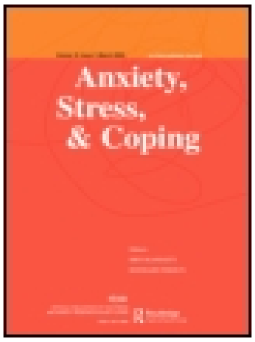

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Couples' co-regulation dynamics as a function of perceived partner dyadic coping

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ABSTRACT

Background and objectives: Perceptions of partners' dyadic coping (DC) behaviors are associated with lower stress and higher relationship well-being. Albeit well-documented, these associations have predominately relied on cross-sectional data, overlooking temporal associations during conversations of mutual stress. Based on the systemic transactional model of DC [Bodenmann, G. (2005). Dyadic coping and its significance for marital functioning. In T. Revenson, K. Kayser, & G. Bodenmann (Eds.), *Couples coping with stress: Emerging perspectives on dyadic coping* (pp. 33–50). American Psychological Association.], we hypothesized that co-regulatory dynamics would be displayed for couples who generally perceive high positive DC, whereas co-dysregulatory dynamics would be displayed for couples who generally perceive high negative DC.
Design and methods: Using video-prompted second-by-second recall of stress experience from 42 different-gender romantic couples, this study examined whether couples' co-regulation dynamics were moderated by perceived partner DC behaviors, measured at baseline.
Results: On average, partners' stress ratings were coupled; females tended to coregulate males' stress and both partners' stress dampened over time. Perceived negative DC moderated the coregulation of stress, suggesting that females unidirectionally coregulated males' stress when (1) negative DC was low in both partners and (2) when females reported lower negative DC than males. However, coregulation did not occur when (1) negative DC was high in both partners and (2) females reported higher negative DC than males.
Conclusions: Implications for utilizing methods sensitive to temporal interpersonal emotion dynamics are presented.

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Co-regulation; dyadic coping; mutual stress; coupled-oscillator model; romantic couples

Stress in romantic relationships is inevitable (Randall & Bodenmann, 2017). However, partners can mitigate stressful experiences by providing empathy or problem-focused dyadic coping (DC). Despite the robust associations between positive DC on lower reports of stress and higher relationship satisfaction (Falconier et al., 2015), little is known about how general attributes of partners' engagement in DC may impact partners' experiences of stress during conversational dynamics. Indeed, a majority of research examining these associations have relied on cross-sectional data, which leaves a dearth of understanding of how general attributes of partners' DC may be associated with couples' interpersonal emotion dynamics during conversations of mutual stress (see Kuhn et al., 2017; Lau et al., 2019, for notable exceptions).

The study of couples' interpersonal emotion dynamics has gained increased attention and researchers have clarified its definition and measurement, particularly how partners may help to

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stabilize (or destabilize) each other's experiences during times of distress (e.g., Butler, 2011; Butler & Randall, 2013; Randall & Schoebi, 2018; Sbarra & Hazan, 2008). *Co-regulation* and *co-dysregulation* are two important concepts that categorize the interdependence of partners' interpersonal emotions. *Co-regulation* is defined as the bidirectional coupling (i.e., oscillatory patterns begin to move in-phase) of partners' emotions that entails dampening of partners' emotional experiences (Butler & Randall, 2013). Conversely, *co-dysregulation* is defined as the bidirectional coupling of partners' emotions that entails amplification of partners' emotional experiences, moving partners away from their emotional homeostatic set point (Reed et al., 2015).

Studying partners' co-regulation dynamics requires the "use of dyadic interaction tasks that are salient enough to both partners to perturb their emotional system adequately to require regulation in the first place" (Reed et al., 2015, p. 56). Importantly, however, discrepancies between partners' attributes (e.g., physical, behavioral, cognitive, and/or emotional) may impact how and what co-regulatory patterns may result from these interaction tasks. For example, Reed et al. (2015) examined whether physical/behavioral attributes (i.e., body mass index; BMI) contributed to different-sex partners' emotional patterns. Results showed that discrepancies in partners' body weight (e.g., one partner's BMI being notably higher/lower than the other partner) affected how emotional valence was regulated when couples discussed topics related to health and shared lifestyle choices. For couples where the female partner had higher BMI than her male partner, greater emotional co-dysregulation was found, presumably because the conversation elicited increased negative emotions, which might be associated with relationship dissatisfaction.

While physical/behavioral attributes appear to be associated with partners' co-regulatory dynamics (Butler & Barnard, 2019; Reed et al., 2015), less is known about the influences of cognitive/emotional attributes on partners' co-regulatory dynamics. A promising avenue to further our understanding of these dynamics is examining discrepancies in cognitive and emotional attributes, in particular general perceptions of partner's DC behaviors. Variability in how partners view each other's abilities to help them cope with stress during mutually stressful interactions may affect how stress is experienced and co-regulated as it occurs. To this end, the purpose of this study was to examine how perceptions of partners' DC behaviors may be associated with couples' co-regulation dynamics, as measured by video-prompted stress ratings during a mutual stress discussion.

Grounded in the systemic transactional model of DC (Bodenmann, 2005), we expected to find evidence of couples' co-regulation for partners who generally perceived each other to engage in high levels of positive DC. Conversely, we expected to find evidence of couples' co-dysregulation when partners generally perceived each other to engage in high levels of negative DC. Additionally, we examined differences in co-regulation dynamics when male and female partners differentially perceived each other to engage in specific DC behaviors.

The systemic transactional model of dyadic coping (DC)

Romantic partners' experiences are interconnected due to their interdependence (Kelley, 1983). According to the systemic transactional model of DC (Bodenmann, 2005), partners' stress experiences, their coping efforts, and associated outcomes are interdependent. As such, partners rely on one another to help regulate their stress experiences as a method for coping with stress (Bodenmann et al., 2017). The better partners can (positively) cope together with stress, the greater their chance for decreased stress experiences, and increased relationship satisfaction and stability over time (see Falconier et al., 2015 for a meta-analysis).

Process and forms of dyadic coping (DC)

Partners can communicate their stress to each other verbally or non-verbally. Following stress expression, partners appraise the situation and respond either positively or negatively (Bodenmann, 2005). Specifically, partners can either empathize (*emotion-focused DC*) or help to find solutions (*problem-focused DC*); both to help each other regulate their stress response. Conversely, partners can offer support unwillingly or minimize the seriousness of their partner's experiences (i.e., "You're *still* stressed about that?!"), defined as *negative DC*.

Perceptions of partners' engagement in positive DC (i.e., perceived partner dyadic coping) is associated with decreased symptoms of depression and anxiety in different-gender couples (Papp & Witt, 2010) and increased relationship satisfaction (Falconier et al., 2015). Negative DC is commonly found in dissatisfied couples or those who are not committed in their relationship (Bodenmann et al., 2017). While empirical research conducted with different-gender couples find low reports of negative DC (e.g., Randall et al., 2016), Bodenmann (2005) posits that the perceptions of negative DC can erode couples' relationship functioning, decreasing intimacy and trust between partners.

Gender differences

Men and women experience stress at disproportionate rates: within the U.S., women are report higher levels of stress compared to men (Cohen & Janicki-Deverts, 2012). Furthermore, women are more likely to engage in stress communication compared to their male partners (Kuhn et al., 2017). Despite this difference, gender differences in partners' DC behavior are not commonly found (e.g., Bodenmann et al., 2010; Pasch & Bradbury, 1998). For example, one study found that the quality of the support men offered their stressed female partner was poorer compared to when their partner was not stressed (Bodenmann et al., 2015).

These results could be partly due to men being more sensitive to the experience of stress (i.e., increased hypothalamic pituitary adrenal (HPA) activity during a laboratory interaction task) than women (Kudielka & Kirschbaum, 2005). Research does, however, suggest that men may benefit from their (female) partner's support more than their female partner benefiting from the male partner's support (Neff & Karney, 2005), as women are thought to serve as the emotional regulators in different-gender relationships (e.g., Randall et al., 2013). Given the inconclusive evidence, we explored possible gender differences associated with perceptions of dyadic coping.

Functions of dyadic coping (DC)

Partners' engagement of (positive) DC serves two important functions, (1) reduces partners' levels of stress, and (2) helps foster partners' feelings of mutuality and trust within the relationship (Bodenmann et al., 2017). Recently, there is increased attention on examining emotional dynamics within social interactions (Butler, 2011, 2015; Randall & Schoebi, 2018), and the possible moderators associated with partners' emotional interdependence.

Given DC is theorized to be associated with partners' emotional stability, the goal of the present study was to test whether general perceptions of partners' DC, measured at baseline, yielded such effects from partners' mutual stress discussions. Specifically, we hypothesized that general perceptions of partners' engagement in positive DC would be associated with lower stress ratings and patterns of co-regulation (i.e., coupled dampening of partners' stress ratings) during a mutual stress conversation, as measured by video-prompted second-by-second recall.

Present study

Grounded in the systemic transactional model of DC (Bodenmann, 2005), the present study examined possible co-regulation or co-dysregulation between partners' (video-recalled) stressful experiences (stress ratings) as measured by the coupled linear oscillator (CLO) model (Butner et al., 2005; Reed et al., 2015). Stress ratings are assumed to oscillate around a homeostatic set point (Reed et al., 2015), and the CLO directly models frequency, dampening/amplification, and coupling of partners' oscillating stress ratings (see Method). In general, partners' stress ratings are expected to be bidirectionally coupled and dampen over time as a function of perceived partner's dyadic coping. As such, we examined if co-regulatory dynamics varied among three patterns of positive and negative DC behavior, respectively: (1)

"low DC" (low average DC and zero difference between partners), "high DC" (high average DC and zero difference between partners) and "mixed-coping DC" couples (mean average DC and high difference between partners), wherein one partner perceived their partner to engage in more (or less) DC. Specifically, we hypothesized that partners' stress ratings would be bidirectionally coupled and dampen over time toward stability (i.e., co-regulation) when both partners perceived each other to engage in high baseline levels (high average and zero difference between partners) of positive DC. Conversely, we hypothesized that partners' stress ratings would be bidirectionally coupled and amplify over time (i.e., co-dysregulation) for couples wherein both partners perceived each other to engage in high baseline levels of negative DC. Furthermore, we explored possible gender differences within couples' emotional patterns (e.g., when female partners perceive their male partners to engage in more DC behaviors, and when male partners perceive their female partners to engage in more DC behaviors), however, do not offer any *a priori* hypotheses.

Method

Participants

This study was reviewed and approved by the Institutional Review Board at Arizona State University. Data were collected from a community sample of heterosexual committed couples recruited by postings on Craigslist, Facebook, and electronic mailing lists from university listservs and various professional organizations in a Southwestern region of the U.S. Couples had to meeting the following criteria to participate: (1) both partners were over the age of 18 years; (2) had been in a romantic relationship for at least 6 weeks; and (3) both partners were willing to participate in the study.

A total of 73 couples ($N = 146$ individuals) inquired about the study; among these, 67 couples ($n =$ 134 individuals) were screened eligible, 53 couples ($n = 106$ individuals) completed the baseline questionnaire, and of those 44 couples ($n = 88$ individuals) completed all portions of the study (i.e., baseline and laboratory session). Two couples were removed based on their lack of stress rating variability (i.e., did not follow instructions), thus the final sample included a total of 42 couples ($n = 84$ individuals).

Of the 42 couples, the mean age of women was 30.47 years ($SD = 7.51$) and the mean age of men was 30.89 years ($SD = 7.86$). Thirty-seven participants self-identified as non-Hispanic White (44%), twenty-five self-identified as European American (29.8%), thirteen self-identified as Hispanic (15.5%), three self-identified as Asian American (3.6%), two self-identified as Native Hawaiian or Pacific Islander (2.4%), one self-identified as African American (1.2%), and three self-identified as "other." Overall, participants in this sample were highly educated: thirty-six (42.9%) reported holding an undergraduate degree, thirty-three (39.3%) reported holding a graduate degree, eleven (13.1%) reported having completed some college, three (3.6%) reported completing a professional program, and one (1.2%) reported completing high school. Twenty participants (23.8%) reported earning between $0 and $25,000, twenty-one (25%) reported earning between $25,000 and $50,000, nine (10.7%) reported earning between $50,000 and $75,000, seventeen (20.2%) reported earning between $75,000 and $100,000, fifteen (17.9%) between $100,000 and $150,000, and two (2.4%) reported earning over $150,000.

Partners had been together, on average, for 6.11 years ($SD = 6.89$). Most participants reported being married (47.6%) or engaged and living together (23.8%). Thirteen participants (15.5%) reported being in a committed heterosexual relationship and living together, eight (9.5%) reported being in a committed heterosexual relationship and not living together, and three (3.6%) reported being engaged and not living together.

Procedure

Data for this study were collected in three parts: (1) a screening survey, (2) a baseline questionnaire, and (3) a laboratory session. Following the screening process to ensure study eligibility, participants were instructed to complete a baseline questionnaire independent from their partner. The baseline questionnaire included standard demographic questions and took approximately one hour to complete. Once completed, couples were contacted to schedule their laboratory session.

During the laboratory session, couples were asked to first complete a guided breathing exercise and watch a six-minute nature film of nature to relax them. Following this, couples were instructed to have three video-recorded, six-minute conversations with each other regarding a stress reported by one partner, a mutual stress, and shared area of enjoyment. For the purpose of this study, we were interested in examining couples' co-regulation dynamics during the mutual stress conversation as these topics were thought to be salient enough to both partners to solicit emotional responses (cf. Reed et al., 2015). Following each video-recorded conversations, participants were asked to watch their conversation, and rate on a second-by-second basis how stressed they felt during the conversation using a Perception Analyzer ® – a validated continuous indicator of emotional experience (Ruef & Levenson, 2007). Said differently, couples provided retrospective ratings of their stress during their mutual stress conversation. A privacy screen was placed between partners so that they were unable to see their partner's dial.

Topic selection

Partners' mutual stress conversation topics were selected from their responses on the Multidimensional Stress Scale for Couples (Bodenmann et al., 2008) administered at baseline. This scale asks participants to rate how stressful various topics are on a 4-point scale (0 = *not at all* to 4 = *very much*) including *differences of opinion with your partner*, *different attitudes concerning the relationship*, *disturbing habits of the partner*, and others. Topics were selected from areas of stress that were ranked high by both partners. A majority of participants reported *disturbing habits of the partner* ($n = 14$ couples) and *differences in opinion* ($n = 12$ couples) as sources of high mutual stress.

Measures

Dyadic coping (DC)

Participant reports of perceived partner DC behavior were measured with the English version of the Dyadic Coping Inventory (DCI; Randall et al., 2016), measured at baseline. The DCI is a self-report questionnaire that assesses how partners cope when one or both partners experience stress. Items were rated on a five-point Likert-scale ranging from 1 = *very rarely* to 5 = *very often*, where higher mean scores indicate greater agreement with the items. For this study, we examined *positive* and *negative* perceived partner DC. *Positive DC* was assessed by a mean score of six items that reflect one's perceptions of the other partners' engagement in emotion-focused supportive coping (e.g., "My partner shows empathy and understanding"), problem-focused supportive coping (e.g., "My partner helps me to see stressful situations in a different light"), and delegated coping strategies (e.g., "My partner takes on things that I normally do in order to help me out"). *Negative DC* was assessed by four items that reflected one's perceptions of the other partner's engagement in avoidance, dismissal, or negative reactions in coping (e.g., "When I am stressed, my partner tends to withdraw," and "My partner provides support, but does so unwillingly and without enthusiasm"). Higher mean scores represented greater perceptions of each respective DC. Reliabilities for all scales were in the acceptable ranges for men and women (positive DC_{men} $\alpha = .71$, positive DC_{women} $\alpha = .75$; negative DC_{men} $\alpha = .73$, negative DC_{women} $\alpha = .73$).

Stress ratings

Participants rated their experiences of stress using the Perception Analyzer (PA)® rating system using a rating dial, which collects second-by-second experiential data (see Levenson & Gottman, 1983). Partners were each given a dial and instructed to turn their dial all the way to the left (showing 0) to indicate they were feeling the "least stressed," and turn the dial all the way to the right (showing 100) to indicate they were feeling the "most stressed" during the conversation. Participants were asked to turn their dial to 50 before the video recording began and turn the dial frequently as they watch the recordings of their conversation.

Data analysis

To examine the couples' co-regulatory patterns during the mutual stress conversation, we used a bivariate extension of the damped linear oscillator (DLO) – a differential equation model that estimates the frequency and damping of a variable that oscillates around an equilibrium over time (Boker & Nesselroade, 2002). An application of the DLO would be modeling the behavior of simple pendulum, namely the speed of its oscillations (i.e., frequency) and change in speed (i.e., dampening) over time. Rather than modeling the focal variable x (e.g., stress rating) as the dependent variable, the DLO model takes x (i.e., *displacement* from set point) and its first derivative (i.e., *velocity*) as predictors of its second derivative (i.e., *acceleration)*. The general equation for the DLO takes the form:

$$d^2x(t)/dt^2 = \eta x_{(t)} + \zeta(dx_{(t)}/dt) + \epsilon_{(t)} \tag{1}$$

where, $x_{(t)}$, $(dx_{(t)}/dt)$, and $(d^2x(t)/dt^2)$ represent the displacement, velocity, and acceleration, respectively, of x at a time t. The parameter η represents the effect of displacement on acceleration, or how quickly x is returning to its set point (i.e., frequency). In the DLO, η estimates are typically negative, and as η becomes more negative, x fluctuates more rapidly around its set point. Conversely, ζ represents the effect of velocity on acceleration, or how much the amplitude of x is increasing (i.e., amplifying) or decreasing (i.e., dampening) in magnitude over time. A positive ζ signifies amplification over time, whereas a negative ζ signifies dampening.

For the present study, we use the coupled linear oscillatory (CLO), a bivariate extension of DLO which takes the multilevel form:

$$d^2x_{(t)}/dt^2 = \eta x_{(t)} + \zeta(dx_{(t)}/dt) + \kappa(y_{(t)} - x_{(t)}) + \epsilon_{x(t)0} \tag{2}$$

$$d^2y_{(t)}/dt^2 = \eta y_{(t)} + \zeta(dy_{(t)}/dt) + \kappa(x_{(t)} - y_{(t)}) + \epsilon_{x(t)0} \tag{3}$$

which includes separate equations to model oscillations of female (x) and male (y) stress, respectively. Moreover, this model includes κ as a coupling parameter for both x and y. κ represents the effect of the instantaneous difference between partners' stress ratings (i.e., $y_{(t)} - x_{(t)}$ for females, or $x_{(t)} - y_{(t)}$ for males) on the acceleration of each partners' stress. A large κ estimate (either $+\kappa$ or $-\kappa$) suggests that partners' stress ratings are being *pulled* into parallel movement (i.e., in-phase). As a concrete example, readers can think of a non-zero κ as a stiff coil that connects two adjacently oscillating pendulums and pulls them into synchrony over time ($\kappa = 0$ would represent no coil; refer to Hessler et al., 2013 for further detail). Conceptual definitions of η, ζ, and κ have been included in Table 1, including the interpretations for different values of κ. For the purposes of our study, we predict that κ will be non-zero for both partners with opposite signs (e.g., Partner $x = +\kappa$ and Partner $y = -\kappa$), suggesting that partners are bidirectionally influencing each other into a similar oscillatory pattern (e.g., Partner x is accelerating to match y, and Partner y is decelerating to match x).

To determine the appropriateness of the CLO, we graphed couples' raw stress experience ratings to visually examine the presence of oscillations, amplifications, or dampening, and coupling of partners' stress ratings (see Reed et al., 2015). Second, we obtained first and second derivatives of the person-centered stress ratings using functional data analysis (FDA) per the recommendation of Chow et al. (2016). Third, we ran a baseline CLO model with which included fixed and random effects for partners' *frequency* (η), *dampening/amplification* (ζ), and *coupling* (κ). Within this step, we compared one model that treated partners as indistinguishable (assuming male and female partners' effects do not differ) with another model that treated partners as distinguished by gender (unique effects for males and females). We compared the −2 log-likelihood between these two models to determine if distinguishing by gender significantly improved model fit. Fourth, we entered non-centered, dyad-level averages (i.e., average of DC within a single dyad) and difference

Table 1. Definitions of the Coupled Linear Oscillator (CLO) parameters and interpretation of the kappa (κ) parameter.

CLO parameter	Definition	Interpretation	
Eta = η	Effect of stress rating *displacement* (i.e., distance from one's set point) on acceleration.	Represents stress rating *frequency*, or how fast stress ratings oscillate (i.e., return to set point). As η becomes more negative, stress oscillates more rapidly.	
Zeta = ζ	Effect of stress rating *velocity* (i.e., rate of change) on acceleration.	Represents the *amplifying* (+ζ) or *dampening* (−ζ) effect of stress ratings over time.	
Kappa = κ	Effect of instantaneous difference in partners' stress rating on acceleration.	Represents the coupling effect between partners' stress ratings, or how they are being pulled in-phase over time.	
Kappa	**Variable**	**Partner**	**Interpretation**
$+\kappa$	$y_{(t)} - x_{(t)}$	Female (x)	When male stress is higher, females' stress accelerates; When male stress is lower, females' stress decelerates.
$-\kappa$	$y_{(t)} - x_{(t)}$	Female (x)	When male stress is higher, females' stress decelerates; When male stress is lower, females' stress accelerates.
$\kappa = 0$	$y_{(t)} - x_{(t)}$	Female (x)	Females' stress oscillates independently of male oscillations.
$+\kappa$	$x_{(t)} - y_{(t)}$	Male (y)	When female stress is higher, males' stress accelerates; When female stress is lower, males' stress decelerates.
$-\kappa$	$x_{(t)} - y_{(t)}$	Male (y)	When female stress is higher, males' stress decelerates; When female stress is lower, males' stress accelerates.
$\kappa = 0$	$x_{(t)} - y_{(t)}$	Male (y)	Males' stress oscillates independently of female oscillations.

Note. $y_{(t)}$ = displacement of male's stress from set point at time t; $x_{(t)}$ = displacement of female's stress from set point at time t.

scores (i.e., difference in DC within a single dyad) of DC as moderators. Next, we compared the −2 log-likelihoods to determine if the moderated model improved overall fit. Assuming the improved fit of the moderated models, we examined the CLO parameters (i.e., η, ζ, and κ) as influenced by the DC scores. When applicable, significant interactions were decomposed with the DC scores centered at four relevant combinations (e.g., high coping, low coping, and mixed (male > female, female > male) coping couples), with each combination corresponding to a different level of matching between one partner' perceptions of the other partner's DC behaviors.

Baseline CLO model

Data from this study are interdependent; time is nested within person and person is nested within dyad. To account for partners' interdependence, we used linear mixed effects modeling (Kenny et al., 2006) in PROC MIXED of SAS 9.4 (SAS Institute, 2013). All partners' stress ratings were person-mean centered and detrended prior to analyses to account for variability in participants' stress experience at baseline (see Figure 1 in the supplementary file). To examine if partners were indistinguishable across gender, we compared the fit of one baseline CLO model with and without gender. The Level 1 equation for the baseline CLO model which included a distinguishing factor for gender took the form:

$$\begin{aligned} d^2x_{(t)}/dt^2_{ij} =& (\text{female})*[\eta_{1j}(x_{(t)}) + \zeta_{1j}(dx_{(t)}/dt) + \kappa_{1j}(y_{(t)} - x_{(t)})] \\ &+ (male)*[\eta_{2j}(x_{(t)}) + \zeta_{2j}(dx_{(t)}/dt) + \kappa_{2j}(y_{(t)} - x_{(t)})] + e_{ij} \end{aligned} \tag{4}$$

where $d^2x_{(t)}/dt^2_{ij}$ is the second derivative of stress at time i for dyad j. Dummy gender variables were used to test for effects across gender within a single model. η_{1j} represents the change in frequency for the female partner in dyad j, ζ_{1j} represents the change in amplitude (i.e., amplification or dampening) for the female partner in dyad j, and κ_{1j} represents the degree to which the female partner's stress ratings are coupled with her male partner in dyad j. η_{2j}, ζ_{2j}, and κ_{2j} represent the same effects for the male partner relative to the female partner in dyad j. We specified the residual error term e_{ij} to have separate variance components across genders and allowed them to covary. We also specified a AR

(1) covariance structure to account for autocorrelation across time within individuals. The Level 2 equation for the model drops into:

$$
\begin{aligned}
\eta_{1j} &= \gamma_{10} + \mu_{1j} \\
\zeta_{1j} &= \gamma_{20} + \mu_{2j} \\
\kappa_{2j} &= \gamma_{30} + \mu_{3j} \\
\eta_{2j} &= \gamma_{40} + \mu_{4j} \\
\zeta_{2j} &= \gamma_{50} + \mu_{5j} \\
\kappa_{2j} &= \gamma_{60} + \mu_{6j}
\end{aligned}
\tag{5}
$$

where each γ parameter represents the fixed effects (i.e., average effect across all dyads) for all Level 1 parameters, and the μ parameters represent random effects (i.e., between-person residual variance for the effect) which we assume do not covary.

Moderated CLO model

Building upon the baseline CLO model, we examined the moderating effects of DC using a dyadic average-difference approach (Kenny et al., 2006; Reed et al., 2015). Based on partners' individual reports, we generated average (i.e., average perceived DC within a single dyad) and difference scores (i.e., difference in perceived DC between two members of a dyad) at the level of the dyad that were added as additional terms to the baseline model. Because perceived DC was a trait-level measure and did not vary across time, this factor was included as a time-invariant covariate. The Level 1 equation for the moderated CLO was identical to Equation (4), and the Level 2 equation took the form:

$$
\begin{aligned}
\eta_{\text{female}\,j} &= \gamma_{10} + \gamma_{11}(\text{DC\_avg}) + \gamma_{12}(\text{DC\_diff}) + \mu_{1j} \\
\zeta_{\text{female}\,j} &= \gamma_{20} + \gamma_{21}(\text{DC\_avg}) + \gamma_{22}(\text{DC\_diff}) + \mu_{2j} \\
\kappa_{\text{female}\,j} &= \gamma_{30} + \gamma_{31}(\text{DC\_avg}) + \gamma_{32}(\text{DC\_diff}) + \mu_{3j} \\
\eta_{\text{male}\,j} &= \gamma_{40} + \gamma_{41}(\text{DC\_avg}) + \gamma_{42}(\text{DC\_diff}) + \mu_{4j} \\
\zeta_{\text{male}\,j} &= \gamma_{50} + \gamma_{51}(\text{DC\_avg}) + \gamma_{52}(\text{DC\_diff}) + \mu_{5j} \\
\kappa_{\text{male}\,j} &= \gamma_{60} + \gamma_{61}(\text{DC\_avg}) + \gamma_{62}(\text{DC\_diff}) + \mu_{6j}
\end{aligned}
\tag{6}
$$

where each of the positive DC average and difference terms represent the non-centered, continuous forms of these variables. A unique model was fit for positive and negative DC, respectively. These models were tested against the baseline model to check for improved fit. Assuming a significant improvement to model fit, interactions between DC variables and the CLO parameters were decomposed by re-running the analysis with the DC average and difference scores centered at the levels of four meaningful combinations for both positive and negative DC, respectively (described below). New estimates of the CLO parameters (i.e., η, ζ, and κ) were generated for each of the combinations.

Following Reed et al. (2015), average and difference scores for both positive and negative DC were centered at values that signified theoretically relevant combinations; DC average and difference scores were centered as either −1 *SD* or +1 *SD* based on the type of combination. For example, the *low coping* group comprised of couples wherein both partners perceived each other as engaging in infrequent DC behaviors (average DC centered at −1 *SD* and difference scores grand mean centered). The *mixed coping* group comprised of couples wherein one partner perceived their partner as engaging in more frequent DC than the other. Here we had two subgroups: (1) *mixed coping – female* lower *(F < M)*, where female partners perceived their male partner as engaging in less frequent DC behaviors, relative to how the male partner perceived her coping (average DC scores grand mean centered and difference scores centered at −1 *SD*), and (2) *mixed coping – male lower* (*M < F*) group, where male partners perceived their female partner as engaging in less frequent DC behaviors relative to how the female partner perceived his coping (average DC scores grand mean centered, and difference scores centered at +1 *SD*). The *high coping* group was comprised of couples wherein both partners perceived one another as engaging in frequent DC behaviors (average DC centered as +1 *SD* and difference scores grand mean centered). Separate models were conducted that used the re-centered values for each of the four theoretically combinations for both positive and negative DC.

Results

Descriptive statistics

Participants' stress ratings ranged from 0 to 100 across all 42 six-minute mutual stress conversations. Average stress rating was 50.76 ($SD = 25.70$). Table 2 illustrates descriptive statistics of perceived partner positive and negative DC by partner gender and DC group, as measured at baseline. Male partners' DC scores corresponded to their perceptions of their female partner's DC behaviors, whereas female partners' DC scores corresponded to their perceptions of their male partner's DC behaviors.

Baseline CLO model

The baseline model with partner gender entered as a distinguishable factor showed a significant improvement in model fit compared to the model without gender as a distinguishable factor, $\chi^2(6) = 151.7$, $p < .001$. Therefore, gender was included for partner distinguishability in subsequent models (refer to Equation 4). A summary of the *F*-test statistics of the baseline CLO model with gender entered as a distinguishable factor can be found in Table 3.

In the baseline model both males and females demonstrated evidence of dampening over time (negative ζ parameters for males and females; see Table 4 for estimates). Moreover, males appeared to dampen in accordance with females (negative κ parameter for males). The fixed effect of male partners' overall frequency (γ_{40} in Equation 5) was −0.63, suggesting male partners demonstrated a complete cycle of emotional oscillations at every 1.32 min (79.16 s), calculated by the formula –(2π)/(sqrt(η)) (Reed et al., 2015), $t(2808) = -0.63$, $p < .001$. Female partners demonstrated a similar oscillation pattern at every 1.41 min (84.72 s), $t(2808) = -0.56$, $p < .001$.

Co-regulation dynamics: moderating effects of dyadic coping (DC)

To test our hypotheses, we examined the moderating associations of DC averages and differences on CLO parameters. A summary of the overall *F*-test statistics for the moderated models for each form of DC can be found in Table 3. For ease, we organized the results below by DC type.

Table 2. Descriptives of perceived DC from the partner by gender.

		N (%)	
		Male	Female
Positive DC	*M* (*SD*)	3.79 (0.56)	3.86 (0.58)
	≤−1 *SD* (3.25)	8 (19)	8 (19)
	−1 *SD* ~ +1 *SD*	29 (69)	28 (67)
	≥+1 *SD* (4.40)	5 (12)	6 (14)
Negative DC	*M*(*SD*)	1.71 (0.69)	1.88 (0.69)
	≤−1 *SD* (1.10)	13 (31)	6 (14)
	−1 *SD* ~ +1 *SD*	21 (50)	26 (62)
	≥+1 *SD* (2.48)	8 (19)	10 (24)

Note. DC = dyadic coping. The mean (M) and standard deviation (SD) reflects the respective perceptions of partner's DC behaviors (i.e., male rating female partner; female rating male partner). The score in the parenthesis next to the score range (≤−1 *SD*, ≥+1 *SD*) represents the DC score at 1 standard deviation below and above the mean score, respectively.

Table 3. *F*-tests for the baseline and moderated CLO models by forms of dyadic coping averages and differences.

	Baseline	*F* Positive DC	Negative DC
Female * frequency (η_1)	208.30***	6.44*	10.17***
Female * dampening (ζ_1)	7.92***	2.04	0.84
Female * coupling (κ_1)	0.29	0.01	0.16
Female * frequency*DCavg	–	0.93	1.07
Female * dampening*DCavg	–	1.21	3.43
Female * coupling*DCavg	–	0.01	0.16
Female * frequency*DCdiff	–	0.79	0.61
Female * dampening*DCdiff	–	0.26	3.80
Female * coupling*DCdiff	–	0.77	3.80
Male * frequency (η_2)	336.52***	0.02	59.38***
Male * dampening (ζ_2)	4.59*	0.14	2.27
Male * coupling (κ_2)	1.94	2.18	6.10*
Male * frequency*DCavg	–	4.93*	5.46*
Male * dampening*DCavg	–	0.02	0.98
Male * coupling*DCavg	–	2.66	4.93*
Male * frequency*DCdiff	–	1.99	0.17
Male * dampening*DCdiff	–	0.12	1.47
Male * coupling*DCdiff	–	0.47	2.55

Note. DC = dyadic coping; DCavg = DC couple average; DCdiff = DC couple difference.
*= $p < .05$; **=$p < .01$; ***= $p < .001$.

Positive DC

The moderated model with positive DC averages and differences included as moderators did not demonstrate an improved fit over the baseline CLO model, $\chi^2(12) = 14.0$, $p = 0.30$. This suggests that perceived positive DC did not moderate couples' emotional coregulatory dynamics.

Negative DC

The moderated model with negative DC averages and differences demonstrated an improved fit when compared to the baseline model, χ^2 $(12) = 22.4$, $p = 0.03$. Frequency parameters (η) for both females, $t(2796) = -3.19$, $p < 0.01$, and males, $t(2796) = -7.71$, $p < 0.001$, were statically significant, as was the male coupling parameter (κ), $t(2796) = -2.47$, $p = 0.01$, the interaction term for male frequency and negative DC, $t(2796) = 2.34$, $p = 0.02$, and the interaction term for male coupling and negative DC, $t(2796) = 2.22$, $p = 0.03$. Given the improved fit when negative DC was added, we continued to decompose the interaction using the four meaningful combinations of negative DC averages and differences.

For couples wherein (1) both partners perceived each other as having low negative DC or (2) females perceived lower negative DC than males, there emerged a pattern such that the man partner's stress dampened over time (negative ζ in males), but females' stress did not dampen or amplify (see Table 5). Moreover, it seems that males' stress dampened in accordance with unidirectional coupling with females (negative κ in males, only). Because the κ parameter in females is not significantly different than zero, these groups do not meet the full criteria for stress coregulation (i.e., bidirectional coupling). Instead, this finding suggests that in these groups, males benefited from having

Table 4. Baseline CLO model.

Effect	Estimate (*b*)	Std. Error
Females' frequency (η_1)	−0.56***	0.04
Males' frequency (η_2)	−0.63***	0.03
Females' dampening (ζ_1)	−0.17**	0.06
Males' dampening (ζ_2)	−0.09*	0.04
Females' coupling (κ_1)	−0.02	0.03
Males' coupling (κ_2)	−0.06*	0.04

Note. Estimates are unstandardized coefficients.
*=$p < .05$ **=$p < .01$; ***=$p < .001$.

Table 5. CLO model unstandardized parameter estimates of combinations of perceived negative dyadic coping averages and differences.

	Both low coping	Mixed-coping F < M	Mixed-coping M < F	Both high coping
DC difference	0	−1 *SD*	+1 *SD*	0
DC average	−1 *SD*	Average	Average	+1 *SD*
Females' frequency (η_1)	−0.50***	−0.51***	−0.58***	−0.59***
Males' frequency (η_2)	−0.72***	−0.65***	−0.62***	−0.55***
Females' dampening (ζ_1)	−0.05	−0.04	−0.25***	−0.24***
Males' dampening (ζ_2)	−0.12*	−0.13*	−0.03	−0.04
Females' coupling (κ_1)	−0.01	−0.05	−0.05	<0.01
Males' coupling (κ_2)	−0.13*	−0.11*	0.02	0.04

Note. F < M = Female perceived as providing more DC than male partner; M < F = Male perceived as providing more DC than female partner. *=$p < .05$ **=$p < .01$; ***= $p < .001$.

their stress coregulated by their partner, whereas females' stress did not dampen over time and oscillated independently of their partners' stress.

Conversely, in couples wherein (1) both partner's reported high negative DC or (2) females reported higher negative DC than males, there emerged a pattern wherein females' stress dampened over time (negative ζ in females), but males' stress neither dampened nor amplified. Moreover, there was no evidence of coupling in either partner. This finding suggests that when both partners report high negative DC (i.e., +1 *SD* above average), or when females report higher negative DC than males, females do not coregulate their partner's stress, but still demonstrate an ability to regulate their own stress (i.e., dampening over time). Conversely, males neither regulate their own stress nor their partners in these groups.

Discussion

Romantic partners' experiences of stress and coping are interdependent, and partners can regulate each other's stressful experiences by engaging in positive DC (Falconier et al., 2015). Modeling partners' video-recalled emotional experiences during mutually stressful conversations provides a unique perspective to understanding the dynamics that may help contribute to emotional stability and well-being for partners over time (Butler, 2011). On average, we found that stress in both females and males appears to dampen over time. Moreover, males' stress is unidirectionally coupled to females' stress ($-\kappa$ in males), such that females appear to coregulate their partners' stress over time, but males' do not coregulate their partners' stress. Interestingly, results from this study suggest that negative DC, but not positive DC, moderated the coregulatory stress dynamics between partners. Results from this study provide initial insight into the study of couples' stress and coping experiences, particularly as it pertains to future directions for the applications of the systemic-transactional model (Bodenmann, 2005).

Association between couples' stress ratings and perceived dyadic coping (DC)

It was hypothesized that perceptions of partners' engagement in positive DC would yield co-regulatory patterns such that partners' stress ratings would dampen, and negative DC would amplify, stress ratings across the conversation. Unexpectedly, our results did not explicitly support these hypotheses, but still appear to cohere with past findings (Neff & Karney, 2005). Negative DC, but not positive DC, moderated couples' coregulator dynamics. In couples that reported low negative DC, female's coregulated their partners' stress (i.e., males' stress was unidirectionally coupled to females', gradually being *pulled* in-phase with females' stress over time). However, in couples that reported high DC, no coregulation or co-dysregulation was found, but females did seem to effectively self-regulate their own stress (i.e., dampening occurred independent of their partners' stress). This finding aligns with previous research that suggests men and women provide equal levels of social support on average, but women may be more adept than men at providing social support in high stress moments (Neff & Karney, 2005). Because our study observed participants during a prompted stress paradigm (i.e., a discussion about a relational stressor), it follows that women would be stronger coregulators in this context. Our study builds on this notion by suggests that women coregulate in different-gendered relationships, but only in couples where negative DC is low. When negative DC is high, women do not co-regulate their partners' stress, and seem to prioritize self-regulation.

Given that our results most notably highlight patterns associated with emotional oscillations, future studies should continue to pursue novel methods for quantifying interpersonal stress dynamics using other differential equation models besides the CLO (Steele et al., 2014). CLO models assume that data follow an oscillatory pattern, which may not be effective for mapping interpersonal stress dynamics in all contexts. The domain of dynamical systems modeling offers a broad range of options for parameterizing the dynamics of stress as they unfold in close relationships, affording researchers the flexibility to determine if partners' oscillatory patterns of stress differ from that of affect and other emotional processes.

Limitations and future directions

Several factors are acknowledged as limitations to the present study. First, the prior exposure to stressful conversation topics likely decreased partners' emotional responses. Second, we note limitations in the variability across couples' DC scores and in the operationalization of the stress ratings. Specifically, participants rated their conversations on a 0–100 scale from "least stressed" to "most stressed," we acknowledge that these ratings do not necessarily include a true zero point of "not at all stressed" or a positive emotion opposite to stressful feelings. Third, although the systemic transactional model of dyadic coping (Bodenmann, 2005) and Dyadic Coping Inventory (Randall et al., 2016) have been well-established and widely used, there may be inherent limitations in relating a self-reported assessment of perceptions of partner's DC to temporal data. To put it simply, self-reported perceptions of partners' DC behaviors may not accurately predict patterns of partners' behaviors (or perceptions of one's partner's behaviors) during any given real-time interaction. Examining partners' interpersonal emotion dynamics calls for the use of temporal data and sophisticated modeling to account for such variations (Butler, 2018). Although beyond the scope of the current paper, future research is encouraged to have partners use rating dials to rate their partner's (or their own) coping behaviors following the conversation. Collecting this type of recall data, along with behaviorally coded data of DC behaviors (e.g., Kuhn et al., 2017), will allow researchers to examine the more nuanced experiences of partners' stress communication and coping processes.

Nonetheless, our results point to the notion that traditional self-report measures may be viable instruments for differentiating qualities in real-time interaction dynamics, as others have highlighted (Reed et al., 2015). However, it must be underscored that our study makes use of cross-level interaction terms to estimate interactions across two levels of nested data (i.e., dyad-level and participant-level) for positive DC and negative DC, respectively. Statistical power to detect significant cross-level interaction effects in multilevel models is highly sensitive to the magnitude of the cross-level interaction and lower and upper-level sample size (Mathieu et al., 2012). Though our sample size (42 couples; $N = 84$ individuals) is comparable to similar studies that test for cross-level interactions with 39 (Reed et al., 2015) and 48 couples (Butner et al., 2007), respectively, non-significant findings should be interpreted with caution. Said differently, positive DC was not found to moderate partners' interpersonal stress dynamics, but this may have been a function of an underpowered test, and not the absence of a true effect. Each experimental context varies, and this will impact significance testing with cross-level interaction terms; therefore, researchers are encouraged to follow guidelines for assessing statistical power without deferring to simple heuristics (Mathieu et al., 2012).

Conclusion

The ways in which romantic partners cope with one another during times of distress has immense implications for both individual and relational well-being (e.g., Randall & Bodenmann, 2017; Randall & Messerschmitt, 2020), especially given that the perception of one's romantic relationship is considered one of the most important factors affecting life satisfaction (Ruvolo, 1998). While research on positive dyadic coping continuously points to its beneficial effects (e.g., Falconier et al., 2015), researchers are still unclear how engaging in specific types of dyadic coping may impact partners' interpersonal emotional experiences *during* real-time interactions. Furthermore, to date, romantic relationship research has relied primarily on data from cross-sectional study designs. Rather limited attention has been paid to the theoretical and methodological tools to understand partners' momentary emotional experiences (see Butler, 2018 for a discussion). Nevertheless, the intersection between affective and relational science continues to be an important area for future research (Randall & Schoebi, 2018).

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