Dispositional Attachment Style Moderates the Effects of Physiological Coregulation on
Short-Term Changes in Attachment Anxiety and Avoidance

*Keywords*: physiological coregulation, personality disorders, attachment, interpersonal
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Abstract

Individuals with personality disorders often experience romantic relationship dysfunction and have an insecure attachment style. Here, we examined attachment dynamics in dyadic interactions, focusing specifically on the role of physiological coregulation in state attachment processes in couples oversampled for personality pathology. One hundred twenty-one couples completed a ten-minute discussion about an area of disagreement in their relationship and a five-minute discussion in which they planned an event together. We employed a dynamical model of heart rate changes to estimate coregulation. We found that (a) increases in state attachment avoidance were associated with contrarian coregulation (heart rate becoming misaligned from the partner’s physiology) and (b) conversely, increases in state attachment anxiety were associated with dependent coregulation (heart rate becoming aligned toward the partners’ physiology). Dispositional attachment insecurity moderated the effects of state attachment insecurity on physiological coregulation. Whereas dispositional anxiety predicted individuals exhibiting dependent coregulation in response to state insecurity, dispositional avoidance predicted contrarian coregulation in response to state insecurity. This work provides insight into the role of physiological coregulation in attachment dynamics among couples oversampled for personality pathology, suggesting that disruptions to coregulation contribute to impaired emotion regulation during romantic conflicts.
Interpersonal dysfunction is a core problem in personality disorders (PDs; Hopwood et al., 2013; Pincus, 2005). This deficit has particularly deleterious consequences for romantic relationships (South et al., 2008; Whisman & Schonbrun, 2009), increasing the risk for instability, turbulence, and violence (Daley et al., 2000; South, 2014; Stepp et al., 2011). Interpersonal dysfunction in PDs is often associated with insecure attachment dynamics that may emerge from childhood adversity (Hughes et al., 2011; Levy et al., 2015). Importantly, attachment insecurity in PDs is associated with behaviors that exacerbate relationship discord (e.g., stonewalling; Beeney et al., 2019). Despite the centrality of attachment theory in the conceptualization of many PDs (Levy et al., 2015), little research has elucidated how moment-to-moment attachment processes relate to the broader pattern of interpersonal problems.

Physiological coregulation – the synchrony of physiology that facilitates an individual’s return to a homeostatic set point (Butler & Randall, 2013) – supports healthy relationship functioning (Sbarra & Hazan, 2008). Because autonomic flexibility is involved in emotion regulation and is disrupted in psychiatric populations (Beauchaine, 2001; Beauchaine et al., 2007), coregulation of heart rate is particularly relevant to understanding relationship functioning in psychiatric populations (Butler & Randall, 2013). In a previous investigation of romantic relationships in PDs, disruptions to physiological coregulation during a conflict discussion accounted for the association between personality pathology and relationship dissatisfaction 12 months later (Schreiber et al., 2020). Building on evidence that attachment dynamics are a key component of interpersonal dysfunction in PDs, this study examined the role of physiological coregulation in attachment processes in couples with PDs.
Physiological Coregulation in Attachment Relationships

Attachment theorists have argued that coregulation is the physiological analogue of psychological ‘felt security’ in secure attachment relationships (Sbarra & Hazan, 2008). In childhood, a caregiver helps regulate an infant’s emotional distress via physiological coregulation (Feldman, 2006). Although adults primarily engage in self-regulation of emotions (Gross, 2002; Sbarra & Hazan, 2008), physiological coregulation between adults is nonetheless important (for review, see Timmons et al., 2015).

Social Baseline Theory provides a useful framework for understanding why coregulation within attachment relationships persists into adulthood: the availability of a conspecific allows for the burden of dysregulated emotion to be shared (Beckes & Coan, 2011). As such, physiological coregulation may be less physiologically taxing than self-regulation of emotions. Consistent with this notion, physiological coregulation is associated with perspective taking and fewer negative behaviors during a conflict discussion (Nelson et al., 2017). In both healthy couples (Nelson et al., 2017) and those affected by personality pathology (Schreiber et al., 2020), poor physiological coregulation predicts larger increases in negative affect after a conflict discussion.

Emotion regulation during a threat context (e.g., conflict discussion) is thought to involve the attachment system. When a threat activates the attachment system, individuals typically engage in emotion regulation strategies consistent with their dispositional attachment style (Mikulincer et al., 2003). Anxious individuals engage in hyperactivating strategies (e.g., hypervigilance), reflecting the experience that an attachment figure is available to provide support, while avoidant individuals engage in deactivating strategies (e.g., distancing oneself from attachment cues), reflecting the
experience that an attachment figure is unavailable to provide support (Davila & Kashy, 2009). If physiological coregulation is an important process in attachment relationships, it follows that physiological coregulation may contribute to emotion regulation in response to attachment threats.

Both theory and research point to the involvement of physiological coregulation between romantic partners during contexts that threaten attachment (Hofer, 1987; Sbarra & Hazan, 2008; Timmons et al., 2015). Consistent with the notion that the type of emotion regulation strategy in which an individual engages depends on attachment style (Mikulincer et al., 2003), attachment insecurity and the behavioral dynamics it potentiates predict altered affective and physiological coregulation (Butner et al., 2007; Helm et al., 2012; Sadikaj et al., 2011). Whereas attachment anxiety seems to amplify physiological attunement, attachment avoidance appears to attenuate physiological attunement (Helm et al., 2012).

Dispositional attachment style reflects the central tendency of an individual’s distribution of attachment states (Gillath et al., 2009), which vary over time and across contexts. We view changes in state attachment as reflecting momentary attachment processes: specifically, we frame heightened state insecurity as a response to a perceived attachment threat. This perception subsequently activates the attachment system and evokes emotion regulating strategies. In the present research, we examined how dispositional attachment insecurity moderated the role of physiological coregulation in state attachment processes (Gillath et al., 2009) during a conflict discussion.

Present Study
We recruited couples for a study examining interpersonal dynamics during a conflict discussion. Couples were oversampled for PDs and were composed of at least one psychiatric outpatient. Our hypotheses reflect the view that (a) physiological coregulation accounts for state changes in attachment insecurity and (b) dynamics observed in a lab-based conflict discussion may lend insight into conflicts between couples in daily life (Ferrer & Helm, 2013).

Prior research indicated dispositional attachment style would likely moderate these interpersonal dynamics (Davila & Kashy, 2009; Helm et al., 2012). We thus sought to elucidate how dispositional attachment style influences state attachment dynamics. Self-reported and clinician-rated measures of attachment are distinct (differential predictive utility; e.g., Riggs et al., 2007; meta-analytic r = .09; Roisman et al., 2007), potentially reflecting unconscious versus conscious attachment processes (George et al., 1985). As such, we examined both self- and clinician-reported dispositional attachment ratings as moderators of state attachment processes.

To capture physiological coregulation, we employed a stochastic differential equations model of dyadic heart rate dynamics that estimated the joint effects of self- and co-regulatory influences (Schreiber et al., 2020; Steele et al., 2014). We focused on examining each individual’s physiological tendency to be co-regulated by the partner, reflected by an individual’s heart rate becoming aligned with the partner’s heart rate. Because positive cross-partner influence would lead to a dyadic system in which an individual’s heart rate increasingly aligns with and becomes pulled towards the partner’s physiology, we frame greater cross-coupling as dependent coregulation. Conversely, because negative cross-partner influence would lead to a dyadic system in which an
individual’s heart rate becomes misaligned with and pulls away from the partner’s physiology, we frame negative cross-coupling as contrarian coregulation (this nomenclature builds on Schreiber et al., 2020 and Steele et al., 2014).

Building on the results of prior investigations linking attachment style with coregulation (Butner et al., 2007; Helm et al., 2012), we hypothesized (a) contrarian coregulation would account for increases in state attachment avoidance and (b) dependent coregulation would account for increases in state attachment anxiety. Consistent with the notion that dispositional attachment style impacts how individuals respond to perceptions of an attachment threat (Mikulincer et al., 2003), we expected that individuals would respond to both state anxiety and avoidance in a similar manner: dispositionally avoidant individuals would exhibit contrarian coregulation in response to both state anxiety and avoidance and dispositionally anxious individuals would exhibit dependent coregulation in response to both state anxiety and avoidance.

Methods

Participants

Recruitment. We recruited probands via fliers posted in clinics located in Pittsburgh, PA. Probands were enrolled, in equal proportions, who exhibited clinically significant a) symptoms of Borderline PD, b) symptoms of other PDs, or c) symptoms of another psychiatric disorder but did not meet criteria for a PD. Whereas probands were selected on the basis of psychiatric diagnoses, their partners were unselected for these criteria. Couples were required to be in a relationship for at least thirty days and to be in regular contact with each other (more than three interactions per week, two of which needed to be face-to-face). The McLean Screening Inventory for Borderline PD
(Zanarini et al., 2003) and the personality disorder scales from the Inventory of Interpersonal Problems (Pilkonis et al., 1996) were used to screen participants for PDs. We excluded participants who had a history of bipolar disorder or psychotic symptoms.

**Sample Characteristics.** The total sample of the parent study included one hundred thirty couples. Nine couples’ data was unavailable for the present research due to either couples not completing the behavioral and physiology session or due to equipment malfunctions. Eleven additional couples’ data was unable to be adequately fit by the coregulation model as a result of (a) prescription medication usage (N = 9), (b) a large number of premature ventricular contractions (PVCs; N = 1), or (c) poorly fitting data ($R^2 = .61$ vs. average $R^2 = .99$ for the other couples; N = 1).

Preliminary analyses identified several multivariate outliers (generalized Cook’s distance values > 2). Because multivariate outliers undermine the parameter estimates of interest (for a useful review of outlier treatment in SEM, see Aguinis et al., 2013), we sought to omit data that would misrepresent the overall pattern in the data. Further analyses identified eleven univariate outliers on the coregulation parameters: once these couples were excluded from analyses, we saw no remaining evidence of multivariate outliers. We report on the sample characteristics of the 99 couples whose data passed these quality checks. Couples included on the basis of these quality checks (N = 99) did not differ from the total sample for the parent study (N = 130) in terms of demographic characteristics or diagnoses ($p$’s > .07).

Of the 99 couples, the average relationship length was 5 years 1 mo. ($SD = 4$ yr. 4 mo.; range: 2.5 mo. – 20 yr.) and most couples were cohabitating (75%). Eighty-five percent of couples were comprised of opposite sex partners (14% female couples, 1%
male couples). A majority (76%) of the 198 participants (44% male) identified as white, while other participants identified as African American (14%), Asian American (2%) or multiracial (8%). The average age of participants was 30 years old ($SD = 7$ yr.).

Procedure

The University of Pittsburgh Institutional Review Board approved all study procedures, and participants provided informed, written consent. We report on data collected during three sessions of the parent study: (1) a clinical interviews session, (2) a self-report session, and (3) a behavioral and physiology session.

Interview-Based Clinical Assessment. Psychiatric symptoms and attachment ratings (described in further detail under the Adult Attachment Ratings subsection) were assessed by PhD and masters-level clinical interviewers. To avoid contamination of ratings between partners, separate interviewers assessed each member of a couple. In a diagnostic case conference, ratings for each participant were discussed and finalized by at least three judges: the principal clinical interviewer and at least two other members of the research team (Pilkonis et al., 1995).

Psychiatric diagnoses were determined using the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID; First et al., 1997) and the Structured Interview for DSM-IV Personality (SIDP-IV; Pfohl et al., 1997). We verified interrater reliability (ICC = .90) of personality disorder severity (i.e., the sum of 80 items assessing PDs) by having seven interviewers score SIDP-IV criteria based on recorded videos from a subset of interviews (five videos).

Conflict Discussion. To identify a topic appropriate for the conflict discussion, couples completed an “Areas of Disagreement” form that asked participants to rate
conflicts in the relationship across different domains (e.g., household duties, sex, finances). The experimenter then (a) facilitated a discussion to determine the area of greatest conflict and a brief conversation about the nature of the disagreement between members of the couple, and (b) instructed the couple to discuss this topic further. During the discussion of the conflict, the experimenter monitored the couple via a live video stream of the ten-minute discussion in an adjoining room. Examining coregulation during this discussion allowed us to assess coregulation during an attachment-threat context (c.f. Sbarra & Hazan, 2008; Timmons et al., 2015).

**Event Discussion.** After the conflict discussion portion of the visit, participants were instructed to plan a “fun event” together for five minutes. We used these data to examine the specificity of our primary results (Mikulincer et al., 2003). The experimenter monitored this discussion via a live video stream in an adjoining room.

**Electrocardiogram Recording (ECG).** Research assistants affixed two Ag-AgCl electrodes in a Lead II configuration to each member of the couple. Using a BIOPAC MP150 system, cardiac activity was measured using an electrocardiogram (ECG), which was sampled at 1000 Hz (see Fig 1a – ECG Raw panel; BIOPAC Systems, Inc.; Goleta, California, USA). Using a peak detection algorithm implemented in the `processHrv` toolbox, we converted ECG data into an inter-beat intervals (IBI) time series (Larry Greishar, University of Wisconsin) in MATLAB. IBI time series were then spline-interpolated onto a 10 Hz grid to generate an evenly sampled time series reflecting heart rate variation. Trained research assistants inspected IBI time series to identify and then to correct missed or artifactual beats. Unreliable portions of IBI time series (e.g. due to PVCs) were censored from analyses ($M = 3.9\%$, $SD = 4.9\%$ for 15 participants
with PVCs). While visual inspection suggested limited linear trends in the IBI time series, low frequency components of the IBI time series undermine estimation of momentary regulatory dynamics; as such, we centered and detrended the IBI time series (see Fig 1a – IBI Time Series panel).

**Attachment Measures**

Participants’ dispositional attachment style was assessed via Adult Attachment Ratings (AAR), conducted during the clinical-interview session, and via the Experiences in Close Relationship scale-Revised (ECR-R; Fraley et al., 2000), collected during the self-report session. Participants’ state attachment insecurity was assessed via the State Adult Attachment Measure (SAAM; Gillath et al., 2009), which was collected twice during the behavioral and physiology session: just before (*baseline* assessment) and immediately following (*change* assessment) the conflict discussion.

**Adult Attachment Ratings (AAR).** Using an interview focused on parental, work, and romantic relationships throughout the lifespan (Interpersonal Relations Assessment; Heape et al., 1989), clinical interviewers rated participants on attachment dimensions using the Adult Attachment Ratings (AAR; Pilkonis et al., 2013). For the purpose of the present research, we report on the excessive dependency (corresponding to attachment anxiety) and defensive separation (corresponding to attachment avoidance) AAR subscales. In a secondary analysis, we additionally report on the secure AAR subscale.

**Experiences in Close Relationships – Revised (ECR-R).** Participants completed the Experiences in Close Relationships – Revised scale (ECR-R; Fraley et al., 2000), which assesses attachment security within adult relationships. We examined
the anxiety and avoidance subscales of the ECR-R. Whereas attachment anxiety is associated with seeking excessive reassurance and nurturance, attachment avoidance is associated with emotional distancing of oneself from other people (Mikulincer et al., 2003). The anxiety (proband: $\alpha = .92$; partner $\alpha = .93$) and avoidance (proband: $\alpha = .91$; partner $\alpha = .92$) subscales exhibited excellent internal consistency.

**State Adult Attachment Measure (SAAM).** Participants completed the State Adult Attachment Measure (SAAM; Gillath et al., 2009) prior to and immediately after the conflict discussion. The SAAM includes three seven-item subscales that assess momentary attachment security (e.g. "I feel loved"), anxiety (e.g., "I really need to feel loved right now"), and avoidance (e.g., "I feel like I am loved by others but I really don't care"). We report on the anxiety and avoidance subscales of the SAAM, which exhibited acceptable to good internal reliability ($\alpha$’s range from .78 to .88).

** Analyses **

**Coregulation model specification.** We used stochastic differential equations to estimate the coregulation of couples’ heart rates; the equations include self-coupling and cross-coupling parameters that quantify intrapersonal and interpersonal influences, respectively (see Fig. 1a SDEs panel; Steele et al., 2014). Whereas self-coupling reflects an individual’s tendency to return to a personal homeostatic set point of heart rate (fixed to the mean of the linearly detrended IBI time series), cross-coupling indexes coregulation by quantifying the directed cross-partner influence on the alignment or misalignment of heart rate: negative cross-coupling parameter estimates reflect a cross-partner influence that promotes misalignment of heart rate away from the partner, termed here as **contrarian** coregulation, and positive cross-coupling estimates reflect a
cross-partner influence that promotes alignment of heart rate toward the partner, termed here as *dependent* coregulation.

**Parameter estimation.** We fit physiological coupling parameter estimates for each couple’s mean-centered, linearly detrended bivariate IBI time series in a nonlinear stochastic state-space framework (based on Steele et al., 2014) using the Variational Bayesian Analysis (VBA) Toolbox (Daunizeau et al., 2014) implemented in MATLAB 2016b (Mathworks, 2016). To obtain estimates of coregulation for both the conflict and event discussions for each couple, we separately modeled coregulation of heart rate from these two epochs. We assessed fit of the model to the data using posterior predictive checks of observed versus predicted heart rate data and model $R^2$. We then extracted posterior parameter estimates for self- and cross-coupling for the purpose of individual difference analyses.

**Actor-Partner Interdependence Models (APIM).** We tested our hypotheses by examining (a) how coregulation mediated changes in state anxiety and avoidance and (b) how dispositional attachment style moderated state attachment dynamics. To account for the nested structure of the data, these analyses were conducted using APIMs in a Bayesian Structural Equation Modeling (BSEM) framework and were implemented in *Mplus* version 8 (L. K. Muthén & Muthén, 2013).

We report standardized effects and Bayesian two-tailed $p$-values (i.e., a test statistic closely aligned with frequentist null hypothesis significance testing; Makowski et al., 2019). We report on effects that are remarkably different from zero ($p \leq .05$). As assessed via posterior predictive $p$-values (analogous to the model-chi square test in frequentist SEM analyses), all reported models exhibited good fit ($PPp$’s $> .05$).
Results

The Role of Physiological Coregulation in State Attachment Processes

State Avoidance. Probands’ baseline avoidance predicted contrarian coregulation ($\beta = -.09, p = .028$), which in turn predicted increases in state avoidance ($\beta = -.17, p = .008$; mediation $\beta = .02, p = .036$). Though coregulation did not mediate changes in partner’s state avoidance, $p$’s $>.10$, probands’ baseline avoidance predicted partners exhibiting contrarian coregulation ($\beta = -.08, p = .028$). Thus, both probands and partners exhibited contrarian coregulation in response to probands’ baseline avoidance.

State Anxiety. Coregulation did not account for changes in state anxiety, $p$’s $>.11$. Nevertheless, more dependent coregulation predicted a within-person increase in anxiety for both probands and partners (proband $\beta = .11, p = .028$; partner $\beta = .14, p = .028$).

Dispositional Attachment Style Moderates Effects of Physiological Coregulation

Self-Reported Dispositional Attachment Style. Self-reported anxiety and avoidance refer to the corresponding subscales of the ECR-R.

State Attachment Avoidance. Partner’s dispositional avoidance amplified the tendency for probands to exhibit contrarian coregulation (Fig. 2b - 1) and attenuated the tendency for partners to exhibit contrarian coregulation (Fig. 2b - 2) in response to probands’ baseline avoidance. Dispositional anxiety did not moderate state avoidance processes, $p$’s $>.06$.

State Attachment Anxiety. Partner’s dispositional anxiety moderated how probands responded to their own baseline anxiety (Fig. 2c - 2). If partners were high in dispositional anxiety, probands exhibited contrarian coregulation, and, if partners were
low in dispositional anxiety, probands exhibited dependent coregulation in response to their own baseline anxiety. Dispositional avoidance did not moderate state anxiety processes, $p$’s > .10.

**Clinician-Rated Dispositional Attachment Style.** Clinician-rated anxiety and avoidance refer to the excessive dependency and defensive separation subscales of the AAR, respectively.

**State Attachment Avoidance.** In couples where either the proband or partner was dispositionally anxious, probands were less likely to respond to baseline avoidance by exhibiting contrarian coregulation, (Fig. 2a -1 and Fig. 2a - 2). Conversely, partners were more likely to respond to probands' baseline avoidance by exhibiting contrarian coregulation (Fig. 2a - 3 and Fig. 2a - 4). Dispositional avoidance did not moderate state avoidance processes, $p$’s > .10.

**State Attachment Anxiety.** Dispositionally anxious probands were more likely to exhibit dependent coregulation in response to their own anxiety (Fig. 2c - 1). Conversely, if either member of the couple was dispositionally anxious, partners tended to exhibit contrarian coregulation in response to probands' baseline anxiety (Fig. 2c - 3 and Fig. 2c - 4).

Partners’ dispositional avoidance predicted (a) probands exhibiting dependent coregulation in response to partners' baseline anxiety (Fig. 2d - 3) and (b) probands' reporting decreases in anxiety in response to their own dependent coregulation (Fig. 2d - 5). Moreover, probands' dispositional avoidance predicted (a) partners' exhibiting dependent coregulation in response to both probands’ and partners' baseline anxiety
(Fig. 2d - 1 and Fig. 2d - 2) and (b) partners reporting decreases in anxiety in response to their own dependent coregulation (Fig. 2d - 4).

Secondary Analyses

Security Moderates Effects of Coregulation. We contextualized our primary results focusing on dispositional attachment insecurity by examining the effects of dispositional security. Secure partners exhibited dependent coregulation in response to probands’ state avoidance and anxiety. That is, secure partners shifted their physiology towards probands’ in response to probands’ state insecurity. Additionally, if either member of the couple was secure, probands exhibited dependent coregulation in response to their own baseline anxiety (results summarized in Table 1 Section 1).

The Role of Context in Coregulation. We tested the specificity of our results by examining the association between state attachment processes and physiological coregulation during the event discussion. We found that partners exhibited contrarian coregulation in response to probands’ baseline avoidance. Dispositional attachment style did not significantly moderate this effect, $p$'s > .34.

On the other hand, state attachment anxiety and physiological coregulation during the event discussion were not significantly related. Follow up analyses indicated that this association was qualified by dispositional attachment style. Dispositionally anxious partners exhibited dependent coregulation in response to their own baseline anxiety. Yet, in couples where either the proband was dispositionally anxious or the partner was dispositionally avoidant, partners exhibited contrarian coregulation in response to their own increases in anxiety (results summarized in Table 1 Section 2). Altogether, these results provide weak evidence that moderation of state insecurity on
coregulation by dispositional attachment style was specific to the conflict discussion context. Instead, results suggest that dispositional attachment style moderated effects of state insecurity on coregulation similarly across contexts.

**Incremental Utility of Self-Report and Clinician-Ratings.** We observed that self-reported and clinician-rated measures of attachment style provided unique information (self versus clinical ratings were modestly correlated; $r_{avo} = .20; r_{anx} = .35$) and predicted distinct outcomes. As such, we tested the incremental utility of self-reported and clinician-rated attachment style in our data: when both self-reported and clinician-rated measures of attachment style were included simultaneously, effects from primary analyses were qualitatively unchanged and quantitatively similar (13 of the 15 primary results remained statistically significant; see Table 1 Section 3).

**Sensitivity Analyses**

In sensitivity analyses, we first verified that our results were not driven by demographic factors (including race, sex, and age): demographic variables and coregulation were not significantly correlated, $p's > .06$, and effects of interest were unchanged when demographic variables were included as covariates. Second, we verified that our results were not better accounted for by global functioning (Global Assessment of Functioning; outlined on p. 34 of American Psychiatric Association., 2000): global functioning and coregulation were not significantly correlated, $p's > .18$, and effects of interest held when global functioning was included as a covariate.

**Discussion**

Physiological coregulation is observed in attachment relationships (Sbarra & Hazan, 2008), is disrupted by attachment insecurity (Helm et al., 2012), and is
associated with relationship dysfunction in couples with personality disorders (Schreiber et al., 2020). Extending these lines of inquiry, this study examined the role of physiological coregulation in moment-to-moment attachment processes in couples affected by personality pathology. We hypothesized that contrarian coregulation would account for increases in state attachment avoidance following a conflict discussion, while dependent coregulation would account for increases in state attachment anxiety (Helm et al., 2012). Our results supported these hypotheses: (a) probands’ increases in state attachment avoidance were accounted for by a tendency to exhibit contrarian coregulation, and (b) in both probands and partners, exhibiting dependent coregulation predicted increases in state anxiety.

Based on the notion that individuals respond to a threat context in accordance with their attachment style (Mikulincer et al., 2003), we further hypothesized that (a) dispositionally avoidant individuals would exhibit contrarian coregulation in response to both state anxiety and avoidance and (b) dispositionally anxious individuals would exhibit dependent coregulation in response to both state anxiety and avoidance. Our findings partially supported these hypotheses: dispositionally anxious probands exhibited contrarian coregulation in response to both momentary anxiety and avoidance.

These results support the notion that coregulation of heart rate is involved in state attachment dynamics evoked in response to a perceived threat. Specifically, physiological coregulation may be a component of the hyperactivating or deactivating strategies that support emotion regulation in response to a perceived threat (Mikulincer et al., 2003). Indeed, theory and empirical research indicate that coregulation is involved
in emotion regulation (Butler & Randall, 2013; Nelson et al., 2017). Likewise, prior work demonstrated disruptions to coregulation portended increases in negative affect among psychiatric outpatients (Schreiber et al., 2020).

Importantly, psychiatric populations often have lower autonomic flexibility, which contributes to difficulties regulating emotions (Beauchaine, 2001; Beauchaine et al., 2007) and may impact effective coregulation of heart rate (Hughes et al., 2011). Moreover, reduced capacity for patients to regulate their own emotions may increase their reliance on coregulation by a romantic partner (Butner et al., 2007). Therefore, we examined how proband and partner dispositional attachment style was associated with dependent versus contrarian physiological coregulation and how individual differences in coregulation were associated with momentary changes in attachment processes.

For couples where either the proband or partner was dispositionally anxious, partners exhibited contrarian coregulation—leading the partner’s heart rate to become increasingly misaligned away from the proband’s heart rate—in response to probands’ baseline insecurity. This finding aligns both with evidence that attachment anxiety and demanding behavior elicit withdrawal behavior from a romantic partner (Beeney et al., 2019) and with the notion that dispositional attachment anxiety interferes with providing support to a romantic partner (Davila & Kashy, 2009). In cases where the partners’ dispositional attachment style matched the probands’ baseline attachment insecurity (i.e., state anxious proband with dispositionally anxious partner or state avoidant proband with dispositionally avoidant partner), the proband exhibited contrarian coregulation in response to state insecurity.
To illustrate such dynamics, let us say that Ainsley and Charlie are about to discuss how they manage money, a contentious issue for the couple. If Ainsley is currently experiencing heightened attachment anxiety and Charlie is dispositionally anxious about their relationship, Ainsley’s cardiovascular physiology is likely to diverge from Charlie’s during the conflict discussion. Importantly, \textit{avoidant dynamics} are thought to be elicited by the perception that the attachment figure is unavailable for support (Mikulincer et al., 2003). As such, contrarian coregulation may reflect a sense (conscious or unconscious) that the romantic partner does not have the capacity to provide support. In other words, Ainsley’s tendency to pull away from Charlie may reflect the sense that Charlie is unavailable (possibly as a result of Charlie’s anxious preoccupation about the relationship) to share the physiological load of Ainsley’s heightened attachment anxiety.

Conversely, incongruence between an individual’s dispositional attachment insecurity and the romantic partner’s state insecurity (i.e., state avoidant proband with a dispositionally anxious partner or state anxious partner with a dispositionally avoidant proband) increased the tendency for the individual to exhibit dependent coregulation in response to state insecurity. \textit{Anxious dynamics} are thought to be elicited by the perception that the attachment figure is available (Mikulincer et al., 2003), and incongruence between a romantic partner’s dispositional attachment style and an individual’s state insecurity may lead to the perception that the romantic partner is available to provide support, thus eliciting dependent coregulation. Taken together, our findings suggest that romantic partners’ dispositional attachment style alters how individuals respond to their own state insecurity about the relationship. Whereas
congruency may lead to the perception that the partner is unavailable for support and elicit avoidant dynamics, incongruency may convey that the partner has capacity to provide support and elicit anxious dynamics.

We conducted a series of secondary analyses to contextualize our results. First, we examined the effects of dispositional security (reflecting low anxiety and low avoidance; Bartholomew & Horowitz, 1991). Dispositional security of partners or probands predicted probands responding to their own state anxiety with dependent coregulation, and dispositional security of partners predicted partners exhibiting dependent coregulation in response to proband’s state insecurity. These results align with the view that physiological coregulation is involved in providing emotional support (Sbarra & Hazan, 2008) and with the view that attachment security reflects the sense that a partner is responsive and available to provide support (Bowlby, 1969, 1982).

Second, we assessed the incremental utility of self-reported and clinician-rated measures of attachment style. These measures were only modestly correlated and predicted different outcomes. Overall, we observed greater predictive utility for clinician-rated measures of dispositional attachment insecurity. While self-reported avoidance was a moderator of state avoidance dynamics, clinician-rated avoidance was associated with state anxiety dynamics and clinician-rated anxiety was more closely related to state insecurity (7 effects using clinician-rated measure versus 1 effect using self-report measure). The relative strength of clinician-rated measures suggests that clinicians may form judgments about internal working models of self and other that are particularly informative for predicting momentary interpersonal dynamics in romantic couples. Our findings suggest that clinicians working with couples may benefit from
assessing dispositional attachment style to inform their conceptualization of a couples’ relational dynamics.

Finally, we examined the role of context in coregulation and attachment dynamics. Physiological coregulation may play a particularly important role in threat contexts such as a conflict discussion (Timmons et al., 2015). Indeed, we observed a greater number of statistically significant findings in the threat context. Nonetheless, the specific dynamics observed in an unthreatening context (i.e., event discussion) largely mirrored our main findings. Across both contexts, partners exhibited contrarian coregulation in response to the probands’ baseline anxiety. Whereas probands’ and partners’ dispositional anxiety moderated effects of probands’ baseline anxiety on probands’ coregulation during the conflict discussion, anxiety moderated effects of partners’ state anxiety on partners’ coregulation during the event discussion. Taken together, we found support that effects of dispositional attachment style on coregulation are similar across situational contexts, but these effects seem to be particularly pronounced in an attachment threat context.

**Strengths and Limitations**

Our study design provides new insights into how attachment relates to physiological coregulation across multiple contexts (e.g., conflict discussion), allowing us to establish the specificity of our effects to a given context. Nonetheless, all couples first engaged in the conflict discussion and then in the event planning discussion. Thus, the cross-context alignment of our results could be partly driven by carryover effects. Future work could circumvent this limitation by randomizing the order of different discussions. We note that this decision was guided by ethical considerations aimed at
reducing distress elicited by the conflict discussion. As such, future work that aims to control for order effects would entail additional design considerations to mitigate participants’ distress.

To our knowledge, this is the first study to examine how both self-reported and clinician-rated dispositional attachment style affect physiological coregulation and attachment dynamics. That said, we used the clinician-rated Adult Attachment Ratings (AAR) scale, which assesses attachment themes broadly across past and present relationships (Pilkonis et al., 2013). The AAR contrasts with other interview-based measures of attachment, particularly the Adult Attachment Interview (George et al., 1985), that focus on participants’ attachment relationships during childhood. It is thus possible that our findings may not match future research that employs clinician-rated measures of attachment based primarily on experiences with caregivers during childhood.

Methodologically, our use of stochastic differential equations to quantify heart rate dynamics had the advantages of (a) capturing a directed momentary influence of one partner on the other (Ferrer & Helm, 2013) and (b) inclusion of state noise in the model to account for random physiological fluctuations (Daunizeau et al., 2012). Nonetheless, our use of a two-step analytic approach in which we first estimated coregulation parameters for each couple separately (Steele et al., 2014) and then conducted group analyses to test our hypotheses precluded us from (a) propagating uncertainty of the parameter estimates to the group analysis and (b) regularizing parameter estimates through hierarchical modeling.
Finally, our sampling frame of couples with PDs allowed for a fine-grained analysis of the role of coregulation in attachment dynamics among individuals for whom these dynamics are highly relevant (Levy et al., 2015). Future work with diverse clinical populations and community samples, however, is needed to provide insight into the generality of our findings. We mitigated the concern that our effects were driven by the severity of psychopathology by testing models that included psychiatric global functioning as a covariate.

Conclusion

Our findings suggest that physiological coregulation is a component of the emotion regulation strategies elicited by a perceived attachment threat. Whereas momentary increases in attachment avoidance were associated with *contrarian* coregulation, momentary increases in attachment anxiety were associated with *dependent* coregulation (c.f. Mikulincer et al., 2003). Moreover, individuals responded to *state* insecurity in a manner consistent with their *dispositional* attachment style: whereas *dispositionally* avoidant individuals exhibited *contrarian* coregulation in response to *state* insecurity, *dispositionally* anxious individuals exhibited *dependent* coregulation in response to *state* insecurity. These effects were particularly pronounced for psychiatric outpatients, suggesting that psychopathology may be associated with a greater reliance on a romantic partner to regulate emotional arousal (Butner et al., 2007). Altogether, our findings highlight the role of physiological coregulation as a proximate process of dysfunctional attachment dynamics in romantic couples affected by personality pathology.
The data to support the findings of this study and the code to reproduce results from analyses are available at: https://zenodo.org/record/4050387#.X248Iy9h3OQ
References


Figure 1. (a) An overview of the preprocessing and analysis pipeline: for each couple (1) raw ECG signal is (2) preprocessed to allow for (3) idiographic estimation of self-coupling and cross-coupling parameters. (b) Conceptual figure of how we test hypothesized links among dispositional attachment measures, state attachment measures and physiological coregulation. Arrows denote that the following index was regressed on the preceding index. Black circles denote moderation of a pathway.
Figure 2. State measures of attachment insecurity and coregulation are bounded in rectangles. Dispositional measures of attachment style are bounded in rounded rectangles. † denotes clinician-rated (AAR) effects. ^ denotes self-reported (ECR-R) effects. Standardized coefficients of significant effects are included alongside the corresponding path. Regression paths are indicated with a single arrow. Moderation paths are indicated with a single circle. Whereas red (dark gray) reflects a positive association, blue (light gray) reflects a negative association. Dashed gray lines reflect a non-significant path. Moderation paths are further denoted with enclosed numerals. Graphs of the predicted effects for these moderation paths are included on the right-hand side of the corresponding panel and are denoted with the corresponding enclosed numeral. In these graphs, red (dark gray) lines are used for the predicted effect for an individual high (80th percentile) on the dispositional measure of attachment insecurity and blue (light gray) lines are used for the predicted effect for an individual low (20th percentile) on the dispositional measure of attachment insecurity. These graphs are further annotated with the p-value for the corresponding moderation path. Paths included in the model but not shown for clarity: post-discussion levels of state attachment insecurity regressed on baseline levels and covariances between temporally concurrent predictors. Dispositional (a) anxiety and (b) avoidance moderating state avoidance processes. Dispositional (c) anxiety and (d) avoidance moderating state anxiety processes. See Table S1 in the online supplement for additional info on the models presented here, including all coefficients and p-values for all paths in the models and the posterior predictive p-values for each of the models.
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*Note.* $\text{pro} = \text{proband}; \ \text{par} = \text{partner}. \ \text{ANX} = \text{attachment anxiety}. \ \text{AVO} = \text{attachment avoidance}. \ \Delta \text{refers to change in a state measure}. \ \text{sr} = \text{self-reported}. \ \text{cr} = \text{clinician-rated}. \ \times \text{indicates that the preceding term is a moderator}. \ \rightarrow \text{indicates that the following term is regressed on the preceding term}.