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Cardiovascular indexes of threat impair responsiveness in situations of conflicting interests

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A R T I C L E I N F O

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A B S T R A C T

This research examined how situations in which self- and relationship-interests are misaligned can “get under the skin” to negatively impact cardiovascular and relationship processes. Interdependence theory was integrated with the biopsychosocial model of challenge and threat to better understand the biological processes that underlie relationship behavior in stressful circumstances. Couples engaged in a discussion in which one person (the *discloser*) revealed s/he had just gotten into her/his dream job or school and the other person (the *responder*) reacted to the news. Couples were randomly assigned to discuss living apart (self and relationship interests do not align) or together (self and relationships do align). Both responders and disclosers who discussed long-distance relationships *and* exhibited greater cardiovascular indexes of threat were behaviorally less responsive to their partners. Analyses also revealed that responders (regardless of conversation topic) who exhibited greater cardiovascular indexes of threat were less responsive. In addition to direct consequences for relationship processes and affective dynamics, these data implicate indirect pathways between relationship wellbeing and cardiovascular functioning.

1. Introduction

Individuals in relationships must carefully consider how their decisions will influence their partners. Situations in which self- and relationship-interests align are considered *correspondent* because decisions or choices that benefit the self also benefit the partner (Kelley and Thibaut, 1978). Alternatively, *noncorrespondent* situations arise when self-oriented interests clash with a partner's, and hence the relationship's, interests (Cavallo et al., 2013). Noncorrespondent situations represent a potent form of interpersonal stress where the stakes are high and responses have direct repercussions for relationship wellbeing and functioning (Rusbult and Van Lange, 2008). As we shall argue, biological responses in these situations play an important role in shaping interpersonal behavior.

The research presented here examined how seemingly positive news for one partner that conflicts with the other partner's interests may “get under the skin” to produce maladaptive physiological responses and relationship behaviors. To do so, we integrated two theories – the *biopsychosocial (BPS) model of challenge and threat* and *interdependence theory* – that have developed independently in the literature. Interdependence theory (Kelley and Thibaut, 1978; Rusbult and Van Lange, 2008) focuses on interaction processes in various situations, such as noncorrespondence. The BPS model of challenge and threat (Blascovich and Mendes, 2010) provides a mechanistic framework for understanding how appraisals of demands and resources shape physiological and behavioral responses in stressful situations. Integrating these theories allowed us to investigate the biological processes that underlie dyadic responsiveness processes.

1.1. Interdependence theory

Within *interdependence theory*, noncorrespondent situations are considered ‘diagnostic’ of the state of a relationship because partners must choose between pursuing self-interests or doing what is best for the partner and relationship (Kelley and Thibaut, 1978; Rusbult and Van Lange, 2008). Extant research has focused almost exclusively on one specific type of noncorrespondence: Conflict, and the hostile behaviors that manifest therein (e.g., Murray et al., 2006; Rusbult et al., 1991). In particular, conflict is the only type of noncorrespondence that has been examined in biologically focused studies (e.g., Gottman and Levenson, 1992). This limited focus has produced conceptual ambiguity because conflict situations conflate noncorrespondence (misalignment

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of partners' interests) with valence (negativity). However, noncorrespondence can also occur in more favorable situations that intertwine positive elements with conflict, such as when individuals have an opportunity to pursue a "dream job" away from their partners. The hostility typically associated with negative conflicts – arguments and disagreements – has been shown to produce specific physiological consequences: physiological linkage of heart rate, skin conductance level, pulse transmission time, and somatic activity (Levenson and Gottman, 1983) and larger increases in systolic blood pressure, heart rate, and cardiac output, and larger decreases in peripheral resistance and pre-ejection period (Nealey-Moore et al., 2007); however, less is known about the physiological consequences of noncorrespondence that is based on inherently more positive circumstances. In these situations, couples still must determine how to coordinate goal-directed activities in a way that does not damage the relationship (Van Lange et al., 1997).

For both partners, resolving noncorrespondence requires effort, entails uncertainty and personal cost, and compromises social coping resources (Baumeister et al., 1998; Cavallo et al., 2013; Murray et al., 2006; Reis and Arriaga, 2015). Appraising and addressing the demands and lack of social coping resources inherent in noncorrespondent situations is a dynamic, dyadic process (Kelley et al., 2003). For instance, an individual seeking to pursue her "dream job" in a distant location may feel uncertain about whether her partner will respond supportively. Her partner (the responder) must exert effort to respond constructively despite potential sacrifices and may also worry about abandonment. Appraisals of demands and resources in acute stress contexts like noncorrespondent situations directly impact cardiovascular responses, behaviors, and even downstream health outcomes (Blascovich and Mendes, 2010; Seery, 2011). However, little is known about how interpersonal, dyadic stress processes unfold within noncorrespondent situations. By integrating interdependence theory with the BPS model of challenge and threat, the research presented here seeks to elucidate how stress responses shape romantic relationship processes in vivo.

1.2. Biopsychosocial model of challenge and threat

When faced with stressful situations, appraisals of demands (e.g., perceptions of required effort, uncertainty, and danger) relative to coping resources (e.g., skills/ability, social support, and familiarity with the stressor) can directly determine downstream affective, behavioral, and physiological responses (Blascovich and Mendes, 2010; Jamieson et al., 2017). In challenge and threat theory, individuals experience approach-motivated challenge when coping resources are appraised as exceeding perceived demands. Alternatively, avoidance-motivated threat manifests when appraisals of demands outweigh resources. Notably, challenge and threat states are associated with patterns of physiological responding (for a biologically oriented review, see Mendes and Park, 2014) derived from activation of the sympathetic-adrenal-medullary (SAM) and hypothalamic-pituitary-adrenal (HPA) axes, mobilizing resources that enable individuals to respond to stressors.

Both challenge and threat responses are accompanied by SAM activation, leading to increased catecholamine levels, which increase ventricular contractility (decrease pre-ejection period and increase heart rate), constrict veins (facilitating return of blood to the heart), and dilate blood vessels (via the binding of epinephrine to beta-2 receptors, Brownley et al., 2000). Challenge-type responses, which are dominated by SAM activation, are thus characterized by increased cardiac output (CO) – the volume of blood pumped by the heart across a given period of time (usually 1 min.) – and decreased resistance in the peripheral vasculature (TPR). Challenge-type responses also allow for a rapid onset and offset of responses: resources are mobilized rapidly and individuals return to homeostasis quickly after stress offset.

In addition to activating the SAM axis, the experience of threat also strongly activates the HPA axis, which triggers the release of cortisol from the *zona fasciculata* of the adrenal glands. Given the shorter half-lives of catecholamines relative to catabolic hormones such as cortisol (e.g., a few minutes versus over an hour, respectively), HPA activation is associated with a more prolonged stress response as cortisol lingers after stress offset. Because HPA activation tempers effects of the SAM axis, a threat response results in reduced (or little change in) CO and increased TPR downstream in the cardiovascular system (for reviews see Blascovich and Mendes, 2010; Seery, 2011).

Behaviorally, the physiological responses characteristic of challenge result in approach motivated behaviors, whereas threat promotes avoidance behaviors (Beltzer et al., 2014; Jamieson et al., 2013). For instance, research from the risk decision literature demonstrates that cardiovascular responses associated with challenge predict increased risk taking and more behavioral displays of anger, whereas threat responses predict more cautious decisions and behavioral displays of anxiety in adults (Jamieson et al., 2013).

How might these biological processes unfold during couples' interactions? The increased demands and lack of resources associated with noncorrespondent situations are hypothesized to promote threat-like affective states and corresponding physiological and motivational responses, and direct behavioral responses. That is, physiological responses diagnostic of challenge and threat not only have consequences for performance and decision outcomes (e.g., Blascovich et al., 1999; Jamieson et al., 2013; Jamieson et al., 2012), but also directly inform approach and avoidance behaviors in interpersonal contexts (e.g., Mendes and Koslov, 2013; Peters and Jamieson, 2016). To illustrate, interacting with a stigmatized partner elicited threat responses, which then lead to effortful overcorrections of positive behaviors enacted toward the partner (Mendes and Koslov, 2013). More directly related to relationship contexts, recent work has demonstrated that when one person suppressed (vs. expressed) affective displays, coders rated the suppressor as less responsive, both partners elicited stronger threat responses, and couples exhibited reduced intimacy behavior in a later task (Peters and Jamieson, 2016).

An integral part of constructive responses to partners in noncorrespondent situations is to be *responsive*—understanding, validating, and caring (Reis and Shaver, 1988). Responsiveness is generally inhibited during hostile conflict, but it also has been shown to influence partners' emotional outcomes when one of them receives good news (Gable et al., 2012). When experiencing threat, even in the face of good news, partners may be less able to reply responsively. Moreover, assessing threat with physiological measures has the important advantage of circumventing biases associated with self-reports (e.g., Blascovich and Mendes, 2010). Thus, when faced with a noncorrespondent situation, individuals who perceive that demands outweigh their coping resources (i.e., a threat state) should be less likely to engage in approach motivated, constructive relationship behavior: responsiveness (c.f., Neff and Karney, 2017).

1.3. Current research

The current research integrated interdependence theory with the BPS model of challenge and threat to help explicate the role of dyadic affective processes in relationship wellbeing and functioning (Rusbult and Van Lange, 2008). Our central hypothesis is that exhibiting physiological threat will impede responsive behavior, and this effect will be exacerbated when faced with a noncorrespondent (vs. correspondent) situation. Identifying physiological indicators of responsiveness in the absence of hostile conflict is an important area of inquiry given that the lack of responsiveness during noncorrespondent situations has been shown to thwart future attempts to be supportive and open, thereby contributing to relationship deterioration (e.g., Wieselquist et al., 1999).

To disentangle hostility and noncorrespondence, we created a novel paradigm in which one partner (the *discloser*) received hypothetical good news (offered her/his dream job or accepted into her/his dream graduate program) and would discuss this news with her/his partner (the *responder*). The extent to which the good news corresponded with relationship outcomes was then experimentally manipulated. In the *correspondent* condition, couples were told that they could live together as disclosers began their new job/graduate program. In the *noncorrespondent* condition, couples were told that they could not live together and instead would endure a long-distance relationship. By combining both positive news and conflicting interests, this novel paradigm provides a more discriminating test of the effect of noncorrespondence on romantic relationships.

Primary hypotheses centered on the effects of noncorrespondence on physiological responses indicative of threat and, in turn, the effects of physiological threat on behaviorally coded responsiveness. First, we expected that, on average, couples assigned to the noncorrespondent (vs. correspondent) condition would exhibit greater physiological responses indicative of threat. Second, we suspected that greater physiological responses consistent with threat would be associated with less approach-oriented, responsive behavior. More pointedly, we expected the negative association between threat and responsiveness to be exacerbated for individuals in the noncorrespondent (vs. correspondent) condition.

Second, we hypothesized a parallel effect of role. Similar to how we hypothesized the noncorrespondent situation to be more demanding than the correspondent situation, the responder role was expected to be more demanding than the discloser role based on past research (Burnette et al., 2014; Gable et al., 2012). Thus, conversation role was also expected to moderate the relationship between physiological threat and responsiveness: The combination of being in the responder role *and* exhibiting physiological threat responses was predicted to be associated with less responsive behavior.

2. Method

2.1. Sample size estimation

A series of Monte Carlo simulations were conducted with equality constraints for the paths modeling effects of each dyad (Mehl and Conner, 2012) using past dyadic datasets with similar physiological measures to approximate effects (Peters and Jamieson, 2016; Peters et al., 2014). Focusing on hypothesized interaction effects with an estimated small-to-medium effect size ($r \sim 0.20$), 105 dyads were needed to achieve sufficient power (> 0.80).[1]

2.2. Participants

Two-hundred and twenty-four (224) participants in 112 dyads were recruited. After data collection, seven dyads revealed they were not actually involved in a romantic relationship and were excluded from analyses, resulting in a final sample of 210 participants (108 females, 102 males; 108 White, 59 Asian, 14 Hispanic, 18 Black, 11 mixed/other; $M_{\text{age}} = 20.17$, $SD = 1.27$, range = 18–25) in 105 dyads (102 heterosexual; Relationship length: $M = 14.04$ months, $SD = 12.04$, range = 3–61). Seven participants were excluded from analyses of self-report measures for responding incorrectly to an attentiveness question (Maniaci and Rogge, 2014).

Participants were recruited via an online study pool (SONA) and posted flyers. Upon arrival, participants were pre-screened and excluded for physician-diagnosed hypertension, the presence of a cardiac pacemaker, or medications with hemodynamic side effects. Participants were compensated $10 or 2-h of course extra credit for participation.

2.3. Procedure

All procedures were performed in accordance with ethical standards. Couples were escorted to individual, private testing rooms where they provided informed consent, and completed initial questionnaires. As part of these questionnaires, we asked participants, "*Hypothetically, what is your dream job? Or, if you are planning to continue going to school after your undergraduate career, what would be your dream school to get in to?*" Experimenters then affixed physiological sensors and participants relaxed quietly for a 5-min autonomic baseline recording. Participants remained separated in their private testing rooms and were told they were about to discuss a hypothetical event with their romantic partner. One person was randomly assigned to be the *discloser* of good news: Experimenters incorporated the participants' answers from the initial questionnaire and indicated to disclosers they had been hypothetically hired for their "dream" job or accepted into their "dream" graduate program. The other members of the romantic dyads—the *responders*—were informed that their partners received this good news.

After role assignment, we implemented a manipulation of the conversation context. In the *noncorrespondent* condition, couples were told to imagine having to live apart from their partners and endure a long-distance relationship. The news was noncorrespondent for disclosers because the pursuit of their dream job (i.e., self-directed goal) conflicted with their relationship-directed goal. The news was also noncorrespondent for responders who would have to endure a long-distance relationship so that their partners could pursue their dream jobs. In the *correspondent* condition, couples were told to imagine they could live together, with the news being positive for disclosers, responders, and the relationship. Participants were explicitly asked to discuss how this news would make each of them feel and how the news would impact their relationship in the short-term and the long-term (see Supplementary online materials, SOM, for full manipulation instructions).

After receiving manipulation instructions, disclosers and responders remained in their private testing rooms for an anticipatory period during which they were given three minutes to "gather their thoughts" to prepare for the conversation. A set of double doors that separated the two private testing rooms was opened to create one, large dyad room when the preparation period ended. Couples then engaged in a conversation for 5-min.

2.4. Measures

2.4.1. Demand appraisals

Perceived task demands were assessed after the conversation to help ensure that the noncorrespondent condition was experienced as more demanding than the correspondent condition. To do so, participants rated the extent to which they agreed with the following statement, "*The task was very demanding*" (1 = strongly disagree, 4 = neutral, 7 = strongly agree).

2.4.2. Cardiovascular reactivity measures

As is standard in laboratory paradigms examining autonomic responses to stressful social situations, reactivity scores were computed by subtracting scores taken during the last minute of baseline (i.e., the most relaxed period) from those collected during the first minute of target tasks (i.e., the most reactive period; see Llabre et al., 1991, for psychometric justification of the use of change scores in psychophysiology; see Jamieson et al., 2012; Peters and Jamieson, 2016, for examples using this approach in BPS research). Raw baseline scores were also tested for condition differences that could interfere with reactivity analyses, and no baseline differences were observed (raw means and *SDs* are presented in Table S1 of the SOM).

[1] A new tool is currently in development to estimate power for the Actor-Partner Interdependence Model (https://robert-ackerman.shinyapps.io/APIMPowerR/). However, this tool is limited to indistinguishable dyads and main effects. As an exploratory exercise, we used this tool to compute power for the effects obtained in the current research and the results suggested we only needed 98 couples to achieve a power of 0.80.

2.4.2.1. PEP reactivity. Pre-ejection period (PEP) is a measure of sympathetic arousal. PEP indexes the contractile force of the heart by measuring the time from the initiation of left ventricle contraction to aortic valve opening. Shorter PEP intervals indicate greater sympathetic activation. Both challenge and threat responses are accompanied by decreases in pre-ejection period relative to baseline. Thus, the first step in assessing cardiovascular markers of challenge and threat is to ensure that participants exhibited increased sympathetic arousal (i.e., reduced PEP interval) from baseline to the anticipation period and the conversation task (see Results).

2.4.2.2. Threat reactivity index. We then computed a threat reactivity index. This index combined two cardiovascular measures that, in conjunction, allow distinction between challenge and threat: cardiac output (CO) and total peripheral resistance (TPR). Cardiac output is the amount of blood ejected from the heart during a minute and is calculated by multiplying stroke volume (the amount of blood ejected per beat) by heart rate. Decreases in CO indicate worsened cardiac efficiency, and are typically observed in threat states (note that threat is also associated with "little or no change" in CO; Jamieson et al., 2012). TPR is a measure of overall vascular resistance. When threatened, vascular resistance increases, limiting blood flow to the periphery. TPR was calculated with the following validated formula: TPR = (MAP / CO) ∗ 80 (Sherwood et al., 1990). TPR and CO reactivity scores were standardized (*Z*-scores) with CO reverse-scored. These standardized reactivity scores were then summed to form a challenge and threat reactivity index (henceforth referred to as "threat reactivity index"), such that higher scores indicated greater threat (for an identical approach, see Blascovich et al., 2004; Hangen et al., 2017; see Table S1 in SOM for means and *SD*s).

2.4.2.3. Physiological acquisition. To obtain the cardiovascular measures of PEP reactivity and threat reactivity index, the following signals were collected during baseline, preparation for the conversation, and conversation periods: electrocardiography (ECG), impedance cardiography (ICG), and blood pressure (BP). ECG and ICG signals were collected at 1000 Hz, and integrated with a MP150 system (Biopac Systems Inc., Goleta, CA). ECG sensors were placed in a Lead II configuration. Cardiac impedance hardware (NICO100C, Biopac Systems, Inc.) with band sensors was used to measure impedance magnitude (Zo) and its derivative (dZ/dt). BP readings were obtained using a Colin7000 medical system (Colin Medical Instruments, San Antonio, TX). Cuffs were placed on participants' non-dominant arm to measure pressure derived from the brachial artery. Recordings were taken at 2-min intervals during each epoch and initiated from a separate control room. The BP system recorded systolic and diastolic pressure (SBP and DBP), and mean arterial pressure (MAP). This system and method has been used previously in psychophysiological research (Peters and Jamieson, 2016; Peters et al., 2014).

ECG and ICG signals were scored offline by trained personnel. First, signals were visually examined for artifacts, and ensemble averages were analyzed using Mindware software (IMP v3.0.21; Mindware Technologies, Gahanna, OH). One-minute segments were analyzed. B-points in the dZ/dt wave (opening of aortic valve) were calculated using the maximum slope change method. Q-Points in the ECG wave (start of left ventricle contraction) were also computed using the maximum slope method. R-points in the ECG wave (left ventricle contraction) were detected by Mindware software. Trained coders blind to condition assignment visually examined all B, Q, and R points and manually corrected erroneous placements when necessary.

2.4.3. Responsive behavior

Two coders blind to condition assignment and hypotheses independently coded behaviors of disclosers and responders during the conversation. Responsive behavior (i.e., overt behavior that demonstrates understanding, validating, and caring of the other; Reis and Shaver, 1988) was coded using an adapted form of an established scheme (Maisel et al., 2008; see SOM, Appendix A, for the full coding scheme). Coders rated the extent to which participants "*understood their partner*" (e.g., demonstrated comprehension, clarified partner's thoughts and feelings, listened attentively), "*validated their partner*" (e.g., agreed with partner, acknowledged partner's thoughts and feelings, expressed respect), and "*demonstrated caring*" (e.g., expressed warmth, conveyed support, emphasized the relationship, and conveyed shared experience) on 7-point scales (1 = low, 4 = moderate, 7 = high). As is standard with research using this coding scheme, understanding, validating, and caring codes were combined (intraclass correlations: understanding = 0.75, validating = 0.75, caring = 0.77) to create a responsiveness composite (Cronbach's α = 0.88).

3. Results

3.1. Data analytic plan

To account for statistical dependence in dyadic data, we followed guidelines established by Kenny et al. (2006) and analyzed dyadic models using the MIXED procedure in SPSS, version 24. Dyads were distinguished by sex; members of same-sex couples (3 dyads) were randomly assigned on the distinguishing variable. We tested our hypotheses by regressing scores on (a) a contrast code that indexed Condition (−1 = correspondent, 1 = noncorrespondent), (b) a contrast code that indexed Role in the conversation (−1 = disclosers, 1 = responders), (c) the Condition × Role interaction, and (d) a contrast code that indexed participants' sex (−1 female, 1 male) and associated interactions with condition and role.

To test our hypotheses that individuals in the noncorrespondent condition or in the responder role exhibiting greater (vs. lesser) threat in the conversation would be less responsive, we added to the model: 1) *individuals'* own grand-mean centered scores of threat reactivity during the first minute of the conversation, and associated interactions with Condition and Role (to assess actor effects); and (2) *partners'* grand-mean centered scores of physiological reactivity, and associated interactions with Condition and Role (to assess partner effects).

Although we did not hypothesize sex differences a priori, previous research suggested the possibility that biological sex might impact cognitive and physiological responses (e.g., Hyde et al., 1990; Kirschbaum et al., 1999; Neff and Karney, 2005). However, sex did not moderate any predicted findings.

3.2. Demand appraisals

Individuals in the noncorrespondent (vs. correspondent) condition rated the conversation as more demanding, $B = 0.50$, $t = 4.02$, $p < 0.001$, $r = 0.37$, 95% CI [0.25, 0.74] (see Table S2 in SOM).

3.3. Cardiovascular reactivity

3.3.1. Anticipation of conversation

3.3.1.1. Pre-ejection period (PEP). As expected, *all* participants (regardless or role or condition) exhibited increased sympathetic arousal (PEP reactivity < 0) in anticipation of the conversation compared to baseline, $B = -4.57$, $t = -9.52$, $p < 0.001$, $r = 0.70$, 95% CI [−5.52, −3.62] (see Table S3 in SOM). Analyses also revealed a main effect of role, $B = -0.98$, $t = -2.11$, $p = 0.037$, $r = 0.21$, 95% CI [−1.91, −0.06], such that responders exhibited greater decreases in PEP than disclosers.

3.3.1.2. Threat reactivity index. Supporting predictions, a significant main effect of condition emerged for threat reactivity, $B = 0.36$, $t = 2.76$, $p = 0.007$, $r = 0.27$, 95% CI [0.10, 0.62] (see Table S4 in SOM). When anticipating the conversation, individuals assigned to the noncorrespondent condition (regardless of role) exhibited physiological responses consistent with greater threat than those assigned to the correspondent condition.

3.3.2. Conversation

3.3.2.1. Pre-ejection period (PEP). As expected, all participants exhibited increased sympathetic activation during the conversation relative to baseline, $B = -9.87$, $t = -15.77$, $p < 0.001$, $r = 0.85$, 95% CI [−11.12, −8.63] (see Table S5 in SOM). Thus, participants were engaged and sympathetically aroused during the conversation.

3.3.2.2. Threat reactivity index. In support of the hypothesis that the responder role is more demanding than the discloser role (Burnette et al., 2014; Gable et al., 2012), analyses revealed a Role main effect, $B = 0.32$, $t = 2.29$, $p = 0.024$, $r = 0.23$, 95% CI [0.04, 0.59] (see Table S6 in SOM). Responders were more threatened than disclosers during the conversation. There was no main effect of condition or its interaction with role.

3.4. Responsive behavior

We first tested for relations between Condition and Role on responsiveness. Across conditions, responders were rated as more responsive than disclosers, $B = 0.19$, $t = 2.54$, $p = 0.013$, $r = 0.26$, 95% CI [0.04, 0.35], which reflected their primary role to be responsive to the news they received from disclosers in the conversation (see Table S7 in SOM).

We then tested our central hypotheses—individuals in the noncorrespondent condition *or* in the responder role exhibiting physiological responses indicative of threat would engage in less responsive behavior (see Table 1). Supporting predictions, analyses revealed a significant Condition × Actor threat reactivity interaction, $B = -0.13$, $t = -2.36$, $p = 0.020$, $r = 0.22$, 95% CI [−0.23, −0.02] (Fig. 1). Individuals assigned to the noncorrespondent condition who were more (vs. less) threatened were, indeed, less responsive, $B = -0.17$, $t = -2.40$, $p = 0.018$, $r = 0.22$, 95% CI [−0.31, −0.03]. In contrast, individuals assigned to the correspondent condition did not differ significantly in their responsiveness behavior as a function of physiological reactivity, $B = 0.08$, $t = 1.02$, $p > 0.250$, $r = 0.10$, 95% CI [−0.08, 0.24].

A significant Role × *Actor* threat reactivity interaction was also observed, $B = -0.11$, $t = -2.07$, $p = 0.040$, $r = 0.19$, 95% CI [−0.21, −0.01] (see Fig. 2). In line with predictions, simple effects tests revealed a marginally significant effect such that responders exhibiting greater (vs. lesser) threat were less responsive, $B = -0.15$, $t = -1.94$, $p = 0.055$, $r = 0.19$, 95% CI [−0.31, < 0.01]. Disclosers, however, did not differ significantly in responsiveness as a function of threat responses, $B = 0.07$, $t = 0.93$, $p > 0.250$, $r = 0.09$, 95% CI [−0.07, 0.20].[2]

Table 1
Effects of condition (correspondent vs. noncorrespondent), role (disclosers vs. responders), and actor's and partner's threat reactivity index on responsive behavior.

	B	t	r	95% CI
Condition	−0.04	−0.42	0.05	−0.24, 0.16
Role	**0.23**	**2.42***	**0.30**	**0.04, 0.42**
Condition × role	0.11	1.19	0.15	−0.08, 0.30
Actor effects				
Actor threat	−0.04	−0.84	0.09	−0.15, 0.06
Actor threat × condition	**−0.13**	**−2.36***	**0.22**	**−0.23, −0.02**
Actor threat × role	**−0.11**	**−2.07***	**0.19**	**−0.21, −0.01**
Actor threat × condition × role	−0.02	−0.46	0.04	−0.13, 0.08
Partner effects				
Partner threat	−0.01	−0.07	0.01	−0.11, 0.10
Partner threat × condition	−0.03	−0.55	0.05	−0.14, 0.08
Partner threat × role	−0.01	−0.22	0.02	−0.12, 0.10
Partner threat × condition × role	0.10	1.87†	0.17	−0.01, 0.21

Note. Condition was contrast coded −1 correspondent, 1 noncorrespondent. Role was contrast coded −1 discloser, 1 responder. Values in bold indicate a significant effect. The threat reactivity index was calculated by summing standardized total peripheral resistance (TPR) and cardiac output (CO) conversation reactivity scores such that higher scores indicate greater threat.

† $p < 0.10$.

* $p < 0.05$.

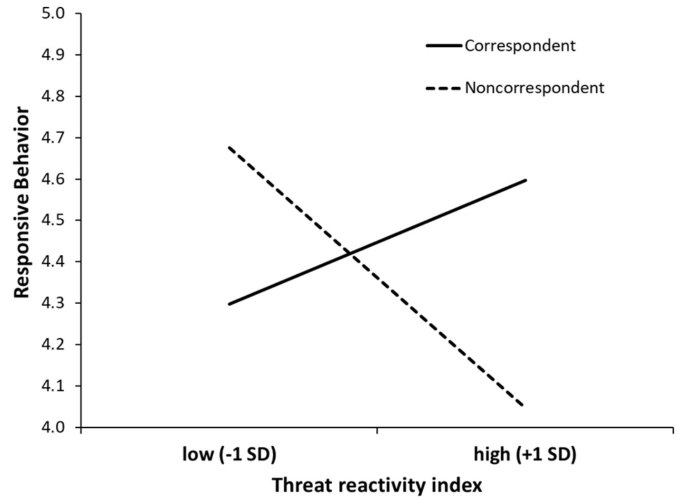

Fig. 1. Behavioral ratings of responsiveness by threat reactivity index and condition.
Note. The threat reactivity index was calculated by summing standardized total peripheral resistance (TPR) and cardiac output (CO) conversation reactivity scores such that higher scores indicate greater threat.

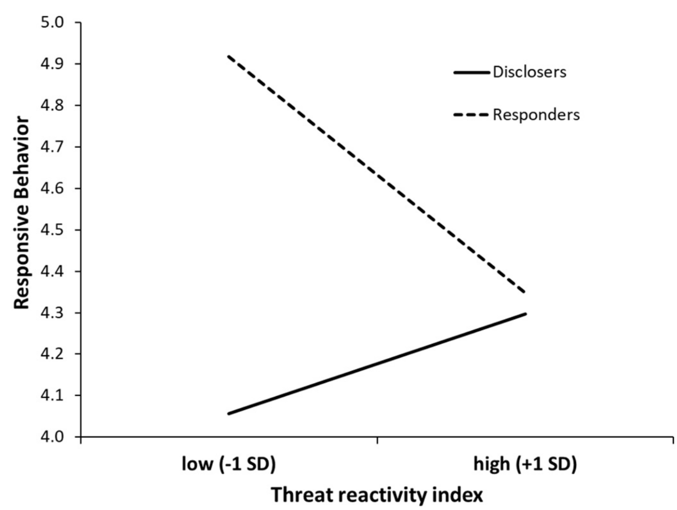

Fig. 2. Behavioral ratings of responsiveness by threat reactivity index and conversation role.
Note. The threat reactivity index was calculated by summing standardized total peripheral resistance (TPR) and cardiac output (CO) conversation reactivity scores such that higher scores indicate greater threat.

4. Discussion

This study integrated the BPS model of challenge and threat with interdependence theory to elucidate the physiological processes underlying relationship partners' responses to noncorrespondent situations. This novel integration directly informed our central hypothesis: That the experience of threat, assessed via cardiovascular reactivity,

[2] Analyses focused on reactivity scores that were calculated by taking the first minute of the conversation (the most reactive minute) minus the last minute of baseline (most relaxed minute). Analyses were also conducted on reactivity scores that used a 5-minute average of conversation cardiovascular reactivity. The pattern of results did not change.

would impede responsive behavior in noncorrespondent situations. Supporting this prediction, individuals assigned to the noncorrespondent condition who exhibited greater (vs. lesser) cardiovascular markers of threat were less responsive (Fig. 1). Similarly, individuals in the responder role who exhibited greater threat responses displayed less responsive behaviors (Fig. 2). Together, these results indicate that during situations in which partners would presumably benefit from sharing each other's good news, threat may undermine the ability to be responsive, linking responses in noncorrespondent situations to relationship and cardiovascular functioning.

The research reported here also informs dynamical models of emotion regulation. A central tenet of Gross's *extended process model of emotion regulation* (Gross, 2015) is that emotions and emotion regulatory processes are embedded in an interactive context. We created a novel paradigm in which the noncorrespondent situation was not inherently negative (e.g., a hostile conflict), but instead intertwined positive news with potentially conflicting interests. This explicit good news afforded couples the opportunity to be relatively more flexible in what they focused on during the discussion. Accordingly, individuals' behaviors were not driven solely by the situation, but also by their challenge and threat responses (Jamieson et al., 2017). That is, simply being placed in a stressful position (i.e., noncorrespondent situation or responder role) was not sufficient to impair responsive behavior, but rather it was the combination of a stressful position and threat-type physiological responses (appraised demands exceeding resources to cope) that attenuated responsiveness. The current research underscores the importance of considering social-contextual factors in conjunction with individuals' responses, ideas at the heart of interdependence theory and dynamical models of emotion regulation (Gross, 2015; Kelley and Thibaut, 1978).

These findings also have implications for theories of emotion co-regulation. Interdependent dyads such as romantic relationships form a regulatory *system* in which individuals' affective responses can depend on or spread to their partners (Butler and Randall, 2012; Sbarra and Hazan, 2008; Waters et al., 2014). Dependence is particularly salient in noncorrespondent situations, where partners' lack of responsiveness can be diagnostic of the state of the relationship. Indeed, individuals who perceive their partners to be less responsive in noncorrespondent situations may be less likely to trust that their partners will be there for them in future situations (Simpson, 2007). This waning trust makes individuals less likely to go to their partners during times of need, which is critical for fostering commitment (Rusbult et al., 2006). In turn, individuals who are less committed are less likely to be responsive, as they do not have a vested interest in making sure their partners' needs are met (Reis and Clark, 2013). In this way, a partner's lack of responsiveness can spread to oneself. Long-term, this iterative process can cause relationships to deteriorate (Murray and Holmes, 2011; Wieselquist et al., 1999).

Just as a lack of responsiveness can spread between partners, so too can physiological responses (i.e., *physiological synchrony*; Palumbo et al., 2017). Physiological synchrony has been used as a proxy for affect contagion (Waters et al., 2014), which is theorized to promote social connection and coordination (Butler, 2011; Hatfield et al., 1994). However, an open question in synchrony research is how physiological responses in one person actually spread to the other and facilitate this coordination. The current research suggests that one behavioral mechanism of physiological synchrony may be responsive behavior: If individuals are less responsive when threatened, their partners may notice their lack of responsiveness, appraise relatively fewer social coping resources (e.g., less trust and commitment), and exhibit threat responses themselves. In support of this argument, research has demonstrated that negative communication behaviors (i.e., demand/withdraw behaviors) increase physiological synchrony (Reed et al., 2013). Greater physiological synchrony in a negative context has been shown to reduce relationship satisfaction (Levenson and Gottman, 1983). Thus, responsiveness, which has served as a core principle in the field of relationships (Reis and Clark, 2013), may be a fundamental way in which individuals' physiological and affective responses spread to and depend on partners.

4.1. Limitations and future directions

To maximize experimental control, couples conversed about a hypothetical situation rather than a situation unique to their relationship. Although hypothetical, this situation had substantial “real-world” relevance for our undergraduate sample nearing graduation and looking for jobs or applying to graduate schools. In fact, the hypothetical life-altering event discussion used here may be one of the strongest noncorrespondent situations for couples in the population we sampled from. Thus, effects observed here may not generalize to other, less potent noncorrespondent situations. Moreover, the noncorrespondent situation couples faced in the current study was potentially asymmetric in terms of individuals' sacrifices: Responders may have perceived they were giving up more than disclosers (i.e., live apart *and* not pursue their own dream jobs), leading to greater threat and less responsive behavior. It may be the interaction of feeling threatened and having to sacrifice more that is driving the lack of responsive behavior. Along these lines, future research might examine the interaction between physiological responses and situational factors such as strength of noncorrespondence and the degree of sacrifice for each couple member (e.g., deciding where to go out to eat for dinner, choosing which family to visit for the holidays).

Although the current study is the first of which we are aware to demonstrate that physiological responses indicative of threat may impede responsive behavior in noncorrespondent situations, results do not provide causal evidence of this pathway. An interesting avenue for future research would include manipulating physiological processes via beta-adrenergic blocking agents (i.e., beta-blockers). Beta-blockers inhibit the sympathetic nervous system by binding to beta receptors, blocking the receptor sites normally used by epinephrine and norepinephrine to elicit a sympathetic response. Accordingly, beta-blockers have been used to treat hypertension, as less sympathetic arousal can slow down the heart, dilate vasculature, and decrease the contractile force of the heart (e.g., Bradley et al., 2006). Thus, if physiological threat responses (e.g., constriction of peripheral vasculature) are leading to less responsive behavior, then the introduction of a beta-blocker may prevent the attenuation of responsive behavior.

The majority of the current sample included couples who had been dating for little over a year. It is possible that the threat experienced by individuals in the noncorrespondent condition or responder role might be prominent in the context of younger relationships when relational uncertainty is high. On the other hand, threat may be similarly or more intensely experienced when high levels of commitment and investment increase the stakes of interdependence and exacerbate the costs of noncorrespondence. Examining effects of threat on responsiveness in more established and more highly interdependent couples is an interesting avenue for future research.

5. Conclusion

Noncorrespondent situations have been theorized to threaten relationship wellbeing and health (Rusbult and Van Lange, 2008). The research reported here integrated challenge and threat theory with interdependence theory to understand how physiological indicators of threat informed responsive behaviors in noncorrespondent situations. Moreover, this research is the first study of which we are aware to examine affective and physiological processes in a noncorrespondent situation that is not uniformly negative, but instead intertwines positive news with conflicting interests. By demonstrating that threat attenuated responsiveness, this research implicates a potential pathway for how relationship processes can affect the wellbeing and cardiovascular responses of couples. For individuals exhibiting signs of threat, even good news for one person can have negative effects on cardiovascular and relationship processes.

More broadly, this research exemplifies the benefits of an integrative approach to psychological science – advancing research by synthesizing and consolidating existing models. Future integrations of relationship and affective science models have the potential to provide a more holistic and dynamic picture of how these processes unfold in everyday life.

Disclosure statement

Authors have nothing to disclose.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijpsycho.2017.12.005.

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