimates when data is missing completely at random or missing at random (Enders & Bandalos, 2001).[1]

Results

Table 1 displays descriptive statistics for the participants in the current study for all variables as estimated using FIML. Tables 2 and 3 provide correlations for all variables included in the study, for widowed and nonwidowed participants, respectively. Initial (Time 1) quality of life was correlated among couples in both the widowed (r = .61) and nonwidowed subsamples (r = .56). Note that throughout the Results section, for widowed couples, "partner" refers to the deceased partner, and "participant" refers to the surviving spouse; for nonwidowed couples, one member was randomly designated as the participant and one as the partner.

Hypothesis 1

To test Hypothesis 1, we first examined the association between deceased partners' Time 1 quality of life and surviving spouses' Time 2 quality of life for widowed participants (Model 1; n = 546). We controlled for the surviving spouses' Time 1 quality of life and accounted for subsample membership. In Model 1, widowed participants' Time 1 quality of life predicted their Time 2 quality of life, β = 0.51, 95% confidence interval (CI) = [0.42, 0.60], p < .001. Deceased partners' quality of life also predicted widowed participants' later quality of life, β = 0.16, 95% CI = [0.05, 0.26], p = .003. Both partners' and surviving spouses' quality of life prior to the partners' death was included to account for a variety of plausible environmental factors shared among couples (e.g., geography, housing, family support). As a result, the association of the two partners' quality of life before the partner's death and widowed participant's quality of life after the partner's death is independent of these possible alternative predictors of quality of life.

To further test these associations, we then included a number of relevant covariates as additional alternative predictors for the associations observed in Model 1. The augmented model (Model 2) again evidenced a significant association between widowed participants' Time 1 and Time 2 quality of life, β = 0.44, 95% CI = [0.33, 0.55], p < .001, as well as the deceased

partners' Time 1 quality of life and widowed participants' Time 2 quality of life, β = 0.17, 95% CI = [0.07, 0.28], p = .002. Notably, the association of interest remained comparable with Model 1 results after the covariates were added. In addition, we investigated the interaction of subsample membership and partner quality of life as a predictor of participants' Time 2 quality of life to explore the similarity in the association between the independent subsamples. The effect size of the interaction was small in both models (Model 1: β = –0.01; Model 2: β = –0.00), which suggests that the observed results were equivalent in both subsamples. We also ran the models independently within each subsample, and the association of deceased partners' Time 1 quality of life and surviving spouses' Time 2 quality of life was replicated independently in both subsamples (Waves 1-2: β = 0.18; Waves 2-4: β = 0.17). The full results of Models 1 and 2 are presented in Table 4, and the results of Model 2 are shown visually in Figure 1.

Accounting for differences in time prior to the partner's death. Although including surviving spouses' Time 1 quality of life as a predictor accounted for the effects of environmental factors shared among spouses, an additional concern was whether differences in the time between the Time 1 assessment and the death of partners may have affected the strength of the association between deceased partners' quality of life and surviving spouses' Time 2 quality of life. It is possible that additional shared time as a couple between the Time 1 assessment and the partner's death could result in stronger interdependent effects. Therefore, we ran two analyses that included the interaction between partners' quality of life and the time between the Time 1 assessment and the partners' death to explore this possibility.

First, we entered this interaction in the original model for Hypothesis 1, which included the relevant covariates. One statistical issue we encountered, however, was multicollinearity between sample membership and time between the Time 1 assessment and the partners' death (*r*

= .72), due in large part to the lengths of time between Time 1 and Time 2 varying systematically between the two subsamples. In the previous analysis, the Subsample × Partner Quality of Life interaction was nonsignificant and small in size. Therefore, we ran our analysis including the Time to Death × Partner Quality of Life interaction without including the highly correlated Subsample × Partner Quality of Life interaction term. The Time to Death × Partner Quality of Life interaction was nonsignificant and small in size, β = –0.07, 95% CI = [–0.15, 0.01], p = .071, which suggests that the association of partners' Time 1 quality of life and participants' Time 2 quality of life did not differ based on the amount of time between the Time 1 assessment and the death.

Second, we also ran the regression model for Hypothesis 1 including only surviving spouses whose partner passed away within 1.5 years of the next assessment. In this subsample, the strength of the association between partner Time 1 quality of life and surviving spouse Time 2 quality of life was stronger than in the overall sample (β = 0.20) though nonsignificant because of the smaller sample size (n = 50). These two additional analyses provide evidence that differences in the amount of shared time between the initial assessment and death does not attenuate the association of partner's Time 1 quality of life as a predictor of widowed participants' Time 2 quality of life.

Hypothesis 2

To test Hypothesis 2, we examined differences in absolute quality of life between married participants who became widowed and nonwidowed participants using multiple regression with Time 1 age, gender, education, income, depressive symptoms, and partner age included as covariates.[2] As predicted, widowed participants had significantly lower levels of both Time 1 quality of life, β = –0.23, 95% CI = [–0.33, –0.13], p < .001, and Time 2 quality of life, β =

–0.24, 95% CI = [–0.34, –0.13], $p < .001$. The effect of subsample membership was small at both Time 1 and Time 2 (βs = 0.01 and –0.02, respectively), which suggests that the observed results were equivalent in both subsamples. In addition, we tested whether this difference in absolute quality-of-life level extended to the Wave 1 assessment in the Waves 2-4 subsample, for which there was an earlier assessment (Time 0) available. Two years prior to Time 1, widowed participants did not show significantly lower levels of quality of life compared with nonwidowed participants, β = –0.01, 95% CI = [–0.06, 0.05], $p > .250$. The results suggest that the differences in absolute quality of life between spouses who will become widowed in the future extend to Time 1 (mean time to partners' death = 3.18 years), but not Time 0 (2 years earlier than the mean time to partners' death). Full results are presented in Table 5 and illustrated in Figure 2.

Hypothesis 3

To test Hypothesis 3, we examined whether there were differences between widowed and nonwidowed participants in the association of partners' Time 1 quality of life and participants' Time 2 quality of life. To test this, we used multiple regression with the interaction of widowed status and partners' Time 1 quality of life as a predictor of later quality of life above and beyond the main effects of Time 1 partner and participant quality of life and widowed status. We also included relevant covariates, statistically accounting for Time 1 age, gender, education, income, depressive symptoms, and partner age.[3] The Partners' Time 1 Quality of Life × Widowed Status interaction did not significantly predict participants' Time 2 quality of life (n = 3,113), β = –0.01, 95% CI = [–0.19, 0.17], $p > .250$. The association was nonsignificant, in spite of the large sample, and small in size (β = –0.01). The results suggest that the effect of partners' Time 1 quality of life on participants' quality of life at Time 2 are comparable between nonwidowed and widowed participants. The effect of subsample interaction was also small (β= –0.01), which

suggests that the observed results were equivalent in both widowed subsamples. Full results of both models are presented in Table 6 and illustrated in Figure 3.

Discussion

Using a multinational longitudinal sample of aging adults, we determined that deceased partners' quality of life prior to their death predicted their widowed spouses' later quality of life. In addition, surviving spouses had lower quality of life both before and after their partner's death compared with nonwidowed people. Finally, the strength of independence in couples' quality of life was equivalent between widowed and nonwidowed participants. Attachment and interdependence theories predict dyadic effects in couples' psychology and physiology (Lewis et al., 2006; Rholes & Simpson, 2004; Sbarra & Hazan, 2008), though these effects would hold only if the couples have ongoing interactions. In the current study, our findings suggest that dyadic effects of quality of life continue after one's partner passes away. This effect is more than simply the effect of the association between widowed participants' current quality of life and their prior quality of life, as including widowed participants' prior quality of life accounts for multiple factors of a couples' shared life (e.g., family support, housing) that might affect surviving spouses' quality of life. Although marriages may "end" in a literal sense, the distal effects of the individual characteristics of deceased partners continue to predict their surviving spouse's wellbeing.

Although we used data from a longitudinal, multinational sample and therefore could not explicitly test the psychological mechanisms of action, there are at least two plausible pathways through which deceased partners' characteristics might affect surviving spouses' later quality of life. Attachment theory hypothesizes that the internal working model of the spousal relationship must be reorganized after a spouse's death, and recalling positive memories of the deceased may

aid in this process by creating a potential source of symbolic support. For example, having a deceased partners with higher prior quality of life may result in a more positive internal working model of the deceased, and such a model may act as a psychological resource for surviving spouses to draw on to improve their later quality of life.

Second, having a partner with higher quality of life prior to death might better enable surviving spouses to make meaning of their partner's death. Meaning-making attenuates the association of risk factors for distress and consequent bereavement complication in bereaved people (Neimeyer, Baldwin, & Gillies, 2006) and can make losing an attachment figure less threatening (Sbarra & Hazan, 2008). In addition, the circumstances of death can affect bereavement outcomes. For example, spouses adjust better to bereavement when death is supported by hospice care (Bradley et al., 2004). If deceased partners' quality of life affects surviving spouses' ability to make meaning of the death, this would in turn affect surviving spouses' later quality of life by reducing their distress levels following their partner's passing.

We also found that surviving spouses' absolute quality-of-life level was significantly lower than that of nonwidowed people, both prior to and after becoming widowed. This finding conceptually replicates the findings reported by Vable et al. (2015) and extends these results to quality of life. Interestingly, the lower levels of quality of life were present among widowed participants approximately 3, but not 5, years prior to their partners' death. One factor that might account for this difference is the effect of caregiving on quality of life (Ho, Chan, Woo, Chong, & Sham, 2009), as widowed participants may be more likely to have been caregivers for their partners. However, the support for this explanation in the data is mixed: Relatively few people reported acting as a caregiver at Time 1 in the widowed (7.9%) or the nonwidowed (7.0%) samples. More reported hours of daily caregiving prior to deceased partners' death, however,

predicted lower later quality of life for surviving spouses. Regardless, these results point to a window of increased risk for lower quality of life in bereaved spouses that occurs prior to their partners' death.

Finally, contrary to our third hypothesis, there was no difference in the association of partners' prior quality of life and their spouses' later quality of life between the widowed and nonwidowed participants. The strength of the association was such that surviving spouses whose deceased partner's Time 1 quality of life was 1 standard deviation above the mean (~6.5 points) evidenced Time 2 quality of life equivalent to that of nonwidowed participants whose partner had an average Time 1 quality of life, despite the group-level differences in Time 2 quality of life. Although these results may suggest equivalent partner effects among widowed and nonwidowed people, it seems likely that the mechanisms of action for the two groups are different. Reorganization of attachment to the deceased or meaning-making around the death may affect widowed people's quality of life, but for those who remain married, ongoing dyadic processes likely mediate interdependence in quality of life.

The implications of the current research are twofold. First, these findings suggest that researchers exploring recovery following spousal bereavement should also consider how characteristics of the deceased partner may affect surviving spouses' outcomes. It is well established that surviving spouses' preloss characteristics have effects on their recovery after losing a spouse (Boerner, Wortman, & Bonanno, 2005; Bonanno et al., 2002). Relatively less research has explored the ongoing effects that prior relationships exert through cognitive or emotional links to past partners after those relationships have physically ended. It is possible that the importance of ongoing interdependence following literal separation exists among other types of close relationships.

Second, interventions targeting end-of-life quality of life may have positive effects on individuals close to the person receiving care. Psychosocial interventions targeting family members of people suffering from chronic or terminal illness have better health outcomes for the patient and better psychological outcomes for both the patient and family compared with individual medical care for the patient (Martire, Lustig, Schulz, Miller, & Helgeson, 2004). Psychosocial interventions targeting patients may reap benefits for surviving partners. The current study is not an experimental intervention, however, and we therefore cannot make causal claims regarding effects on widowed spouses' quality of life.

The findings from this study should be considered in light of its limitations. First, despite the inclusion of a wide array of possible variables from both members of couples, it is possible that our models excluded predictors that may better explain the variation between partners' prior quality of life and participants' later quality of life. Quality of life may serve only as a proxy for other meaningful variables that affect surviving spouses' later quality of life. Second, we control for alternative explanations in our analyses, such as environmental factors shared among couples and differences in the length of time between the initial assessment and the death. However, statistical control is not equivalent to experimental control of possible third-variable explanations. Third, although the widowed subsamples were drawn from a representative, multinational sample, it is possible that becoming widowed differentially affected the makeup of the sample in a way that precludes generalizing the study's results. Finally, because the sample was made up of adults over the age of 50, it is possible this effect does not generalize to people who become widowed under the age of 50.

Conclusion

In the present study, we examined whether deceased partners' quality of life predicted their widowed spouses' quality of life after the partners' death, as well as differences in absolute levels of quality of life between nonwidowed people and widowed people before and after their spouse's death. Partners' predeath quality of life predicted their spouses' later quality of life after their passing. People who became widowed had lower absolute levels of quality of life—both before and after their partners' death—compared with people who remained married. Finally, the strength of the association between partners' earlier quality of life and their spouse's later quality of life was not significantly different for widowed compared with nonwidowed people. In sum, the results provide evidence that interdependence among married couples' quality of life extends beyond the death of one's partner.

Author Contributions

K. J. Bourassa proposed the study concept, and L. M. Knowles and M.-F. O'Connor contributed to the conceptual model. K. J. Bourassa analyzed and interpreted the data under the supervision of M.-F. O'Connor. K. J. Bourassa drafted and revised the manuscript with assistance from L. M. Knowles, D. A. Sbarra, and M.-F. O'Connor. All authors provided additional input for the final version of the manuscript and approved it for submission.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

Funding

This research used data from Study of Health, Ageing and Retirement in Europe (SHARE) Waves 1, 2, and 4 (DOIs: 10.6103/SHARE.w1.260, 10.6103/SHARE.w2.260, 10.6103/SHARE.w4.111, respectively). The SHARE data collection has been primarily funded by the European Commission Fifth Framework Programme (QLK6-CT-2001-00360), Sixth Framework Programme (SHARE-I3: RII-CT-2006-062193, COMPARE: CIT5-CT-2005-028857) and Seventh Framework Programme (SHARE-PREP: No. 211909, SHARE-LEAP: No. 227822, SHARE M4: No. 261982). Additional funding from the German Ministry of Education and Research, the U.S. National Institute on Aging (U01_AG09740-13S2, P01_AG005842, P01_AG08291, P30_AG12815, R21_AG025169, Y1-AG-4553-01, IAG_BSR06-11, OGHA_04-064) and from various national funding sources is gratefully acknowledged (see www.share-project.org).

Notes

1. We also ran all models using listwise deletion to confirm that FIML did not bias parameter estimates. All substantive results held in these analyses.

2. We also ran the analyses for Hypothesis 2 without covariates and all substantive results were replicated.

3. We also ran the analyses for Hypothesis 3 without covariates and all substantive results were replicated.

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Table 1.
Descriptive Statistics for Widowed and Nonwidowed Participants

Variable	Widowed (n = 546)	Nonwidowed (n = 2,566)
Time 0 quality of life (12–48)	37.41 (6.21)	38.05 (5.70)
Time 1 quality of life (12–48)	35.53 (6.83)	38.40 (5.78)
Time 2 quality of life (12–48)	35.09 (6.96)	38.36 (5.93)
Partner Time 1 quality of life (12–48)	35.18 (6.49)	38.52 (5.72)
Depression (1–12)	2.81 (2.48)	2.01 (2.01)
Age (years)	70.02 (9.51)	61.90 (8.47)
Partner age (years)	72.08 (9.44)	61.90 (8.54)
Income percentile (rescaled: 1–10)	5.26 (2.49)	6.17 (2.62)
Years of education	9.20 (4.17)	10.89 (4.41)
Years married	44.62 (11.58)	36.00 (11.01)
Gender (% women)	68.8	50.0
Partner health (1–5)	3.78 (1.05)	—
Time prior to death	2.45 (1.89)	—
Time after death	1.27 (0.83)	—
Length of time partner was ill (1–4)	2.82 (1.27)	—
Hours of help needed daily (0–24)	12.53 (9.02)	—
Time 2 social engagement (0–3)	0.87 (1.43)	—

Note: Except as noted, the table shows mean values. Standard deviations are given in parentheses. For widowed couples, “partner” refers to the deceased partner; for nonwidowed couples, one member was randomly designated as the participant and one as the partner. All variables were assessed at Time 1, unless otherwise indicated. Time prior to death is the length of time between the Time 1 assessment and the partners’ death, whereas time after the partners’ death is the time between death and the participants’ Time 2 assessment.

Table 2.
Correlations Between Variables in the Widowed Subsample

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Time 2 quality of life	—															
2. Time 1 quality of life	.61	—														
3. Partner quality of life	.46	.60	—													
4. Partner health	–.17	–.27	–.50	—												
5. Gender	–.03	–.07	–.11	–.04	—											
6. Age	–.20	–.06	–.09	.12	–.19	—										
7. Time after death	.08	–.07	–.09	.10	–.00	–.03	—									
8. Time prior to death	–.09	.03	.13	–.06	–.03	–.02	–.60	—								
9. Years married	–.14	–.07	–.09	.08	–.03	.72	.01	–.02	—							
10. Length of partner illness	.05	–.10	–.09	.20	–.06	–.05	.08	–.09	–.06	—						
11. Help needed	–.11	.04	.05	–.06	.06	–.08	.02	.03	–.05	–.04	—					
12. Partner age	–.22	–.13	–.18	.12	.12	.82	–.01	–.03	.67	–.08	–.05	—				
13. Education	.42	.38	.30	–.13	–.14	–.20	.03	–.01	–.22	.05	–.01	–.25	—			
14. Income percentile	.20	.11	.13	–.04	.04	–.19	.01	.04	–.17	.06	.08	–.18	.33	—		
15. Depression	–.42	–.62	–.37	.24	.12	.09	.09	–.03	.11	.13	–.02	.14	–.25	–.02	—	
16. Social engagement	.10	.04	.05	–.02	.08	–.09	–.01	–.01	.03	–.10	.02	.05	–.06	.09	.14	—
17. Subsample	–.01	.07	.17	–.04	–.07	–.01	–.06	.72	–.02	–.12	–.04	–.05	.03	–.01	–.08	–.06

Note: All variables measured participants' characteristics unless otherwise noted. See Table 1 for more information about the variables.

Table 3.

Correlations Between Variables in the Nonwidowed Subsample

Variable	1	2	3	4	5	6	7	8	9
1. Time 2 quality of life	—								
2. Time 1 quality of life	.64	—							
3. Partner quality of life	.45	.56	—						
4. Depression	–.37	–.38	–.27	—					
5. Age	–.16	–.12	–.09	.02	—				
6. Partner age	–.15	–.11	–.08	.08	.83	—			
7. Income percentile	.18	.18	.20	–.09	–.31	–.32	—		
8. Education	.25	.27	.25	–.16	–.19	–.22	.35	—	
9. Gender	–.02	–.01	.04	.21	–.16	.18	–.02	–.08	—
10. Years married	–.14	–.13	–.08	.08	.71	.72	.31	–.25	.03

Note: All variables measured participants' characteristics unless otherwise noted. See Table 1 for more information about the variables.

Table 4.
Results of the Models Predicting Participants' Time 2 Quality of Life

Model and predictor	β	95% CI	*b*
Model 1			
Quality of life	0.51**	[0.41, 0.61]	0.51**
Partner quality of life	0.16**	[0.06, 0.28]	0.17**
Subsample	–0.07	[–0.15, 0.01]	–1.01
Subsample × Partner Quality of Life	–0.01	[–0.09, 0.08]	–0.01
Model 2			
Quality of life	0.44**	[0.33, 0.55]	0.45**
Partner quality of life	0.17**	[0.07, 0.28]	0.18**
Depression	–0.08	[–0.17, 0.02]	–0.22
Partner health	0.06	[–0.03, 0.14]	0.37
Age	–0.20*	[–0.36, -0.04]	–0.15*
Partner age	0.03	[–0.12, 0.17]	0.02
Income percentile	0.07	[–0.01, 0.14]	0.18
Education	0.15**	[0.06, 0.23]	0.25**
Years married	0.07	[–0.04, 0.18]	0.04
Time prior to death	–0.02	[–0.21, 0.18]	–0.09
Time after death	0.08	[–0.04, 0.23]	0.83
Length of partners' illness	0.08*	[0.01, 0.15]	0.44*
Help needed	–0.15**	[–0.25, -0.05]	–0.12**
Gender	0.02	[–0.07, 0.10]	0.24
Time 2 social engagement	0.04	[–0.03, 0.11]	0.19
Subsample	–0.05	[–0.20, 0.10]	–0.70
Subsample × Partner Quality of Life	–0.00	[–0.08, 0.08]	–0.00

Note: All predictors were assessed at Time 1 unless otherwise noted. Subsample membership was contrast coded for whether widowed participants were in the Wave 1-Wave 2 or Wave 2-Wave 4 subsample. See Table 1 for more information about the variables.
*$p < .05$. **$p < .01$.

Table 5.
Results of the Models Comparing Quality of Life Among Widowed and Nonwidowed Participants

Sample and predictor	β	95% CI	*b*
Outcome: Time 1 quality of life			
Full sample			
Widowed status	–0.24**	[-0.33, -0.13]	–1.39**
Depression	–0.41**	[-0.44, -0.38]	–1.17**
Age	–0.01	[–0.08, 0.07]	–0.01
Partner age	–0.01	[–0.09, 0.06]	–0.01
Income	0.06**	[0.02, 0.09]	0.13**
Education	0.20**	[0.17, 0.24]	0.28**
Years married	–0.01	[–0.06, 0.05]	–0.00
Gender	0.07**	[0.03, 0.11]	0.83**
Subsample	0.01	[–0.03, 0.05]	0.14
Outcome: Time 2 quality of life			
Full sample			
Widowed status	–0.24**	[–0.33, –0.14]	–1.44**
Depression	–0.35**	[–0.39, –0.32]	–1.02**
Age	–0.11**	[–0.19, –0.03]	–0.07**
Partner age	–0.03	[–0.11, 0.05]	–0.02
Income	0.07**	[0.04, 0.11]	0.13**
Education	0.19**	[0.15, 0.22]	0.26**
Years married	0.06*	[0.01, 0.11]	0.03*
Gender	0.05*	[0.01, 0.09]	0.62*
Subsample	–0.02	[–0.06, 0.02]	–0.22
Outcome: Time 0 quality of life			
Wave 2 subsample			
Widowed status	0.01	[–0.06, 0.05]	–0.09
Depression	–0.42**	[–0.46, –0.39]	–1.20**
Age	0.01	[–0.08, 0.10]	0.01
Partner age	0.04	[–0.06, 0.13]	0.02
Income	0.11**	[0.06, 0.15]	0.23**
Education	0.19**	[0.14, 0.23]	0.24**
Years married	–0.02	[–0.08, 0.04]	–0.01
Gender	0.09**	[0.04, 0.14]	1.02**

Note: All variables assessed participants' characteristics unless otherwise noted. See Table 1 for more information about the variables. CI = confidence interval.
*$p < .05$. **$p < .01$.

Table 6.
Results of the Moderation Model Predicting Participants' Time 2 Quality of Life

Predictor	β	95% CI	*b*
Widowed status	–0.01	[–0.22, 0.19]	–0.21
Quality of life	0.48**	[0.45, 0.52]	0.50**
Partner quality of life	0.12**	[0.08, 0.16]	0.12**
Partner Quality of Life × Widowed Status	–0.01	[–0.21, 0.20]	–0.00
Depression	–0.13**	[–0.16, –0.09]	–0.37**
Age	–0.11**	[–0.17, –0.04]	–0.07**
Partner age	–0.02	[–0.08, 0.05]	–0.01
Income percentile	0.03*	[0.00, 0.06]	0.08*
Education	0.06**	[0.03, 0.09]	0.09**
Years married	0.05*	[0.01, 0.09]	0.03*
Gender	0.00	[–0.03, 0.04]	0.05
Subsample	–0.02	[–0.23, 0.18]	–0.34
Partner Quality of Life × Subsample	–0.01	[–0.21, 0.20]	–0.00

Note: See Table 1 for more information about the variables. CI = confidence interval.
*$p < .05$. **$p < .01$.

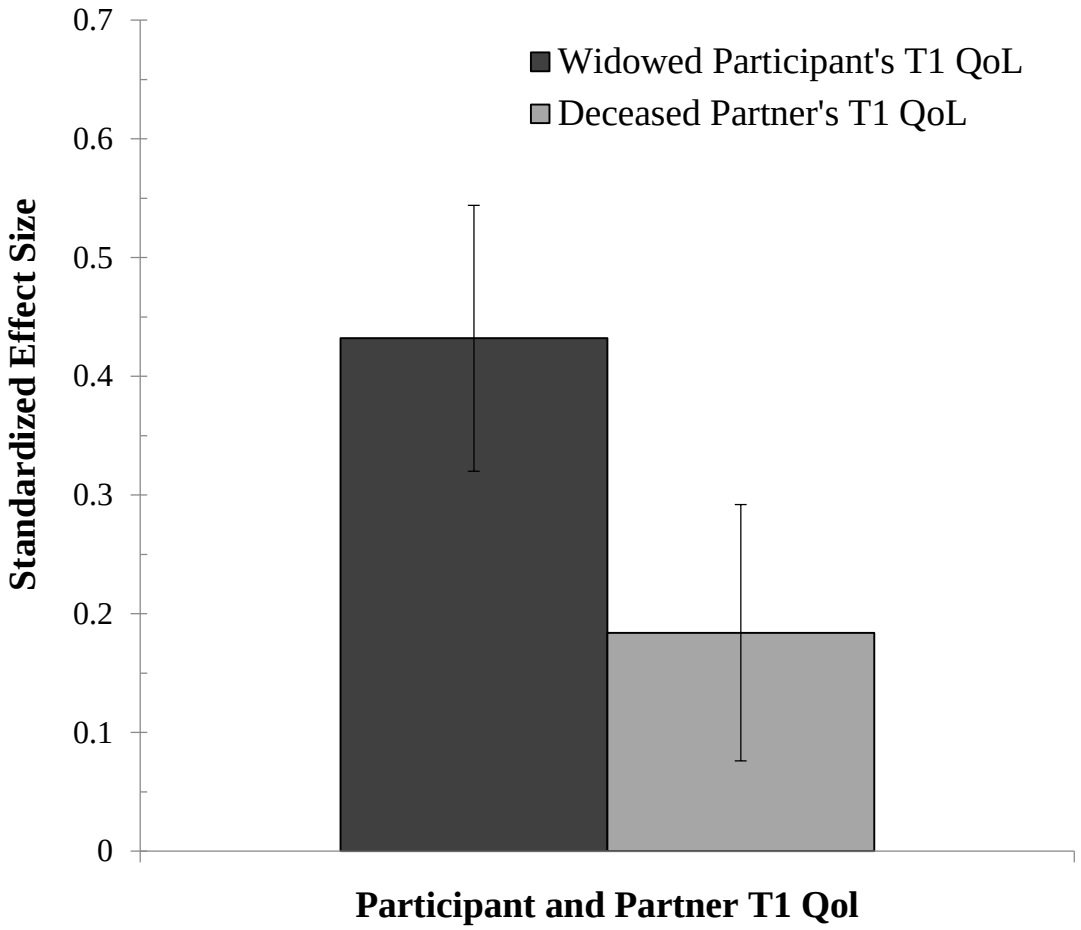

Figure 1. Standardized mean effect size from Model 2 for surviving spouses' and partners' Time 1 quality of life as a predictor of participants' Time 2 quality of life for the widowed subsample. Values shown are from Model 2, which included surviving spouses' Time 1 age, gender, education, and depressive symptoms; years of marriage; partners' age and self-rated health; daily hours devoted to partner care prior to death; time the partner was ill prior to death; length of time since the surviving spouse was assessed prior to the partner's death; and length of time the surviving spouse was assessed after the partner's death, as well as Time 2 social engagement. Errors bars represent 95% confidence intervals.

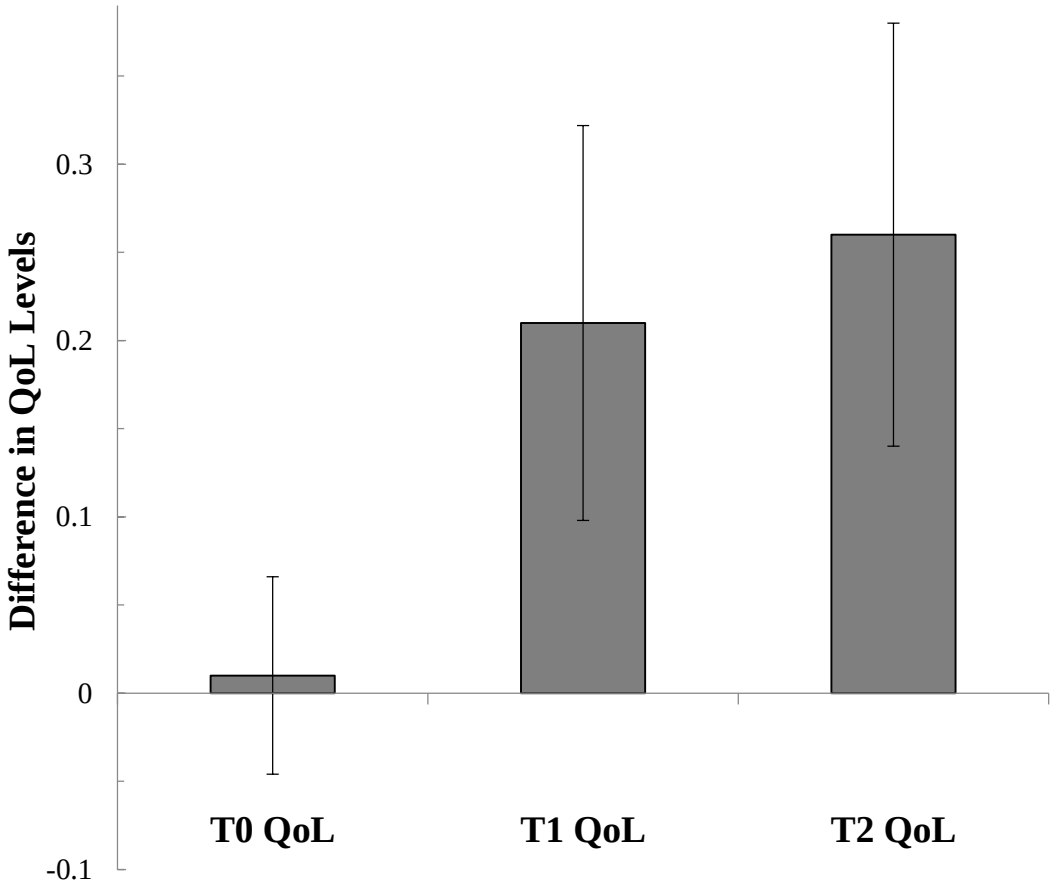

Figure 2. Mean difference in standardized effects for absolute quality-of-life level between nonwidowed and widowed participants. Results are shown for the Wave 2 subsample at Time 0 (2 years prior to Time 1), as well as from both subsamples at Time 1 (before partners' death) and Time 2 (after partners' death). The model included Time 1 age, gender, education, income, depressive symptoms, and partner age as covariates. All effects were negative but are presented here as positive for ease of interpretation. Errors bars represent 95% confidence intervals.

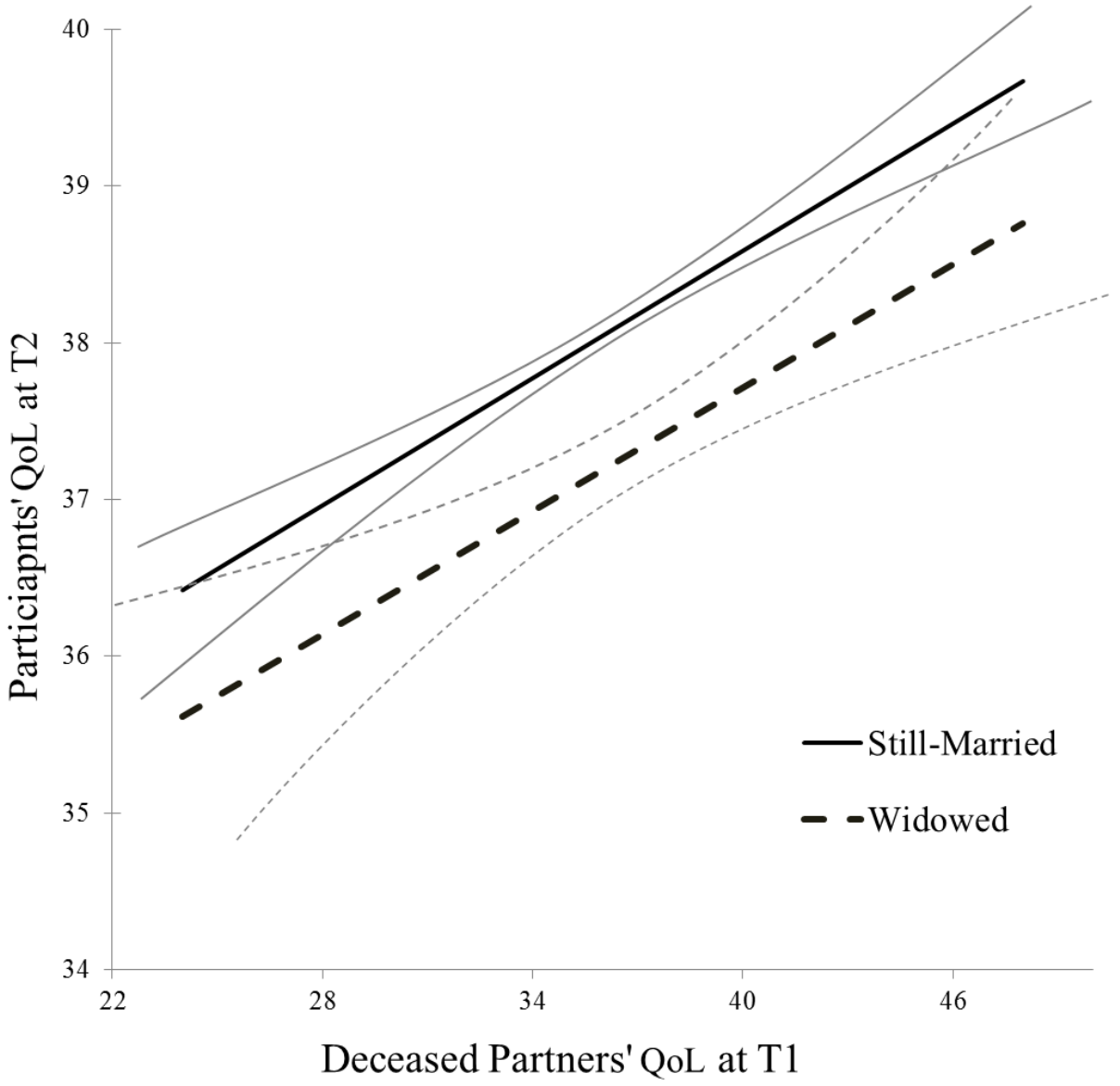

Figure 3. Participants' predicted quality of life at Time 2 as a function of partners' quality of life at Time 1, separately for the widowed and nonwidowed subsamples. This analysis accounted for Time 1 age, gender, education, income, depressive symptoms, and partner age. The thin lines flanking each regression line indicate 95% confidence intervals.

Appendix C

Note: This is a pre-print manuscript and is currently under review (2018). Its final version may vary from this submission.

The Impact of Physical Proximity and Attachment Working Models on Cardiovascular Reactivity: Comparing Mental Activation and Partner Presence

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Pre-print, Manuscript Under Review

Word Count: 5,088

Tables: 2

Figures: 3

References: 40

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Abstract

Maintaining high-quality close relationships, including romantic relationships, is consistently associated with improved physical health, but it is unclear how such effects operate. Drawing on Attachment and Social Baseline theories, this experimental study evaluated two potential mechanisms that may attenuate cardiovascular reactivity to a laboratory-based stressor. Prior to a cold pressor task, 102 participants were randomly assigned to have their partner physically present, to call upon a mental representation of their partner, or to think about their day during the stressor. Consistent with preregistered hypotheses, participants in both the partner present and mental activation conditions had significantly lower blood pressure reactivity during the cold pressor task compared to control participants, but no significant differences emerged for heart rate or heart rate variability. The results suggest that accessing the mental representation of a romantic partner and a partner's presence operate independently to buffer against exaggerated acute stress responses.

Keywords: Attachment Theory, Social Baseline Theory, cardiovascular reactivity, romantic relationships, heart rate variability, heart rate, blood pressure

The Impact of Physical Proximity and Attachment Working Models on Cardiovascular Reactivity: Comparing Mental Activation and Partner Presence

Close relationships are central to human health and provide an essential interpersonal context that affects psychological and physical wellbeing (Sbarra & Coan, 2017). People who are married or who have higher social support, for example, live longer than those who are unmarried or have low social support (Holt-Lunstad, Smith, & Layton, 2010; Sbarra, Law, & Portley, 2011; Shor, Roelfs, Bugyi, & Schwartz, 2012). Close relationships, and specifically romantic relationships, can affect health by attenuating responses to stressful stimuli (Butler & Randall, 2012; Cohen, 2004). When facing stressful situations, romantic partners may act as a psychological resources for coping, and these resources can in turn modulate the stress response and buffer against exaggerated physiological reactivity (Coan, Schaeffer, & Davidson, 2006; Cohen & Wills, 1985; Sbarra & Hazan, 2008). Relatively few experimental studies, however, have tested whether romantic partner's presence is necessary for this stress buffering effect.

Attachment Theory (Bowlby, 1982) and Social Baseline Theory (SBT; Beckes & Coan, 2011) provide complementary but distinct explanations for how stress buffering may operate on a day-to-day basis. Attachment Theory highlights the central role of early caregiving experiences in shaping the development of attachment styles—the characteristic ways in which people think and behave in relationships. These attachment styles are believed to be carried forward into adulthood and impact self-regulatory capacity (Fraley, Roisman, Booth-LaForce, Owen, & Holland, 2013).

People's ability to call on *working models* of attachment figures (Collins & Read, 1994) can enhance self-regulatory capacity even when partners are not physically present (Collins & Feeney, 2004), which may be a core ingredient of successful stress buffering (Cohen & Wills,

1985). For example, accessing internal representations of more supportive relationship targets appears to attenuate affective and physiological response during subsequent stressors (Bloor, Uchino, Hicks, & Smith, 2004). In one such study, thinking about a close friend buffered against blood pressure (BP) reactivity to a stressful task compared to thinking about an acquaintance (Smith, Ruiz, & Uchino, 2004). Drawing on the working model of one's partner may shape secondary appraisal processes (Lazarus & Folkman, 1984); accessing the working model may provide psychological resources to navigate demanding or threatening situations (Bloor et al., 2004).

Social Baseline Theory (SBT; Beckes & Coan, 2011) complements Attachment Theory and proposes that social proximity and interaction helps people conserve biological resources by allowing for sharing burden associated with environmental risk and threat, which has the potential to improve health over the long term (Beckes & Coan, 2011; Coan & Maresh, 2014; Coan & Sbarra, 2015). Relative to facing a stressful situation alone, SBT suggests that people may perceive less threat when a partner is present; this effect may operate via a primary appraisal of task difficulty or threat. The physical proximity of a romantic partner or other close other allows people to "share the load" associated with threatening stimuli, requiring the deployment of fewer physiological resources in response to any given task demand. For example, wives' neural response to threat is attenuated when holding the hand of a spouse compared to holding the hand of an opposite-sex stranger or being alone (Coan et al., 2006). Notably, relationship quality moderated this association, such that wives in higher quality marriages had the greatest reduction in their neural responses.

One physiological pathway through which romantic relationships might impact long-term health is cardiovascular reactivity (CVR). Greater CVR is associated with greater disease

progression and is a risk factor for cardiovascular disease (Chida & Steptoe, 2010; Treiber et al., 2003). Daily experience of CVR may affect the cardiovascular system by increasing wear-and-tear experienced by the body, resulting in coronary calcification and atherosclerosis (Manuck et al., 2005; Matthews, Zhu, Tucker, & Whooley, 2006). Laboratory studies using of standardized acute stressors, such as the cold pressor task (Menkes et al., 1989) or Trier Social-Stress Test (Kirschbaum, 2015), find that the presence of a friend or romantic partner, as well as mentally imagining a close friend all reduce CVR (Bloor et al., 2004; Feeney & Kirkpatrick, 1996; Karmark, Manuck, & Jennings, 1990; Smith et al., 2004). CVR responses to lab stressors are associated with long-term health outcomes (Treiber et al., 2003) and variability in CVR to standardized laboratory tasks is believed to approximate daily patterns of reactivity and attenuated activity to these tasks may reflect less cumulative wear-and-tear on the body, affecting long-term health outcomes (Treiber et al., 2003). Although mechanistic models linking relationship quality to health often cite CVR as a candidate pathway of interest (Robles, Slatcher, Trombello, & McGinn, 2014; Uchino, 2006), relatively fewer well-controlled laboratory studies have examined this process in a theory-driven way. Both Attachment Theory and SBT suggest different routes to a common endpoint. Attachment Theory suggests that increased psychological resources (when calling on a working model) would reduce reactivity to a stressor, whereas SBT suggests reduced CVR in the presence of partner is explained via reduced appraisals of threat.

Present Study

In comparing and contrasting these theoretical accounts of the influence of romantic relationships on CVR, two central questions arise. First, does calling on the mental representation of a romantic partner or having a partner physically present differentially predict CVR? Second, to the extent that the presence of a partner and calling on a representation of a

partner both attenuate a stress response, do these effects operate through different appraisal processes? To answer these questions, the present study compared cardiovascular responses to a laboratory stressor among undergraduate students in a romantic relationship (N = 102) who were randomly assigned to either have a romantic partner present, access the mental representation of their partner, or think about their day as an active control. The preregistered hypotheses and analysis plan for this investigation are available online (https://osf.io/kdt9s). Specifically, we predicted control participants would have significantly greater CVR—in the form of increased heart rate (HR) and blood pressure (BP), and decreased heart rate variability (HRV)—compared to the other conditions. In addition, as a conceptual replication of Coan et al. (2006), we hypothesized that romantic relationship satisfaction would moderate CVR, with lower CVR among people who reported higher relationship quality for people accessing the mental representation of a romantic partner and whose partner was present. In exploratory analyses, we also examined whether the physical presence of a romantic partner affected participants' appraisals of the cold pressor task, as well as self-reported pain during the stressful task.

Method

Participants

A sample of undergraduate students in a romantic relationship (N = 102) at a large university in the Southwest were recruited to participate in a laboratory study. Participants were randomly assigned to one of three conditions, Partner Present, Mental Activation, or Control. The participants were 19.1 years old on average, predominantly female (75.5%), and a majority freshman in college (56.7%). Participants reported current relationship lengths of 20.6 months on average (SD = 17.2, range 1-98 months), that they were largely unmarried (94.5%) and living separately (22.2% cohabitating). The sample was generally diverse, with 46.0% reporting they

were Caucasian and non-Hispanic. Nine participants reported they were Asian, four reported they were American Indian or Native Alaskan, two reported they were Black or African American, one reported they were Pacific Islander, and 16 reported their race as other. Of the total sample, 43.1% reported they were Hispanic. One-way ANOVAs were used to determine whether a variety of demographic covariates (age, gender, class status, marital status, cohabitation status, ethnicity, and relationship status), depressive and anxiety symptoms, or baseline cardiovascular measures (systolic BP, diastolic BP, HR, and HRV) varied significantly across conditions. There were no significant differences in demographic covariates or the baseline cardiovascular measures, suggesting randomization to conditions was successful. Demographic information is presented in Table 1.

Procedure

Potentially eligible participants were identified and recruited using screening questions embedded in a larger survey completed by all undergraduate research participants at a large university in the Southwest US. Participants were eligible if they reported they were in a committed heterosexual romantic relationship of at least one month, their partner was present in the local metro area, they were fluent in English, at least 18 years old, and did not have any uncontrolled medical conditions. Eligible participants were randomized in approximately a 1/3 to 2/3rds ratio to receive an offer to participate in the study either alone (n = 326, 68.9%) or with their romantic partner (n = 147, 31.1%) via email and phone calls, to match the two conditions without a partner present to one condition with partners present. In total, 70 of the 326 participants (21.5%) offered participation alone and 32 of the 147 participants (21.8%) offered participation with their partner expressed interest and were enrolled in the study, the latter making up the Partner Present condition (n = 32). Participants who signed up to participate in the

study alone were then randomized to either the Control (n = 35) or Mental Activation conditions (n = 35). Figure 1 provides the CONSORT diagram outlining participant recruitment and randomization. The University of Arizona Institutional Review Board approved the study protocol.

The full laboratory procedure used by research assistants is available online at https://osf.io/2u9h3/. Once participants arrived, they were then informed about the basic study procedure and completed a variety of self-report questionnaires. Participants had their height and weight measured by the research assistants using a digital scale and tape measure. The research assistants then helped the participant to attach the physiological sensors, after which the laboratory tasks outlined in Figure 2 began.

The lab portion of the study began with the participants completing a 10 minute vanilla baseline task (Jennings, Karmarck, Stewart, Eddy, & Johnson, 1992), in which they were asked to observe ten side-by-side nature scenes for 1-min. Once the baseline period was completed, a research assistant informed participants of the upcoming task and asked them to wait for three minutes. Once this task anticipation period ended, participants were asked to complete a self-report assessment of the upcoming task and asked to place their foot in the water for four minutes. This limb immersion cold pressor task is used extensively in the literature (Menkes, 1989) and is linked to changes in cardiovascular activity in the peripheral vasculature (Allen, Shelley, & Bouquet, 1992; Mourot, Bouhaddi, & Regnard, 2009). The water was measured at 38-40°F and approximately 3” depth. Seven participants either stated they couldn’t continue the cold pressor or took their foot out of the water during the task (Partner Present n = 2; Mental Activation n = 2; Control n = 3) and the data for these participants was collected until the cold pressor ended. After the cold pressor task, participants were asked to wait for a ten minute

recovery period, after which they completed an additional set of self-report assessments about the task. Participants then reported on their thoughts during the cold pressor and completed a four minute stream-of-consciousness task describing their romantic relationship. After these tasks, the participants were debriefed about the study.

Experimental Manipulations

The basic procedure varied slightly for each condition, resulting in the three randomly assigned experimental conditions.

Control Condition. Control condition participants were told prior to the cold pressor "*During the upcoming task, please think about your day and what has happened or will happen today.*"

Mental Activation Condition. Mental Activation participants were told "*For some people, thinking about their romantic partner can be helpful during tasks like this. So before you begin, I will ask you to close your eyes and take 30-seconds to come up with a detailed image of your romantic partner. Please try to create a careful image of his/her face, of him/her doing something, or of the two of you doing something together that you find supportive. The most important piece is that you concentrate carefully on creating a very vivid image that you can use to support you while you're completing this task. For now, please take 30 seconds to come up with the image you can call on during the task.*" Then just prior to the cold pressor these participants were told "*During this task, please try to focus on that image that you created of your partner and draw on it as if he/she was right here supporting you through the task. If you get distracted, just remember to turn your attention back to that image of your partner.*"

Partner Present Condition. The participant's partner was present in the room sitting quietly next to them during the baseline, anticipation, cold pressor, and recovery tasks. No partner was present at any point for the two other conditions.

Measures

Self-report measures. Participants completed several self-report measures prior to the laboratory tasks.

Demographics. Participants reported a variety of demographic information and relationship characteristics.

Relationship quality. The Relationship Quality Index (Norton, 1983) was completed by participants as an assessment of relationship quality. The scale has five items asking about the quality of the participant's relationship using a 7-point Likert scale with anchors ranging from *"Very strongly disagree"* to *"Very strongly agree."* Higher scores on the scale represented relatively greater relationship quality. The scale demonstrated high internal consistency in the current sample ($\alpha = 0.93$).

Task appraisals. Participants completed an adapted Stressor Appraisal Scale (Schneider, 2008) to assess their appraisals (Lazarus & Folkman, 1984) of the cold pressor task both prior to the task and following the recovery period. The original scale had nine total items in a 7-point Likert-scale format, with six items asking about the participant's primary appraisal of the task (e.g. "*How stressful do you think the task will be?")*, and three related to their secondary appraisal of the task (e.g. "*How able do you think you are to cope with the task?")*. We adapted these nine original items to create nine additional items asking about the task once it was completed. Higher scores on the primary appraisal items represent a greater belief in the difficulty of a stressor, whereas higher scores on the secondary appraisal items represent more

ability to cope with the stressor. The scales evidenced good internal reliability both before and after the cold pressor task ($0.84 < \alpha s < 0.94$).

Pain. Pain was assessed using a standard 11-point (0-10) Numeric Rating Scale (Williamson & Hoggart, 2005). Participants were asked to "indicate the intensity of your current pain levels on a scale from 0 (no pain) to 10 (worst pain imaginable)" prior to the cold pressor task and following the 10 minute recovery period. A paired t-test indicated that pain increased after the task, $t = 4.09$, $p < .001$, an increase of 1.31 points.

Depressive symptoms. The Center for Epidemiologic Studies Depression Scale (CESD; Radloff, 1977) assessed participants' self-reported psychological and somatic symptoms of depression using 10 items. Higher scores on this inventory reflected endorsement of more depressive symptoms and emotional disturbance. The CESD demonstrated high internal consistencies in this sample ($\alpha = .83$).

Anxiety symptoms. The Generalized Anxiety Disorder 7-item measure (GAD-7; Spitzer, Kroenke, Williams, & Löwe, 2006) was used to assess participants' self-reported anxiety symptoms. The scale include seven items on a four point scale anchored by the frequency of anxiety symptoms, with higher scores reflecting endorsement of more frequent anxiety symptoms. The GAD-7 demonstrated high internal reliability in this sample ($\alpha = .89$).

Cardiovascular Reactivity (CVR). CVR was collected during the laboratory task using a standard laboratory equipment. Task means were created by averaging the valid measurements—the measurements taken each 45 seconds for BP, the 1 minute epochs for HR and HRV—across each task period. For the baseline task, only the last five minutes were used, whereas all valid measurements during the 4-minute cold pressor were used.

Heart Rate (HR), Heart Rate Variability (HRV), and Respiratory Rate (RR). Electrocardiograph (ECG) data was collected using a Mindware psychophysiological system (Mindware Technologies LTD) using a six lead configuration, including the right clavicle and lower left rib. Leads were also placed on the chest at the suprasternal notch and xiphoid process, as well as two leads on the spine located 1-1.5 inches above and below leads placed on the suprasternal notch and xiphoid process. All leads were connected to standard 1.5 inch adhesive electrodes using 7% Chloride wet gel (Mindware Technologies LTD). Data collection used BioLab v. 3.1.2 (Mindware Technologies LTD) and the configuration including a 500 gain for the signals. The Mindware HRV Analysis program v. 3.1.3 was used for post-processing artifact detection and cleaning of R-spikes. A Hamming function was used for windowing during post-processing. After each segment was cleaned, the number of R-spikes during each minute-long epoch were averaged across task to assess mean task HR. Respiratory sinus-arrhythmia was used as our measure of HRV and was quantified using the variance in the time series related to respiration (0.12-0.42 Hz). This is the standard method used within the Mindware HRV Analysis 3.1.3 processing software to measure parasympathetic vagal influences on cardiac function. In addition, spectral analysis of the signal was used to assess respiration rate (RR) using the Z0 respiration signal. Both HRV and RR task means were also collected in minute-long epochs during all laboratory tasks.

Blood Pressure (BP). BP was assessed using a Carescape V100 Dinamap BP collection device equipped with Critizon Dura-Cuf blood pressure cuffs. Research assistants placed the appropriate sized cuff on the participant's nondominant arm, which the participant then rested on the table in front on them during all lab tasks. The Carescape V100 Dinemap device produces systolic BP (SBP), diastolic BP (DBP), mean arterial pressure, and pulse pressure. SBP measures

the peak pressure present in the arteries during the start of the cardiac cycle, whereas DBP measures the lowest pressure during the cycle. Research assistants triggered and recorded BP values every 45 seconds during the duration of all lab tasks, beginning at the start of the task and continuing until the end of the task. BP tasks means were created by averaging valid SBP and DBP across lab tasks. No extreme, biologically implausible BP scores (scores 40 mmHg < DBP < 130 mmHg; 80 mmHg < SBP < 200 mmHg) were recorded for any participant during the course of the lab study. A small number of attempted BP recordings (2.2%) did not result in valid BP values and were excluded when calculating task means.

Data Analysis

Data analysis following the preregistered analytic plan (https://osf.io/kdt9s/) to assess the primary outcomes of interest—SBP, DBP, HR, and HRV—using multiple regression models. We ran each model independently and controlled for baseline cardiovascular activity levels. In cases of HRV, we also included respiration rate as a covariate. We tested our primary hypotheses using contrast codes first between the Partner Present (scored -1) and Mental Activation conditions (scored 1), with Control scored 0. We then created an additional contrast combining these conditions (scored 1) and comparing them to Control (scored -2). The first contrast compared Mental Activation to Partner Present and the second contrast compared Mental Activation and Partner Present to Control. We next tested relationship quality as a moderator of the association between condition and CVR. In cases where groups did not differ on the moderation effects, we collapsed across conditions. Finally, we conducted exploratory analyses to test if there were differences in participants' reported pain from during the cold pressor task by condition, as well as if participants' appraisals might mediate the CVR outcomes. We used ML estimation in MPLUS version 7.11 (Muthén & Muthén, 2012) when running all models. To

account for missing data in our models, we used full likelihood maximum likelihood (FIML) estimation the regression analyses. This method incorporates all available information from all participants with available data and produces unbiased estimates that outperform other missing data treatments, such as listwise deletion (Graham, 2009).

We also tested additional potential models to ensure our substantive results did not change based on our analytic choices. First,

Results

Table 1 displays descriptive statistics for the participants by condition, as well as the results for one-way ANOVAs testing baseline differences between the study conditions. There were no significant differences by condition for any of the demographic variables collected, and we did not include covariates in the models as a result. Including age, sex, ethnicity, weight, height, relationship length, cohabitation status, marital status, relationship quality, depressive symptoms, or anxiety symptoms as covariates did not change the substantive results of the study.

Analyses of Preregistered Hypotheses

To test the preregistered hypotheses, we first examined our main effects models to determine whether there were differences by condition in CVR. We observed no significant differences between the Partner Present and Mental Activation conditions for SBP, B = -0.06, 95% CI [-1.91, 1.79], p = .950, or DBP, B = 0.58, 95% CI [-0.87, 2.04], p = .434. However, Partner Present and Mental Activation participants had significantly lower BP reactivity compared to Control participants for both SBP, B = -1.45, 95% CI [-2.49, -0.40], p = .007, and DBP, B = -1.18, 95% CI [-2.00, -0.36], p = .005. Figure 3 illustrates the raw reactivity for each condition. Participants assigned to the Partner Present and Mental Activation conditions increased 4.41 mmHg SBP and 3.38 mmHg DBP less from baseline to the cold pressor task

compared to Control, effect sizes of d = -0.54 and -0.53, respectively. The full model results are presented in Table 2.

We observed no significant differences in HR between the Partner Present and Mental Activation conditions, B = 0.61, 95% CI [-1.11, 2.33], p = .489, nor between Partner Present and Mental activation compared to Control, B = -0.53, 95% CI [-1.52, 0.45], p = .286. Similarly, there were no significant differences in HRV between the Partner Present and Mental Activation conditions, B = 0.09, 95% CI [-0.08, 0.26], p = .287, or between Partner Present and Mental activation compared to Control, B = -0.02, 95% CI [-0.11, 0.08], p = .742. These results were essentially unchanged when excluding participants who did not complete the cold pressor task.

We next examined if relationship quality moderated the association between condition and the outcomes of interest, specifically when comparing Control participants to those in the Partner Present and Mental Activation conditions. We found no evidence for a significant Condition × Relationship Quality interaction for either HR or HRV. There was, however, a significant interaction for both SBP, B = 1.73, 95% CI [0.66, 2.81], p = .002, and DBP, B = 1.03, 95% CI [0.15, 1.90], p = .021. The interactions were not in the direction of our preregistered hypotheses; in the Control condition, higher relationship quality was associated with lower SBP and DBP reactivity, B = -3.79, 95% CI [-6.35, -1.23], p = .004, B = -2.38, 95% CI [-4.48, -0.28], p = .025, whereas there was no association for participants in the Mental Activation or Partner Present conditions, B = 1.41, 95% CI [-0.79, 3.61], p = .201, B = 0.69, 95% CI [-1.09, 2.47], p = .439. There was a significant difference between the groups for marital quality below 6.40 and 6.45 points (out of 7) for SBP and DBP on the assessment of relationship quality, which

characterized 37.3% and 52.0% of the total sample, respectively[4]. Figure 4 outlines the simple slopes of these interactions. Participants in the Control condition evidenced the lowest BP reactivity at high levels of relationship quality, such that their BP reactivity was similar to the Mental Activation and Partner Present conditions.

Exploratory Analyses

We conducted a series of exploratory analyses to determine if the observed effects were mediated by differences in appraisals of the cold pressor task. Using a mediational framework, we first assessed whether differences in primary or secondary appraisals prior to or following the task might have explained differences in BP reactivity between the three conditions. There were, however, no significant differences in primary or secondary appraisals by condition, nor did primary or secondary appraisals of the task predict SBP or DBP reactivity. Participants in the Partner Present condition had significantly lower pain ratings after the cold pressor compared to participants in the Mental Activation and Control conditions, B = -1.33, 95% CI [-2.41, -0.25], p = .016. The effect was medium in size, d = -0.57, representing a 1.33 point or 12.1% difference in pain on the 11-point scale. These effects point to a dissociation in self-report and physiology across conditions: Participants in the Partner Present condition perceived the cold pressor task to be less painful than the Mental Activation and Control participants, but evidenced similar, attenuated BP reactivity to Mental Activation participants.

Discussion

[4] It is important to note that removing an outlier in SBP, the interaction effect was no longer significant for SBP, B = 0.44, 95% CI [-0.63, 1.50], p = .422. This participant's scores were not, however, biologically implausible, and were based on several valid BP readings during both the baseline and cold pressor.

In the current study, 102 young adults in a romantic relationship were randomized to either have their partner present, draw on the mental representation of their romantic partner, or think about their day as an active control during a cold pressor task. Consistent with our preregistered hypotheses, participants in the Partner Present and Mental Activation conditions evidenced less BP reactivity from the baseline to the cold pressor task. These results replicate prior research showing that drawing on a close other can reduce BP reactivity during a stressful task (Smith et al., 2004) and extend these findings by directly comparing them to having a romantic partner physically present. Evidence that either drawing on the mental representation of a romantic partner *or* having a romantic partner physically present attenuates BP reactivity during stressful task to a similar degree provides support for the basic premises of both Attachment Theory and SBT. BP reactivity to a cold pressor predicts the development of preclinical disease states (Treiber et al., 2003); if the current findings apply outside the laboratory CVR may be a critical, health-relevant pathway linking romantic relationships to distal health outcomes. Notably, there were not significant differences by condition for HR or HRV. Previous studies have found that cardiac responses to the limb immersion cold pressor evidence greater inter-individual variability than BP related to responses in the vasculature (Mourot et al., 2009) and generally result in BP changes, rather than vagal activation (Allen et al., 1992). It is possible that high levels of intra-group variability in HR and HRV responses to the limb immersion cold pressor task masked group differences by condition.

We also found exploratory evidence that partner presence reduced the perception of pain during the cold pressor task. People whose partner was present reported 12.1% less pain during the task compared to people whose partner was not present (d = -0.57). These results match well with both SBT (Beckes & Coan, 2011) and Attachment Theory (Bowles, 1982); having a partner

present seems to reduce CVR while also reducing the pain associated with a cold, whereas mentally drawing on the working model of romantic partner buffers against CVR, but does not reduce pain. The assessments of primary and secondary appraisals of the task did not, however, differ by condition, nor did they predict people's BP reactivity during the cold pressor task. In the case of appraisals prior to the task, it is possible that participants were not aware how challenging the task would be. Alternatively, it is possible that a partners' presence differs from physical contact in its impact on CVR. Physical contact—such as the paradigms used in handholding studies (Coan et al., 2006)—is associated with reduced CVR (Grewen, Anderson, Girdler, & Light, 2010), and it is unclear how this might differ from physical presence or drawing on the working model of a romantic partner. Future work should examine the association between task appraisals and BP reactivity, as well as whether physical presence might differ from physical contact with a romantic partner.

The main effects of condition were in addition to a significant Condition × Relationship Quality interaction predicting BP reactivity. Participants in the Control condition (but not in the Partner Present and Mental Activation conditions) had a strong negative association between relationship quality and BP reactivity. Partner Present and Mental Activation participants had significantly less BP reactivity at all but the highest levels of relationship quality, and this effect was largest at the lowest levels of relationship quality. We predicted that higher relationship quality would buffer more effectively against reactivity during the stressful task, conceptually replicating previous work by Coan et al. (2006). Instead, our results suggest that having a partner present or explicitly drawing on a supportive image of a partner buffers against reactivity more effectively at all but very high levels of relationship quality. One explanation for this result is that people in very high quality relationships may derive the benefit of being in a romantic

relationship regardless of whether their partner is present or they are asked to call upon the working model of their partner.

The current study should be understood in the context of its limitations. First, the nature of the three experimental manipulations was such that people may have responded to the three prompts differently. For example, it is possible some participants in the Control condition thought about spending time with their partner as part of thinking about their day. The same is true of the Partner Present condition, who were not provided explicit instructions of what to think about. It is possible that changes to the prompts prior to the cold pressor could produce different results. Second, the current study used a sample of undergraduate students in romantic relationships. Although the sample was ethnically diverse and participants' relationship lengths averaged over a year and a half, it is possible using community members or married participants may produce different results. Third, the timing and method for assessing task appraisals might have obscured group differences. Future studies should consider more proximal measurement timing (during or immediately following stressors) or additional assessments that might complement self-report, such as fMRI, to more effectively access differences in task appraisals.

Conclusions

Relative to a control condition, participants who were randomly assigned to draw upon the mental representation of their romantic partner or have their partner physically present in the room evidenced significantly lower BP reactivity during a cold pressor task. There were no significant differences by condition for HR or HRV. The effect on BP reactivity was moderated, such that the difference in BP reactivity for these groups compared to control was larger for participants with lower relationship quality. People assigned to the Partner Present condition also had significantly lower perception of pain during the cold pressor task compared to participants

whose partner was not present. The results suggest that accessing the mental representation of a romantic partner and a partner's presence independently buffer against BP reactivity to a stressful task, but having a partner present makes this process less painful.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

Funding

The current study was supported in part by a grant provided to the first author from the Graduate and Professional Student Council at the University of Arizona (RSRCH-205FY'18).

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Table 1
Demographic Characteristics of the Sample by Condition

	Partner Present *n* = 32	Mental *n* = 35	Control *n* = 35	*f*	*p*
Age	19.38 ± 1.72	18.97 ± 1.69	18.97 ± 1.84	0.61	.547
Sex	71.9%	74.3%	80.0%	0.31	.733
Ethnicity	40.6%	45.7%	51.4%	0.39	.681
Cohabitating	14.8%	25.0%	25.8%	0.60	.549
Married	0.0%	6.3%	9.7%	1.31	.276
Relationship quality	6.55 ± 0.59	6.15 ± 0.98	6.12 ± 0.99	2.45	.091
Relationship length	18.60 ± 16.14	21.00 ± 20.83	22.03 ± 14.19	0.34	.710
Depressive symptoms	16.66 ± 4.48	18.02 ± 5.61	17.71 ± 5.14	0.65	.524
Anxiety symptoms	11.28 ± 3.74	12.71 ± 5.34	12.97 ± 4.64	1.27	.286
Baseline systolic BP	107.89 ± 9.23	106.68 ± 7.93	105.61 ± 8.82	0.58	.563
Baseline diastolic BP	61.18 ± 5.63	61.27 ± 5.53	62.07 ± 6.11	0.25	.779
Baseline HR	80.89 ± 9.16	81.80 ± 12.04	79.21 ± 11.13	0.51	.603
Baseline HRV	6.42 ± 0.80	6.31 ± 0.99	6.04 ± 1.06	0.14	.872

Note: Data are means ± standard deviations from all available data unless otherwise noted. *F* statistics and *p* values are the results of one-way ANOVAs comparing the three conditions. Sex is percentage women, ethnicity is % non-Hispanic white. BP = blood pressure, HR = heart rate, HRV = heart rate variability. Relationship length is measured in months.

Table 2
Model Results for Main Effect Model Preregistered Hypotheses

Outcome: Systolic BP	*B*	95% CI	β
Baseline systolic BP	0.97**	[0.79, 1.14]	0.74**
Contrast 1: MA to PP	-0.06	[-1.91, 1.79]	-0.00
Contrast 2: MA and PP to Control	-1.45**	[-2.49, -0.40]	-0.18**

Outcome: Diastolic BP	*B*	95% CI	β
Baseline diastolic BP	0.87**	[0.66, 1.08]	0.62**
Contrast 1: MA to PP	0.58	[-0.87, 2.04]	0.06
Contrast 2: MA and PP to Control	-1.18**	[-2.00, -0.36]	-0.21**

Outcome: HR	*B*	95% CI	β
Baseline HR	0.84**	[0.71, 0.97]	0.79**
Contrast 1: MA to PP	0.61	[-1.11, 0.33]	0.04
Contrast 2: MA and PP to Control	0.53	[-1.52, 0.45]	-0.07

Outcome: HRV	*B*	95% CI	β
Baseline HRV	0.67**	[0.53, 0.82]	0.66**
Contrast 1: MA to PP	0.09	[-0.08, 0.26]	0.08
Contrast 2: MA and PP to Control	-0.02	[-0.11, 0.08]	-0.02
Cold pressor RR	-0.06	[-0.13, 0.00]	-0.14

Note: 95% CI = 95% confidence interval. MA = mental activation, PP = partner present, BP = blood pressure, HR = heart rate, HRV = heart rate variability, RR = respiration rate.
* $p < .05$. ** $p < .01$.

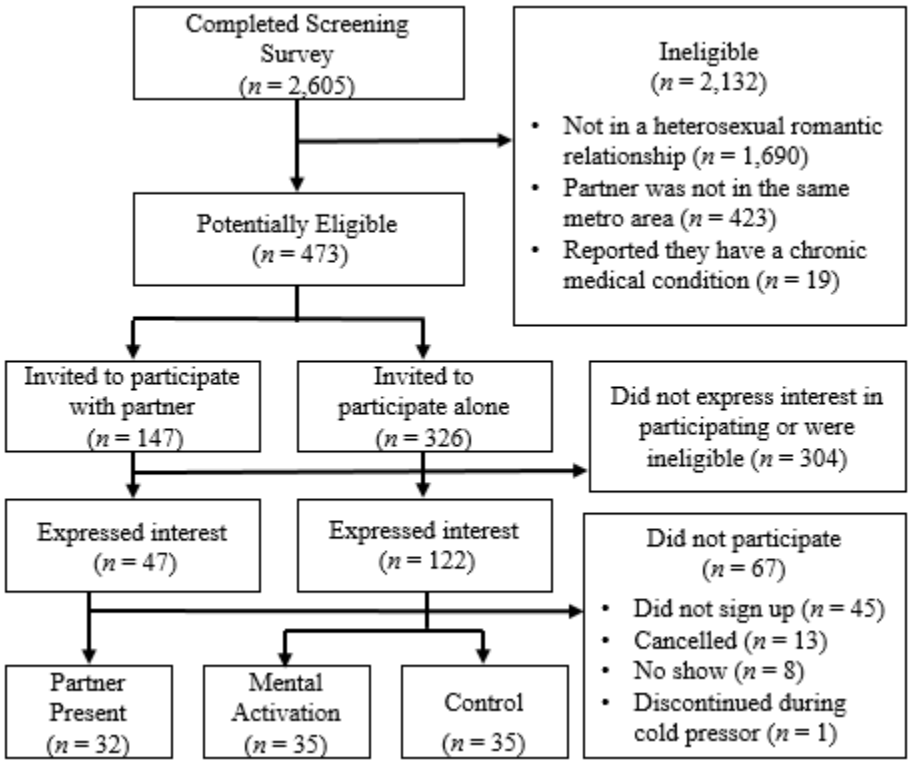

Figure 1. CONSORT diagram outlining the recruitment and randomization of the study participants.

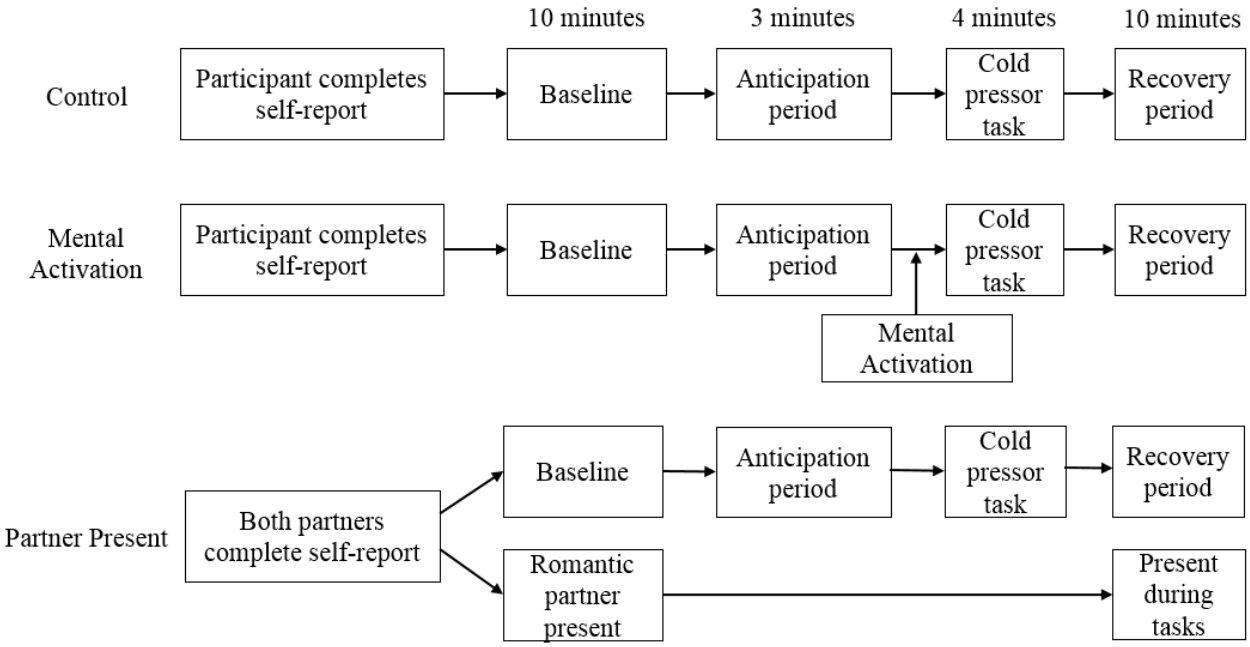

Figure 2. Outline of the study tasks by condition.

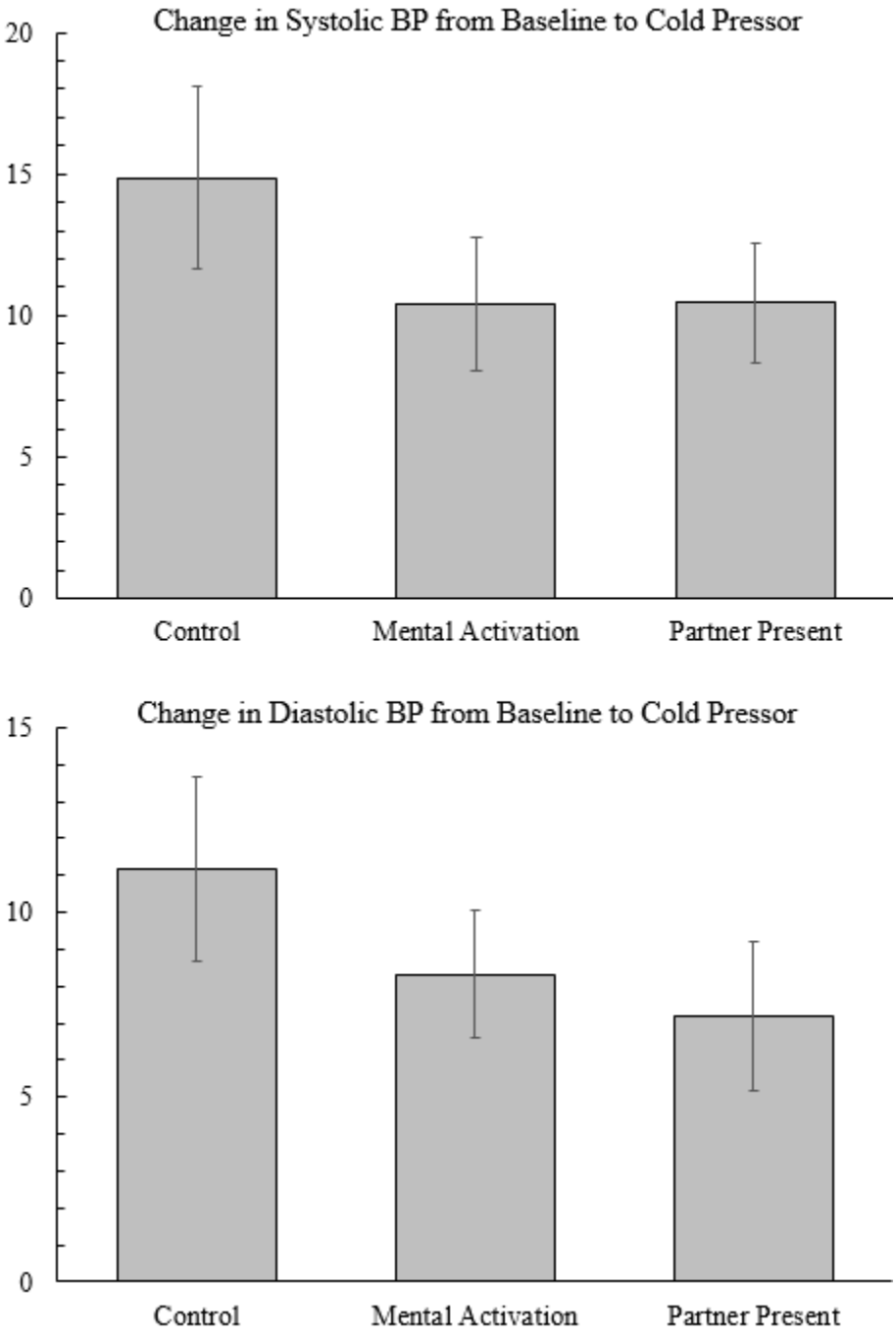

Figure 3. Raw results for systolic and diastolic blood pressure (BP) reactivity from baseline to the cold pressor task averages by condition. Bars represent 95% confidence intervals.

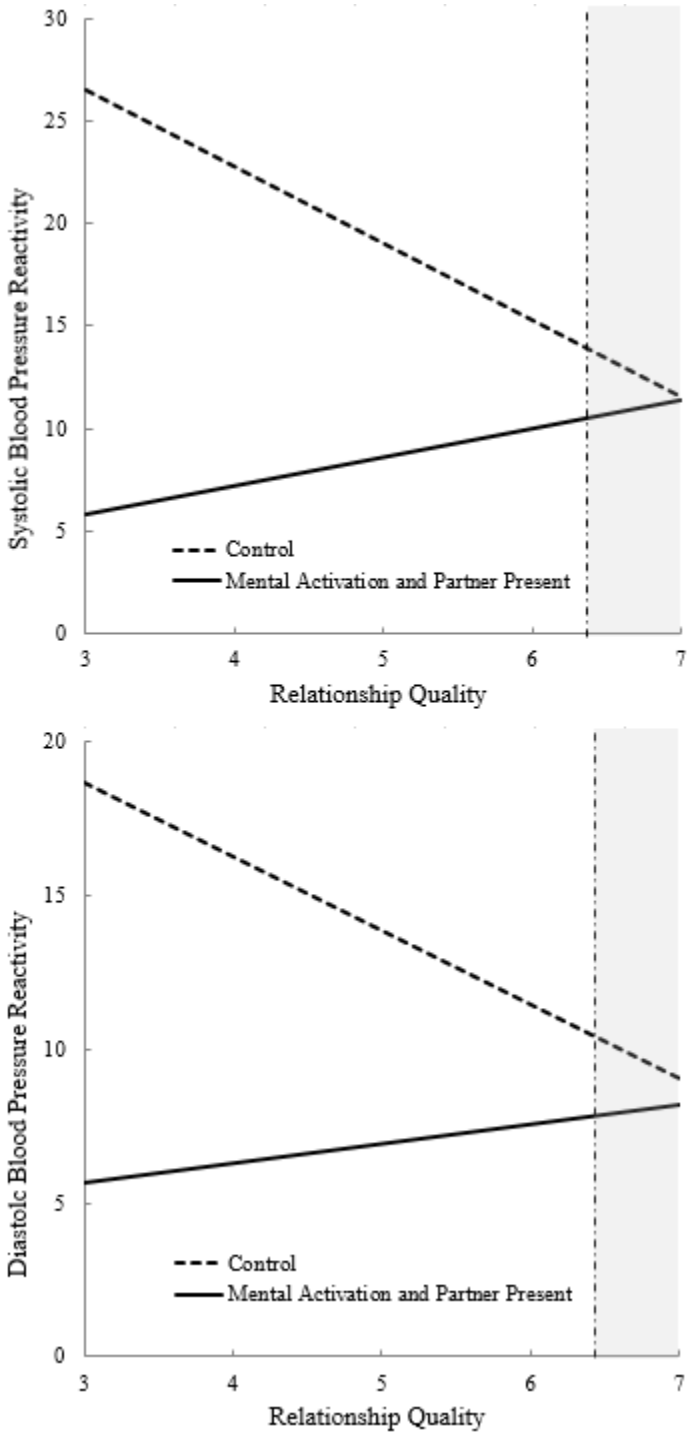

Figure 4. Decomposed simple slopes for the interaction of Relationship Quality × Condition interaction comparing Control to Mental Activation and Partner Present. The shaded area represent the area where the difference between the two groups was not significant.