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Interpersonal Conversations Are Characterized by Increases in Respiratory Sinus Arrhythmia

Nathan C. Stuart[1] | Brett J. Peters[1] | Peggy M. Zoccola[1] | Ashley Tudder[2] | Jeremy P. Jamieson[3]

[1]Ohio University, Athens, Ohio, USA | [2]Florida State University, Tallahassee, Florida, USA | [3]University of Rochester, Rochester, New York, USA

Correspondence: Nathan C. Stuart (ns111021@ohio.edu)

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ABSTRACT

Multiple theoretical perspectives connect vagally mediated heart rate variability, or respiratory sinus arrhythmia (RSA), and self-regulatory and interpersonal processes. Together they suggest that self-regulatory effort and positive social experiences may lead to short-term increases in RSA, which in turn are related to adaptive emotional, social, and physical functioning. However, the extant literature on adult social interactions does not clearly support this premise. To study the connections between dyadic social interactions and phasic changes in RSA, the current research examined 356 dyads (712 adults between 18 and 36 years; 50% males, 50% females) across three studies in which participants engaged in face-to-face social interactions in a laboratory setting. Relationship type and conversation context varied across studies, and high-frequency power was used to estimate RSA across resting baseline, anticipatory periods, and conversation tasks. Analyses indicated that anticipation of and engagement in dyadic social interactions were associated with an increase in RSA from a resting baseline. The mean estimated effect size for anticipation was $r = 0.50$, and the mean estimated effect size for conversation was $r = 0.34$. Associations were robust across relationship types, including strangers and romantic couples, conversation context, including topic and valence, and across speaking and listening roles. The present research provides consistent evidence for increased RSA in anticipation of and during in-person social interactions among adults, prompting the need for further investigation into potential underlying mechanisms.

1 | Introduction

Social interactions are some of the most commonplace and richest experiences humans have. With this richness comes a complexity of interpersonal processes, including changes in cognition, affect, and behavior (Redcay and Schilbach 2019) that are grounded and reflected in a myriad of biological parameters, including changes in heart rate known as heart rate variability (Smith et al. 2020). According to the Neurovisceral Integration Model (Thayer and Lane 2000; Thayer et al. 2009), the central autonomic network—including the vagus nerve—coordinates organismic behavior through systematic self-regulation, which encompasses cognitive, affective, behavioral, and autonomic regulation. Respiratory-driven changes in HRV, or respiratory sinus arrhythmia (RSA) during social interactions, can thus function as a physiological indicator of flexible self-regulation via the dynamic activity of the central autonomic network (Thayer et al. 2009).

However, multiple theoretical and empirical perspectives delineate the role of RSA during interpersonal conversations (Smith et al. 2020), which often describe competing effects on HRV. For instance, reactive RSA may correspond to momentary self-regulatory exertion such as enacting emotion regulation goals during conversations (English and Eldesouky 2020; Segerstrom et al. 2012). Furthermore, the Generalized Unsafety Theory of Stress (Brosschot et al. 2016) postulates that situations perceived as safe such as during positive conversations or interacting with kin—where individuals feel they can let their guard down—can lead to phasic increases in RSA. Conversely, uncertain situations that lack safety cues such as conflict discussions or interacting with strangers may lead individuals to be vigilant of potential danger, which can lead to decreases in RSA. Thus, RSA is a rich biomarker to examine interpersonal dynamics and adjustment, yet the multidetermined nature of RSA (Smith et al. 2020) needs to be considered when characterizing RSA and social interactions. The primary goal of the research reported here was to examine the generalizability of RSA across a multitude of conversational features pertinent to RSA.

1.1 | RSA and Interpersonal Interactions

A meta-analysis (Shahrestani et al. 2015) that investigated RSA reactivity and social interactions—including minimally interactive tasks—concluded that negative social interactions were associated with decreases in RSA reactivity, particularly in samples younger than 30 years old. Most studies that examined RSA reactivity used the Trier Social Stress Test (TSST; Kirschbaum et al. 1993), a task where two evaluators negatively judge a participant's speech and mathematical performance with rude interruptions which is one of the most well-validated methods for inducing stress responses in laboratory settings (Yeager et al. 2022). These findings parallel theoretical and empirical links between negative social evaluative contexts such as the TSST—which removes cues of learned safety given the novelty and socially evaluative nature of the task—and decreases in RSA reactivity (e.g., Bosch et al. 2009; Brosschot et al. 2016). Further, decreases in RSA reactivity during working memory tasks have been linked to adaptive executive function (Graziano and Derefinko 2013; Obradović and Finch 2016). Thus, the cognitively demanding nature of the TSST may further account for observed decreases in RSA during negative social interactions. For instance, engaging in an effortful collaborative problem-solving task led to decreases in RSA in older adult couples (Smith et al. 2009).

Another insight from the meta-analytic data suggests that neither positive nor neutral tasks were associated with particular patterns of RSA reactivity (Shahrestani et al. 2015); however, the number of studies included was small and varied substantially in whether tasks were social in nature. Notably, few studies included in the meta-analysis assessed naturally unfolding interpersonal conversations in vivo (Butler et al. 2006; Willemen et al. 2008). Therefore, there is a need for a large-scale examination of RSA across a variety of interpersonal contexts.

Moreover, the evidence describing RSA reactivity during interpersonal conversations across topic valences is mixed and without a clear pattern, which limits theoretical interpretations. For instance, some studies are broadly consistent with predictions from a social safety framework (Brosschot et al. 2016). An intensive 1-week daily diary study showed that recent face-to-face social interactions rated as affiliative or comfortable compared to cold and hostile were accompanied by momentary increases in RSA among middle-aged and older adults (Liu et al. 2021). In addition, RSA reactivity increased among adolescents when reuniting and conversing with a parent following an alarm stress task (Willemen et al. 2008) and in women, but not men, during a positive conversation (Smith et al. 2011). Other studies found decreases in RSA reactivity during negative conversations involving perceiving the other as dominating (for women in particular; Smith et al. 2011), controlling (Deits-Lebehn et al. 2023), and aggressive (Godfrey and Babcock 2020). However, results from other studies are not consistent with social safety theory.

For instance, one study found increases in RSA reactivity across a variety of conversation valences among men, but not women (Helm et al. 2014), and yet other studies found no to little decreases in RSA reactivity during neutrally (Deits-Lebehn et al. 2023; Nealey-Moore et al. 2007; Smith et al. 2011), positively (Deits-Lebehn et al. 2023; Nealey-Moore et al. 2007), and negatively valenced conversations (Butler et al. 2006; Cribbet et al. 2020). Another study found increases in interbeat intervals—which are related to higher RSA—in adults during a negatively valenced conversation (Kordahji et al. 2015).

Furthermore, self-regulatory effort may potentiate RSA (Thayer et al. 2012; Segerstrom et al. 2012). Indeed, increases in RSA reactivity have been found in adults enacting a caregiver role (Borelli et al. 2019), in wives managing their husbands' negative affect during a conflict discussion (Smith et al. 2011), and during in-person negative conversations among college students instructed (vs. not) to regulate their emotions (Butler et al. 2006). However, no changes in RSA occurred among college students instructed to emotionally regulate during a pre-recorded video interaction (Deits-Lebehn et al. 2023). Thus, effortful self-regulation during in-person conversations may lead to potentiated RSA, yet the available evidence is unclear.

1.2 | Summary and Current Studies

Taken together, prior theoretical and empirical research implicating RSA and interpersonal interactions is inconsistent and without clear replicated patterns or demarcation of confluent influences on RSA (e.g., Butler et al. 2006; Helm et al. 2014; Smith et al. 2009). Further, the existing literature on this subject is relatively limited. We sought to address this gap by utilizing three large archival psychophysiological datasets—a total of 712 participants, which rivals previous meta-analyses (e.g., Shahrestani et al. 2015)—to examine the consistency of RSA reactivity across varying interpersonal contexts including different relationship types (strangers and romantic couples), conversation contexts (topic and valence), and temporal contexts (turn taking and anticipation) and probe sources of affordance and heterogeneity which may be obscured by meta-analyses. The primary aim and test in the current work was to examine the extent to which RSA changed during dyadic conversations, relative to a resting baseline (i.e., whether RSA reactivity, calculated as task—baseline, differed from zero or no change).

We also examined whether emotion regulation instructions, such as suppressing or expressing affective displays, were linked to greater RSA. Suppression of emotional displays is often related to regulatory effort, which may lead to increases in RSA (e.g., Butler et al. 2006). However, suppression is also linked to increased cognitive effort (Gross and Levenson 1997), and therefore may be related to decreases in RSA given the negative association between RSA and effortful cognitive tasks (Smith et al. 2009; Graziano and

Derefinko 2013). In the current work, we leveraged two archival datasets (Studies 1 and 2) that experimentally manipulated expressive suppression within a dyadic context (Peters et al. 2014; Peters and Jamieson 2016) to test whether emotion regulation context may strengthen or attenuate RSA reactivity.

Finally, pre-conversation anticipatory periods involve mental simulation of the upcoming conversation and/or other self-regulatory processes such as cognitive (re)appraisals and meaning-making (De Raedt and Hooley 2016). Thus, we also tested RSA reactivity in anticipation of and during conversations (Studies 1–3).

1.3 | Studies 1 and 2

Studies 1 and 2 examined dyadic conversations by capturing RSA reactivity in different-sex strangers (Study 1) and romantic partners (Study 2) who anticipated and engaged in a discussion about an upsetting video. The only methodological difference between Studies 1 and 2 was the relationship type (strangers vs. couples), thus methods and results are presented together.

2 | Methods

2.1 | Participants

The samples of 91 strangers (Study 1) and 88 relationships (Study 2) dyads were from studies that assessed the effects of emotion regulation and conversation role on cardiovascular challenge and threat responses (Peters et al. 2014, 2019; Peters and Jamieson 2016) and neuroendocrine responses (Peters et al. 2016). Participants were recruited via an online study pool (SONA) and flyers posted in the area. Participants were instructed not to exercise or consume foods with live cultures for 2 h before the scheduled study session. Participants were prescreened and excluded for physician-diagnosed hypertension, the presence of a cardiac pacemaker, medications with cardiac side effects, consuming caffeine or dairy products within 2 h of participating, and pregnancy/breastfeeding. See Table 1 for participant characteristics.

2.2 | Sample Size Estimation

An a priori power analysis was conducted to determine sample size. Using an averaged effect size from dyadic emotion regulation studies that included physiological measures at the time of data collection ($r = 0.26$; Butler et al. 2003, 2006; Mendes et al. 2003) and a target power level of 0.80, 45 couples were needed for each emotion regulation condition, totaling 90 dyads for each study.

2.3 | Procedure

Participation was limited to the afternoon and evening. Dyad members were escorted to private rooms, completed questionnaires (e.g., baseline emotional states), had sensors affixed, and relaxed for a 5-min baseline. During the resting baseline, participants were instructed to sit with feet flat on the floor, not fall asleep, not cross their feet, and not play with the sensors. After baseline, participants remained in their private testing rooms and watched a BBC World War II documentary to induce negative emotions, "Hiroshima: BBC History of World War II" (min 46:54–57:54). Participants reported their emotions immediately after viewing. Dyads were then instructed that they would be discussing their emotional reactions with a partner. One dyad member was randomly assigned to suppress or express affective displays. Their interaction partner was unaware of the manipulation and told simply to discuss. After instructions, dyad members remained in private rooms and were given 3-min to "gather their thoughts." Next, a large set of double doors separating the two participants were opened so that dyads could engage in a conversation for 5-min. All procedures were approved by the institutional review board. Participants were compensated $10 or 2-h of course credit.

TABLE 1 | Participant characteristics.

	Study 1, $n = 182$	**Study 2, $n = 176$**	**Study 3, $n = 354$**
Number of dyads	91	88	177
Relationship type	Strangers	Romantic	Romantic
Relationship length: M_{months}	—	14.7 (13.5)	16.0 (12.0)
Age: M_{years}	19.9 (1.4)	20.6 (2.6)	20.2 (1.9)
Female	50%	53%	54%
Race/Rthnicity			
Asian	27%	32%	26%
Black	5%	5%	7%
White	54%	49%	54%
Multiracial/Other/Unknown	8%	7%	9%
Hispanic	5%	6%	7%

2.4 | Measures

2.4.1 | Emotion Manipulation Check

Participants indicated the extent to which they were currently feeling emotional states at two time points (at baseline and after the negative emotion induction video) using a 7-point Likert scale (1 = *strongly disagree*, 7 = *strongly agree*). Three items assessing general positive emotion (i.e., happy, positive, and proud) and 5 items assessing general negative emotion (i.e., angry, embarrassed, sad, threatened, and guilty) were averaged to form positive (before video, Study 1: Cronbach's $\alpha = 0.786$, Study 2: $\alpha = 0.803$; after video, Study 1: $\alpha = 0.802$, Study 2: $\alpha = 0.894$) and negative (before video, Study 1: $\alpha = 0.807$, Study 2: $\alpha = 0.540$, after video, Study 1: $\alpha = 0.776$, Study 2: $\alpha = 0.804$) emotion composites. Reactivity scores were calculated by subtracting composites after the video from composites before the video for positive and negative emotions. Moreover, participants rated four items to assess the effectiveness of the emotion regulation manipulation, as reported elsewhere (see Peters et al. 2014; Peters and Jamieson 2016).

2.4.2 | Covariates

Biological sex assigned at birth and age were used as covariates in all analyses across studies because prior work has indicated that these can affect RSA (e.g., Liao et al. 1995; Reardon and Malik 1996), and therefore are commonly examined when investigating RSA.

2.4.3 | RSA

Current best practices were used to assess RSA (Laborde et al. 2017; Quintana et al. 2016). Electrocardiograph (ECG) and impedance cardiograph (ICG) signals were collected at 1000 Hz throughout. Signals were integrated with an MP150 system (Biopac Sytems Inc., Goleta, CA) and acquired using Acqknowledge software. ECG sensors were placed in a Lead II configuration. Noninvasive cardiac output hardware (NICO100C, Biopac Systems Inc.) with band sensors was used to measure impedance magnitude (Zo). Two band sensors were affixed at the base of participants' necks and on their torso just below the sternum to measure ICG.

2.4.4 | Data Analytic Plan

RSA was calculated using MindWare software (Heart Rate Variability 3.0.21; Gahanna, OH). Respiration was derived from the Zo signal (Ernst et al. 1999). In line with recommendations, data were analyzed with and without adjusting for respiration, given RSA and respiration have common neural origins (Laborde et al. 2017). Frequency-domain statistics were calculated using a Fast Fourier Transformation (FFT). The Hamming HF/RSA band was used and set to 0.12–0.40 Hz. Min were excluded when values were outside of this range (0.12–0.40 Hz). Data were visually examined for artifacts by trained research personnel. Consistent with other lines of work, within-person changes were calculated by subtracting the last minute of the 5-min baseline (the most relaxed period) from the first minute of the 3-min anticipatory period and the conversation (the most reactive periods; for a similar approach see Peters et al. 2014). One-minute segments of data were analyzed following recommendations that epochs should be the same size when making comparisons (Thorson et al. 2018).[1]

Analyses followed (Kenny et al. 2006) guidelines for dyadic regression models that account for the dependence associated across partners using the MIXED procedure in SPSS 25, where dyad members were distinguished by sex. Maximum likelihood estimation uses available case analysis, and therefore the contribution of the effects was weighted by the reliability of the data (i.e., those with more data contribute more to the estimates of effects). Thus, missing data was partially accounted for when using this statistical approach, and no imputing or estimation was required (e.g., Overall et al. 2014; Peters and Jamieson 2016).

3 | Results

3.1 | Emotion Manipulation Checks

Results indicated that the emotion manipulation was successful in decreasing positive emotion and increasing negative emotion (see OSM for descriptive statistics). Also, as reported in extant work using these datasets (see Peters et al. 2014; Peters and Jamieson 2016), the emotion regulation manipulation was successful as participants instructed to regulate their emotions reported holding back their emotions more in the suppression (vs. expression) condition.

3.2 | RSA

We regressed individuals' RSA reactivity scores on the intercept, which represented the average change in RSA from baseline. We also included the following fixed effects: (1) sex (−1 = female, 1 = male), (2) age (grand-mean centered), and (3) respiration rate reactivity (task—baseline; grand-mean centered; Shahrestani et al. 2015). We also had the following additional effects specific to the experimental paradigm: (4) condition assignment (−1 = suppression, 1 = expression), (5) role assignment (−1 = regulator, 1 = target) and (6) the interaction between condition and role.[2]

Both dyad members exhibited increases in RSA reactivity in anticipation of and during the conversation, controlling for the regulation condition, conversation role, age, sex, and respiration rate, with estimated effect sizes ranging from $r = 0.29–0.58$ (see Table 2), which range from small to moderate according to newer standards (Quintana 2017). Emotion regulation instructions were not significantly related to RSA reactivity. See Tables S1 and S2 for all fixed effects and Table S8 for means and standard deviations.

4 | Study 3

Building on the first two studies, Study 3 examined RSA reactivity in romantic couples before and during interactions in which conversation topics discussed varied in their intended valence (neutral, negative, and positive) and were all personally relevant topics (conflict or partner dependence). Additionally, we also

TABLE 2 | Effects of RSA reactivity across studies 1–3.

	Conversation topic	Valence	*B*	SE	95% CI, low, high	*t*	*r*
Study 1: Strangers	Video: Emotional video	Negative					
Anticipatory period			0.41	0.06	0.29, 0.54	6.43**	0.58
Conversation			0.31	0.09	0.14, 0.50	3.48**	0.36
Study 2: Romantic partners	Video: Emotional video	Negative					
Anticipatory period			0.33	0.06	0.19, 0.56	4.83**	0.50
Conversation			0.23	0.08	0.05, 0.42	2.50*	0.29
Study 3: Romantic partners							
Conversation 1	Events of the week	Neutral					
Anticipatory period			0.26	0.05	0.17, 0.36	5.33**	0.39
Conversation							
Only one person talking			0.21	0.06	0.09, 0.32	3.47**	0.27
Both permitted to talk			0.28	0.06	0.17, 0.39	5.12**	0.37
Conversation 2	Pet peeves/ dependence	Negative/Positive					
Anticipatory period			0.16	0.05	0.05, 0.26	3.11*	0.24
Conversation							
Only one person talking			0.25	0.06	0.13, 0.36	4.15**	0.31
Both permitted to talk			0.36	0.06	0.24, 0.47	5.96**	0.42

Note: Effect sizes (r) were approximated using (Rosenthal and Rosnow 2007) formula:

$$r = \sqrt{\left(\frac{t^2}{t^2 + df}\right)}$$

*$p < 0.05$.
**$p < 0.01$.

assessed the generalizability of RSA reactivity during conversations by manipulating speaking and listening roles.

5 | Methods

5.1 | Participants

177 dyads (total $N = 354$; 169 different sex dyads) who had been involved in a romantic relationship for at least 3 months ($M_{length} = 16$, SD = 11.99, range 18–36) were recruited to participate through an online study pool system (SONA) and flyers posted in the area. Participants were compensated with 2 credit hours or $10–$20. See Table 1 for participant characteristics. This study was part of a larger project examining adult attachment and stress appraisals in romantic relationships (Peters 2017; Peters et al. 2024). However, the analyses presented here concerning RSA reactivity have not been reported before.

5.2 | Sample Size Estimation

A series of Monte Carlo simulations were conducted with equality constraints for the paths modeling effects of each dyad. Based on these simulations, approximately 160 dyads were recruited as part of a larger study on romantic dyads and attachment, to achieve sufficient power (> 0.80) to test small to medium effects ($r = 0.15$). Due to anticipated physiological malfunctions, data collection continued until the end of the academic semester.

5.3 | Procedure

Upon arrival, dyad members were immediately separated into private testing rooms where they provided consent and completed baseline questionnaires (e.g., baseline emotional states). The experimenter then affixed physiological sensors, and participants relaxed for a 5-min resting baseline recording.

5.3.1 | Neutral Conversation Topic

Following baseline, all couples engaged in a conversation about events that occurred to them in the past week. The conversation topic was designed to be neutral and mundane. Indeed, the experimenters emphasized to couples not to discuss stressful topics using the following instructions:

> In a moment, you and your significant other will engage in a 4-min discussion about the events of your week. Just have a chat about how your day or week has been. It is important that you do not discuss stressful issues. Rather, focus on relatively mundane events that happened this past week.

After these instructions, couples had 3-min to "gather their thoughts." After the anticipatory period, but immediately prior to the conversation, one member of the dyad was randomly assigned to disclose the events of their week. That dyad member was given 2-min to explain their choices to their partner, followed by a 2-min free discussion period.[3] After the neutral conversation, participants returned to their private testing rooms and were left alone for a 3-min recovery period to allow physiological responses to return to baseline levels.

5.3.2 | Positive or Negative Conversation Topics

After the conversation about the events of their week, couples were randomly assigned to receive instructions for one of two conversation topics. For one topic, couples engaged in a 4-min discussion about the things they disliked most about each other or considered to be "pet-peeves." One member of the dyad was instructed to reveal their dislikes and discuss them with their partner:

> You are now going to engage in another discussion with your romantic partner. People are not perfect; everyone has flaws. Just like there are things we don't like about ourselves, there are often habits, attitudes, or behaviors we don't like about our romantic partner and may even cause conflict or problems in the relationship. For the next conversation, you and your significant other will engage in a 4-minute discussion about the top 3 things that annoy you the most about your partner or consider to be 'pet-peeves.' For each annoyance or pet-peeve, explain to your partner, in detail, why you picked it. Like during the last conversation you will have 2 min to explain your choices to your partner, and 2 min to discuss.

Couples not randomly assigned to the negative conversation topic were instead assigned to engage in a 4-min conversation about the top three ways in which they depend on their partners. As with the other conversation topic, one member of the dyad was specifically instructed to reveal their top three choices:

> You are now going to engage in another discussion with your romantic partner. Romantic partners can be a primary source of support, closeness, and intimacy. During times of stress, we often rely on our partners to be there for us. Over time, our romantic partners can become the people we are the closest and most intimate with. For the next conversation, you and your significant other will engage in a 4-minute discussion about the top 3 ways you depend on your partner. For each way you depend, explain to your partner, in detail, why you picked it. Like during the last conversation, you will have 2 min to explain your choices to your partner and 2 min to discuss.

After receiving topic and interaction instructions, participants remained in their private testing rooms for a preparation period during which they were given 3 min to "gather their thoughts." Participants were then brought together to engage in the conversation for 4 min while physiological measures were taken. The same person who disclosed their weekly events in the first conversation also disclosed their three selections in conversation two for 2-min. Then, both members of the couple freely discussed for 2 min.

5.4 | Measures

5.4.1 | Emotion Manipulation Check

In order to determine whether the neutral, positive, and negative conversation topics were associated with analogous emotional states, we used the same emotion items from Studies 1 and 2 (note the "angry" item was replaced with "upset") to form positive and negative emotion composites at baseline and before and after each conversation (see OSM for descriptive statistics).

5.4.2 | Covariates

The same covariates were used as in studies 1 and 2.

5.4.3 | RSA

The MindWare software version was updated to 3.0.25. Otherwise, the procedure to assess RSA was identical to studies 1 and 2.

5.4.4 | Data Analytic Plan

As in Studies 1 and 2, analyses followed (Kenny et al. 2006) guidelines for dyadic regression models that account for the dependence associated across partners using the MIXED procedure in SPSS 25 where dyads were distinguished by sex. Note, conversation topic was coded −1 = negative topic, 1 = positive topic, and role assignment was coded −1 = discloser, 1 = listener.

6 | Results

6.1 | Emotion Manipulation Check

Results indicated that the conversation topic manipulation was successful in changing mood accordingly, although the neutral conversation led to more positive and less negative emotion compared to baseline (see OSM).

6.2 | RSA

6.2.1 | Neutral Conversation Topic

As shown in Table 2, in anticipation of and during the discussion of a neutral topic, individuals exhibited increases in RSA reactivity. We observed this effect for *both* dyad members even when only one person was speaking during the conversation.

6.2.2 | Between Conversation Recovery

Analyses on the recovery period between conversations 1 and 2 demonstrated individuals returned to baseline RSA levels ($B = -0.01$, $SE = 0.05$, $t = -0.27$, $p = 0.79$, $r = 0.02$) (see Table S4 for all fixed effects).

6.2.3 | Positive or Negative Conversation Topic

As shown in Table 2, the pattern of results was similar to the results observed during the first conversation (see Tables S3–S5 for a presentation of all fixed effects and Table S8 for means and standard deviations). Individuals exhibited increases in RSA reactivity for both dyad members in anticipation of and during the discussion of the valenced topic, regardless of the conversation topic and whether only one person was speaking.

7 | Discussion

Across three large dyadic studies that included different relationship types (strangers or romantic partners), conversation contexts (conversation topics and valances), and temporal contexts (anticipation and turn-taking), we sought to reconcile a mixed literature by manipulating a variety of interpersonal contexts that prior theory and work have suggested alter RSA. Findings consistently showed that interpersonal interactions were associated with increases in RSA reactivity, regardless of whether the dyads were strangers (Study 1) or romantic partners (Studies 2-3), whether RSA was measured during pre-conversational periods (Studies 1–3) or during conversations with alternating speaking and listening roles (Study 3), whether emotion regulation instructions were given (Studies 1 and 2), and whether the valence of the conversation topic was negative (Studies 1–3), neutral (Study 3), or positive (Study 3). By providing robust and consistent associations across these varied interpersonal contexts, the present research clarified the general pattern of RSA reactivity to be expected before and during a range of conversations.

Although there are methodological similarities between the present and prior work, we consider potential methodological differences that may have contributed to the current results. Notably, sample sizes in prior studies were generally lower relative to the current work; thus, our larger sample sizes may have enabled us to consistently detect smaller effects that would have otherwise gone unnoticed—as the estimated effect sizes in the current work were small to moderate, on average (Quintana 2017). Moreover, our total sample size was comparable to that of a prior meta-analysis that assessed social interactions and RSA (Shahrestani et al. 2015) and included studies that were predominately noninteractive in nature and differed in scope, such as those utilizing the Trier Social Stress Test, nonverbal communication, and adult attachment interviews (see Shahrestani et al. 2015). In contrast, the current study examined a variety of in vivo dyadic conversations, uniquely revealing a consistent pattern of increased RSA reactivity across diverse interpersonal contexts.

Other methodological differences between the current work and prior studies may partly explain discrepant findings. For instance, in the Butler et al. (2006) study, participants engaged in conversations that lasted more than twice as long as those in the current study. Longer durations are more susceptible to habituation processes which also raises the question of whether individuals needed to engage in sustained emotion regulation later in such conversations. Moreover, we chose to examine the first minute of the task periods, as these are typically considered the most reactive periods (e.g., Peters et al. 2014). However, prior studies examining RSA during interpersonal conversations often averaged across these task periods. As noted in endnote 1, we re-ran the analyses averaging across anticipation and conversation periods (see Table S7). In brief, the pattern of results remained the same, though estimated effects sizes were attenuated during the anticipation period in two of the three studies which suggests those effects may be more fleeting. These additional results suggest that prior studies using average anticipation values may have missed opportunities to uncover reactive effects during anticipation.

Moreover, in-person interactions may amplify social cues due to a richer sensory environment. A recent study found that in-person interactions, compared to Zoom interactions, enhanced social processing, including greater attentional focus on the interaction partner, increased social engagement, and higher cross-brain coherence—indicating more effective social cue exchange (Zhao et al. 2023). This enriched sensory environment in face-to-face conversations may lead to greater RSA activation, unlike virtual interactions, where Deits-Lebehn et al. (2023) observed decreases in RSA during socially evaluative virtual exchanges and no differences in RSA reactivity in response to neutral or positive virtual interactions. Future research should directly compare in-person and virtual interactions to further investigate their differential effects on RSA.

Our results that emotion regulation did not alter RSA during conversations (Study 1 and 2) are consistent with a meta-analysis that revealed attempts to regulate negative emotion were not related to increases in HRV (Zaehringer et al. 2020) and a recent study (Deits-Lebehn et al. 2023), although the results are inconsistent with a study that found increases in RSA among those instructed to emotionally regulate (Butler et al. 2006). The cognitively demanding nature of suppression did not blunt increases in RSA in this research; perhaps decreases in RSA are more likely during working memory tasks or those that involve active processing of information such as math problems (e.g., Graziano and Derefinko 2013; Shahrestani et al. 2015).

Manipulations of variables conceptually related to various theoretical frameworks did not alter the results. For instance, despite predictions from social safety accounts (Brosschot et al. 2016), conversing with romantic partners or discussing positively valenced topics did not lead to greater increases in RSA than conversations with strangers or negatively valenced topics. Further, manipulating emotion regulation did not change RSA, which would be predicted by regulatory effort accounts (Thayer et al. 2012). Considering prior work on RSA reactivity is mixed, the current results suggest that these theoretical considerations need refinement as they relate to prior and current findings. We provide our thoughts on these theoretical considerations below, but also hope that the current work inspires further discussion.

At least for the positively valenced conversation in our study, felt social safety may have plausibly contributed to increased RSA, consistent with prior work (Brosschot et al. 2016; Liu et al. 2021; Willemen et al. 2008). Notably, across our studies, we did not directly manipulate cues of social safety or unsafety given these are not inherent in the topic instructions—for example, someone can lack genuine interest during any conversation context (Diamond and Alley 2022). On the other hand, we did have strangers interact, and we manipulated negative conversation contexts (topic and valence), both of which likely remove cues of safety. Also, in anticipation of the conversation, each participant was in a private testing room. Thus, it is unclear from a social safety perspective as to why increases in RSA were observed across interpersonal contexts, and therefore the social safety account of RSA reactivity may need to be revised or reconsidered.

Interestingly, in the current studies—as previously published—there was evidence suggesting that participants perceived at least some degree of social safety across all relationship types and conversation contexts (topic and valence). For instance, in Study 1, participants rated their interaction partners as excellent communicators, on average (Peters et al. 2014). In Study 2 and 3, participants rated their partners as highly responsive on average, indicating they perceived the other person as understanding, validating, and caring (Peters et al. 2024; Peters and Jamieson 2016). Although our results reveal inconsistencies with social safety theories of RSA, social safety theorists could postulate that perceptions of relative or some safety may be sufficient for increases in RSA during conversations. From this perspective, prior work that found decreases in RSA reactivity may have been driven by heightened social evaluative contexts or insufficient social safety (Deits-Lebehn et al. 2023; Godfrey and Babcock 2020; Shahrestani et al. 2015; Smith et al. 2011). Future work should vary negative conversation contexts while manipulating or at least measuring social safety to more directly test this suggested theoretical modification.

Furthermore—across all studies—anticipation of conversations and listening roles within conversations were associated with increases in RSA reactivity. The Pause and Plan model (Segerstrom et al. 2012) posits that parasympathetic control of the heart may reflect self-regulation such as emotion regulation or planning subsequent actions. Our instructions for all participants to mentally prepare for the upcoming conversation or to assume a temporary listening role likely suggest the participants were appraising, simulating, and planning the upcoming conversation or what they may say next, which implies some form of self-regulation and is a consistent explanation for the observed increases in RSA during these conversational periods.

Our results were consistent with prior work that found no changes in RSA between those instructed (vs. not) to regulate their emotions (Deits-Lebehn et al. 2023; but see Butler et al. 2006). Although regulatory effort frameworks (Thayer et al. 2012) would suggest that manipulating emotion regulation would lead to additional increases in RSA, emotion regulation processes are inherent to conversations (English and Eldesouky 2020), and therefore may prevent detection of effects—that is, ceiling effects. Moreover, although we do not have direct assessments of regulatory effort (e.g., see Deits-Lebehn et al. 2023), we found evidence that the emotion regulation manipulation did not make the conversation more difficult (see Peters et al. 2014), which may imply that it was not a valid manipulation of regulatory effort. Thus, considering the increases in RSA reactivity found in anticipation of and during conversations, a potential explanation from a regulatory effort framework may be that increases in RSA reactivity generally reflect self-regulation required to engage in conversations via activation of the central autonomic network (Thayer and Lane 2000) that coordinates attention, cognition, autonomic activity, and emotion for efficient implementation of behavior (Grossman and Taylor 2007; Thayer et al. 2012). However, we did not measure self-regulation broadly enough to elucidate these mechanisms, which future work will need to incorporate in their designs.

Future work could measure and manipulate both regulatory effort and social safety cues to reveal relative contributions to RSA. As mentioned above, RSA reactivity and perceived task difficulty did not differ between the emotion regulation conditions; thus, perhaps assessing and manipulating self-regulation more broadly could reveal nuances. For instance, researchers could manipulate self-regulatory fatigue prior to a conversation such as resisting delicious food (Segerstrom and Nes 2007); those who previously self-regulated may be less motivated (e.g., Giacomantonio et al. 2019) to self-regulate in a subsequent conversation. For social safety, researchers can manipulate responsiveness or other validating signals such as nodding or smiling (Diamond and Alley 2022; Deits-Lebehn et al. 2023). Subsequently, crossing regulation with social safety may be able to tease apart any unique or synergistic effects, although the same factors that cue safety may involve substantial effort.

7.1 | Limitations and Future Directions

There are several limitations within the current study. First, our sample consisted of primarily young undergraduate students. Given there are age differences in parasympathetic tone such that older adults, on average, have lower resting RSA (Cooper et al. 2007), there may be less flexibility in engaging the vagal break during conversations in older age, which future research could examine; although one study did not find differences in RSA reactivity during conversations between middle-aged and older-aged couples (Smith et al. 2009). Second, other important moderators not examined here may qualify observed associations. For instance, ambiguous support during conversations or individual differences in social anxiety or insecure attachment have been linked to sensitivity to social threat (Mathai et al. 2021; Roisman 2007). Moreover, unclear associations between relationship quality and RSA reactivity during conversations requires more attention in future research (e.g., Han et al. 2021).

Third, generalizing the research reported here to more diverse populations and contexts is a needed avenue for future inquiry, such as by replicating findings in daily life rather than in only lab settings (e.g., See Liu et al. 2021). Along these lines, recent work found cultural factors may moderate RSA reactivity during conversations (Li et al. 2025). Further, while we extended prior research—which typically focuses only on romantic partners—by including both romantic partners and strangers, future studies could benefit from examining other relationship types, such as professional or familial relationships. Next, although the effect sizes in our study are small to moderate, they are consistent with RSA associations with clinical symptoms (Calkins et al. 2007; Vasilev et al. 2009), suggesting that even small shifts in RSA reactivity have the potential to meaningfully impact health. Future work is needed to home in on the clinical implications of RSA reactivity during interpersonal interactions.

8 | Conclusion

The present study followed recommendations (Smith et al. 2020) of construing the interpersonal context more broadly by investigating various relationship types, conversation contexts, and temporal contexts. Our large set of studies of 356 dyads consistently revealed increases in RSA reactivity in anticipation of and engagement in face-to-face dyadic conversations relative to a resting baseline. Our findings suggest that increases in RSA reactivity may characterize a variety of interpersonal conversations, potentially reflecting flexible vagal braking (Thayer et al. 2012), though further investigation into precise mechanisms is warranted.

Author Contributions

Nathan C. Stuart: conceptualization, visualization, writing – original draft, writing – review and editing. **Brett J. Peters:** conceptualization, data curation, formal analysis, investigation, methodology, project administration, writing – original draft, writing – review and editing. **Peggy M. Zoccola:** conceptualization, visualization, writing – original draft, writing – review and editing. **Ashley Tudder:** conceptualization, data curation, methodology, project administration, writing – review and editing. **Jeremy P. Jamieson:** conceptualization, data curation, methodology, project administration, writing – review and editing.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Endnotes

[1] We re-ran analyses using averaged values over anticipation and conversation task periods (see Table S7). As noted in the Supporting Information, the pattern of results was consistent with the results in the main manuscript.

[2] All significant effects reported in the main manuscript remained significant when removing experimental and control variables from analyses.

[3] Note, for both conversations 1 and 2 in Study 3, the 4-min blocks that were the focus of the analyses were immediately followed by another 2-min disclosure period and 2-min discussion wherein the listener in the first 4-min block was now the discloser. That is, the disclosers and listeners reversed roles so that both people were able to disclose the events of their week (conversation 1) or top 3 selections (conversation 2). However, analyses from these second 4-min blocks for conversations 1 and 2 were not analyzed or presented for two reasons. First, the 4-min blocks within each conversation were not separated by a recovery period, so it is possible that any significant effects observed could simply be due to carry over effects from the first 4-min block. Second, if non-significant effects were observed, this could have been due to habituation effects. Thus, given the interpretation of the effects would have been muddled and added unnecessary complexity to the methods section, we do not refer to these second 4-min blocks.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.