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Interpersonal physiological regulation during couple support interactions: Examining the role of respiratory sinus arrhythmia and emotional support

Jessica L. Borelli[1] | **Dana Shai**[2] | **Shlomit Fogel Yaakobi**[3] | **Nava Levit-Binnun**[3] | **Yulia Golland**[3]

[1]Psychological Science, University of California, Irvine, Irvine, California

[2]School of Behavioral Studies, The Academic College of Tel Aviv-Yaffo, Tel Aviv–Yaffo, Israel

[3]Sagol Center for Brain and Mind, Baruch Ivcher School of Psychology, Interdisciplinary Center (IDC) Herzliya, Herzliya, Israel

Correspondence
Yulia Golland, Sagol Center for Brain and Mind, Baruch Ivcher School of Psychology, Interdisciplinary Center (IDC) Herzliya, P.O. Box 167, Herzliya, 41650, Israel.
Email: yulia.golland@gmail.com

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Abstract

In times of need, people seek comfort and support from close others. Support provision is an integral component of attachment relationships, one that is linked with physical and psychological well-being. Successful support provision is believed to be grounded in transactions of sensitive, caring behavior between caregivers and support seekers and to serve a profound regulatory function. However, physiological processes underlying support transactions have not been previously studied. We assessed autonomic vagal regulation and coded spontaneous emotional support behaviors in $N = 100$ heterosexual couples involved in a support interaction. We focused on cardiac vagal activation, operationalized as the increase in respiratory sinus arrhythmia (RSA) from baseline to interaction, as an indicator of regulatory efforts. Analyses revealed a negative association between caregivers' and support seekers' regulatory efforts, which was mediated by emotional support behaviors. We found that caregivers with greater increases in RSA from baseline to interaction provided more emotional support to their partners. Such emotional support was associated with smaller increases in support seekers' RSA and with support seekers' perceptions of their partners as being more sensitive to their needs. Finally, these links were only significant among dyads in which caregivers reported lower levels of attachment anxiety. We interpret these results in the framework of interpersonal regulatory processes, suggesting that provision of support may impose regulatory demands on the side of the caregivers, which in turn could result in attenuated regulatory efforts and positive partner perceptions for the support seekers.

KEYWORDS

attachment, couples, heart rate variability, interpersonal emotion regulation, respiratory sinus arrhythmia, support

1 | INTRODUCTION

From early childhood to old age, people seek comfort and support from close others in times of need (Bowlby, 1973; Hazan & Shaver, 1987; Hofer, 2006). Indeed, support provision is one of the pillars of high-quality relationships (Sbarra & Hazan, 2008). Furthermore, the perception of a significant other[1] as supportive is associated with substantial benefits for health and well-being (for reviews, see Cohen & Syme, 1985; Gurung, Sarason, & Sarason, 1997) as well as for satisfaction within relationships (e.g., Rafaeli & Gleason, 2009; Sullivan, Pasch, Johnson & Bradbury, 2010). Multiple theoretical frameworks have highlighted the regulatory function of support provision, suggesting that caregivers' sensitive and supportive responses convey a regulatory effect on support seekers' distress (Coan, Schaefer, & Davidson, 2006; Collins & Feeney, 2000; Hazan & Shaver, 1987; Hofer, 1994; Sbarra & Hazan, 2008; Zaki & Williams, 2013). However, little is known about the physiological processes underpinning the regulatory dynamics of support provision.

The inherent interdependence of romantic partners' emotional and physiological systems (Butler, 2011; Butler & Randall, 2013; Helm, Sbarra, & Ferrer, 2012) opens a possibility that the regulatory transactions of support are instantiated via the coupling of partners' regulatory systems, such that enhanced regulatory effort of one partner is associated with reduced regulatory demand in another partner via support behaviors. To examine this model, we focus on autonomic regulatory processes during a support interaction and investigate (a) the within-person associations of support provision with a key physiological mechanism of emotion regulation in a social context (i.e., a cardiac vagal regulation; Beauchaine, 2001; Thayer & Lane, 2000); (b) the between-person dependency of partners' vagal regulation via sensitive, emotional support. We also explore (c) whether the association between vagal regulation and support is associated with a fundamental individual difference in the context of intimate relationships—the attachment style of the caregivers and support seekers.

1.1 | Interpersonal emotion regulation in attachment interactions

People frequently turn to significant others for help and support in managing their emotional states. Accordingly, support processes in close relationships have been treated from the perspective of interpersonal emotional regulation, according to which sensitive caring behaviors of the caregivers have profound regulatory effects upon support seekers (Niven, Totterdell, & Holman, 2009; Zaki & Williams, 2013). A massive body of evidence has demonstrated that the receipt of support is associated with subjective, physiological, and neural changes in support seekers (Allen, Blascovich, & Mendes, 2002; Coan, 2011; Collins & Ford, 2010; Goldstein, Weissman-Fogel, & Shamay-Tsoory, 2017; Lepore, Allen, & Evans, 1993; Schachter, 1959; Selcuk, Zayas, Günaydin, Hazan, & Kross, 2012). For example, support recipience leads to mood improvements (Collins & Feeney, 2000), reductions in physiological arousal and negative affect (Ben-Naim, Hirschberger, Ein-Dor, & Mikulincer, 2013), and attenuated neural threat reactivity (Coan, Schaefer, & Davidson, 2006). We note that not all studies have demonstrated that the receipt of support is associated with reductions in stress in the support seeker, with some studies finding that support provision is associated with neutral or even negative outcomes (McClure et al., 2013; Rafaeli & Gleason, 2009; Rini & Dunkel Schetter, 2010). These findings suggest the importance of further investigating the caregiving/support-seeking dynamics and examining moderators of the association between the receipt of support and beneficial outcomes.

Although less research has focused on caregivers' efforts in support-relevant contexts, it has been acknowledged that mounting caring and supportive response necessitates mobilization of one's regulatory resources (Gailliot, 2010). For instance, caregivers must modify the tone of interactions that could become stressful and control their own experience and expression of negative emotion (Halford, Lizzio, Wilson, & Occhipinti, 2007; Lindahl & Markman, 1990; Thayer & Lane, 2009). In line with this perspective, a series of studies have shown that a depletion of self-regulatory resources hampers consequent support provision, enhancing aggressive behaviors toward intimate partners (Finkel, DeWall, Slotter, Oaten, & Foshee, 2009) and reducing ability to provide sensitive support (Mikulincer, Shaver, Bar-On, & Sahdra, 2014; Mikulincer, Shaver, Sahdra, & Bar-On, 2013).

Taken together, the above-cited research suggests that support may serve an interpersonal regulatory function, such that caregivers mobilize their regulatory resources for the sake of their spouses, hence sharing the regulatory burden of the support seekers' distress. This perspective also resonates with the social baseline theory, according to which load sharing is a feature of close relationships whereby the burden of emotional distress is distributed across relationship partners (Beckes & Coan, 2011; Lougheed, Kovall, & HollenStein, 2016).

Despite extensive theorizing on the topic (e.g., Sbarra & Hazan, 2008; Zaki & Williams, 2013), much remains to be understood about the physiological mechanisms underlying the regulatory aspects of support giving and receiving.

[1]Throughout this paper, we focus our comments on *spouses* due to the fact that the majority of the scientific literature to date has focused on married couples. Further, our study also focuses on married, heterosexual couples. However, we contend that it is likely that the conclusions derived from our study would also apply to non-married but cohabitating couples, and perhaps even to couples who are not cohabitating; the findings may also apply to same-sex couples. We hope that future work will examine the boundary conditions on the associations we identified in the current study as well as those that have been articulated in prior research.

Specifically, evidence is lacking as to whether the provision of support is associated with the exertion of physiological regulatory effort as well as whether the receipt of support is associated with physiological regulatory benefits.

1.2 | Cardiovascular vagal regulation and regulatory effort

Vagal regulation refers to the control of heart rate by the parasympathetic branch of the autonomic nervous system (Berntson, Cacioppo, & Quigley, 1993; Thayer & Sternberg, 2006), which allows for flexible responding to the changing demands of the environment (Porges, 2007). An impressive body of theory and research suggests that cardiac vagal regulation plays a key role in adaptive social-emotional behavior and regulatory processes (Appelhans & Luecken, 2006; Beauchaine, 2001; Grossman & Taylor, 2007; Hastings et al., 2008; Lewis, Lamm, Segalowitz, Stieben, & Zelazo, 2006; Porges, 2007; Thayer & Lane, 2000, 2009).

A widely accepted metric of vagal regulation can be estimated from the degree of heart rate deceleration and acceleration as the person breathes in and out, such that larger beat-to-beat changes across the respiratory cycle indicate higher vagal activity (Berntson, Cacioppo, & Grossman, 2007; Berntson et al., 1997). Accordingly, measures of high-frequency heart rate variability, also called respiratory sinus arrhythmia (RSA), are employed as an index of vagal activity (Allen, Chambers, & Towers, 2007; Berntson et al., 1997).

RSA levels during rest are believed to reflect the individual‘s trait level capacity for regulation and have been linked with a wide range of beneficial emotional and social conditions (Carney et al., 2000; Diamond & Hicks, 2005; Friedman & Thayer, 1998; Gyurak & Ayduk, 2008; Pu, Schmeichel, & Demaree, 2010; Thayer & Brosschot, 2005; Thayer, Friedman, & Borkovec, 1996; Watkins, Grossman, Krishnan, & Sherwood, 1998). Beyond individual differences in resting RSA, research has also examined within-person changes in RSA as an indicator of transient states of emotion regulation and the effort associated with them (Beauchaine, 2001; Frazier, Strauss, & Steinhauer, 2004; Porges, 1995a, 1995b; Porges, Doussard-Roosevelt, & Maiti, 1994; Porges, Doussard-Roosevelt, Portales, & Greenspan, 1996; Thayer & Lane, 2000).

Central to the present study, task-driven RSA increases, which indicate an enhancement in vagal brake on sympathetic activity, have been suggested to reflect regulatory efforts, facilitating positive engagement with the environment (Beauchaine, 2001; Kettunen, Ravaja, Näätaenen, & Keltikangas Järvinen, 2000; Segerstrom & Nes, 2007; Thayer & Lane, 2000). For instance, instructed emotion regulation has been shown to increase RSA (Butler et al., 2006; Di Simplicio et al., 2012), and adults with self-regulation difficulties display smaller increases in RSA in response to regulatory challenges (Austin et al., 2007; Hughes & Stoney, 2000; Sahar et al., 2001). In social contexts, RSA increases have been linked with emotion regulation during social interaction (Butler et al., 2006), compassionate responses to social targets in distress (Stellar, Cohen, Oveis, & Keltner, 2015), and regulation of emotion and behavior in women during marital interactions (Smith et al., 2011).

Although both support provision and support seeking are believed to impose regulatory demands, the involvement of cardiac vagal regulation in support transactions has not been studied. To account for this gap, the present research examined the path between the caregivers' RSA activation (i.e., a regulatory effort), their supportive behavior, and the resultant regulatory state of the support seekers.

1.3 | Caregiving and support seeking as a function of attachment

The ability to seek support and provide care for another is thought to be regulated via the attachment and caregiving systems, respectively (Bowlby, 1973; Hazan, Campa, & Gur-Yaish, 2006; Sbarra & Hazan, 2008; Shaver & Mikulincer, 2014). These intertwined systems are developed in early life through exposure to care from attachment figures (Bowlby, 1973) and show considerable continuity over time (Mikulincer & Shaver, 2007; Waters et al., 2000). In adulthood, internal working models of attachment, or representations of the self and others, are thought to influence social information processing, emotional reactions, and emotion regulation strategies in romantic relationships (Shaver & Mikulincer, 2014).

In situations requiring support, people higher in attachment security excel in the motivation and ability to respond more sensitively to their romantic partners' needs (Feeney & Noller, 1996; Kunce & Shaver, 1994; Mikulincer et al., 2013; Simpson, Rholes, & Nelligan, 1992). In contrast, attachment insecurity (i.e., anxiety and avoidance) is thought to interfere with care provision (e.g., Feeney & Collins, 2001; Kunce & Shaver, 1994; Mikulincer et al., 2013, 2014). Prior research on caregiving as a function of attachment has suggested that attachment insecurities are associated with a set of secondary emotion regulation strategies, which themselves may hamper sensitive support provision to others (Mikulincer & Shaver, 2018). Specifically, when facing a situation in which one's partner expresses a need for support, caregivers high in anxiety tend to focus on their own distress and need for security rather than that of their partner (Collins & Read, 1994; Mikulincer, Gillath, Halevy, Avihou, Avidan, & Eshkoli, 2001). A different regulatory pattern is observed in people high in avoidance (Davila & Kashy, 2009), who may devote their regulatory efforts to suppressing attachment-related thoughts and feelings, diverting attention from emotional cues and inhibiting expressions of emotion (Collins & Read, 1994; Diamond, Hicks, &

Otter-Henderson, 2006; Main, 2000; Mikulincer & Shaver, 2007). Although the regulatory strategies associated with attachment anxiety and avoidance are phenotypically different, they may similarly result in deviant response patterns to the support seekers' expressions of attachment needs. Specifically, as suggested by the above-reviewed research, the regulatory efforts of caregivers with attachment insecurities focus more on dealing with their own attachment needs and defenses, which ultimately may interfere with sensitive support provision. This framework has led us to ask whether attachment insecurities moderate the links between the physiological regulatory effort of caregivers and their emotional support behaviors. Supportive evidence for such an approach comes from a previous study that showed that in adolescents higher RSA was associated with greater empathic sensitivity but only among those with low attachment anxiety (Diamond, Fagundes, & Butterworth, 2012). In line with the above perspective, the authors interpreted this finding to suggest that, for people higher in attachment anxiety, physiological regulatory capacities may be deployed to self-focused rather than other-focused regulatory efforts.

In addition to attachment moderating links between regulatory efforts and support provision, we would also anticipate that the impact of the receipt of support would be dependent upon attachment of the support seekers. People high in anxiety may receive fewer benefits from support if they doubt whether the support will be there for them in the future (Allen & Miga, 2010; Brooks, Robles, & Dunkel Schetter, 2011; Diamond & Fagundes, 2010). One study found that people high in anxiety benefitted less from the perceived support received from partners (Stanton & Campbell, 2014, but see Kordahji, Bar-Kalifa, & Rafaeli, 2015, for the opposite effect). Similarly, people high in avoidance perceive interactions in which they receive support as being less positive (Campbell, Simpson, Boldry, & Kashy, 2005) and show less physiological regulation from support receipt (Chen, Gilligan, Coups, & Contrada, 2005; Holt-Lunstad, Smith, & Uchino, 2008). Synthesizing these research findings leads us to examine whether the effect of support behavior on support seekers' regulatory state will be weaker for support seekers higher in anxiety or avoidance.

1.4 | Present study

In this study, we tested a series of research questions with broad applicability to the study of regulatory processes in romantic relationships. Romantic couples who were expecting their first child participated in a support interaction (Collins & Feeney, 2000; Mikulincer et al., 2013, 2014), while their cardiovascular responses were recorded. One partner was randomly assigned the role of support seeker (hereafter, SS) and was asked to disclose a personal problem to the other partner, termed the caregiver (hereafter, CG). To index regulatory efforts, we quantified RSA change from baseline to the middle of the support interaction task for both CGs and SSs, during which time support transactions transpired (Butler et al., 2006; Smith et al., 2011). Emotional support behaviors of the CGs were coded using video recordings of the interactions (Collins & Feeney, 2000). Emotional support involves the provision of reassurance and affection and is the form of support most strongly linked to relationship satisfaction (e.g., Chen & Feeley, 2012). Following the interaction, SSs reported the degree of perceived partner (i.e., CG) responsiveness (Reis, Clark, & Holmes, 2004), which was used as an indicator of a beneficial psychological outcome of support provision (Bar-Kalifa & Rafaeli, 2013; Fekete, Stephens, Mickelson, & Druley, 2007; Gadassi et al., 2016; Selcuk & Ong, 2013). This is particularly important in light of the previous research showing that in some cases support can have neutral or even negative outcomes (McClure et al., 2013; Rafaeli & Gleason, 2009; Rini & Dunkel Schetter, 2010).

First, we tested whether CG RSA increase during the support interaction predicted greater support provision (Hypothesis 1, H1). Consistent with the perspective that providing support necessitates a mobilization of regulatory resources, we anticipated that higher levels of CG regulatory effort (operationalized as RSA increases from baseline to interaction, hereafter RSA reactivity) would be associated with higher levels of their emotional support behaviors. Second, we tested whether the degree of emotional support negatively predicted the SS RSA reactivity (H2). Operating under the assumption that the receipt of support is regulating for most people, we expected that SSs who received higher levels of emotional support would demonstrate lower levels of self-regulatory effort (i.e., lower RSA reactivity). To substantiate the regulatory function of emotional support, we further examined its effects upon SSs' perceptions of their partner as being responsive to their needs (H3).

Next, we asked whether individual differences in attachment impacted the degree to which CG physiology correlates with their emotional support (H4) and the degree to which emotional support correlates with SS regulatory effort (H5) and perceived partner responsiveness (H6).

Finally, we examined a full model of interpersonal regulation between CGs and SSs regulatory efforts. We tested whether CG emotional support mediated the association between (a) CG RSA reactivity and SS RSA reactivity, and (b) CG RSA reactivity and SSs' perceptions of CG responsiveness, and whether these links were moderated by attachment.

2 | METHOD

2.1 | Participants

The current study was part of a larger study focused on parenting in cohabiting heterosexual couples (N_{dyads} = 100) expecting their first child (see supporting information,

Appendix S1 for full details of the larger study). The desired sample size was selected based on a power analysis anticipating a medium effect size for the main analyses at an alpha level of .80 and surpassing a p value of .05—the results of the power analysis suggested we needed 76 participants to detect our main effects. We collected data from 100 to allow for data loss through equipment malfunction and noisy physiological data. All mothers were toward the end of their pregnancies ($M = 29.7$ weeks, $SD = 2.55$, range = 22.27–37.08 weeks). Families were recruited through Internet advertisements, flyers, and medical centers and were paid 250 shekels for their participation in this phase of the experiment. The women's mean age was 30.82 ($SD = 3.63$, range = 23–42) and the men's mean age was 32.41 ($SD = 4.01$, range = 23–42). None of the couples reported an at-risk pregnancy or had any known neurological, physiological, or psychological disorders. The mean years of education were 15.36 ($SD = 2.41$) for men and 16.3 ($SD = 2.10$) for women. Experimental procedures were approved by the Ethics Committee for Behavioral Studies at the Interdisciplinary Center Herzliya. The methods were carried out in accordance with the approved guidelines.

2.2 | Procedure

A research assistant contacted the couples by phone and invited them to participate in a study on parenthood and children's social and emotional child development during the first 2 years of life. The research assistant explained that both partners would be asked to complete questionnaires on a website independently and then to participate in an experimental session in the laboratory. After obtaining their consent, the research assistant gave each partner a personal code to enter the study's website and complete the questionnaire, and a date for their first experimental session was scheduled. The laboratory visit was part of a larger study; it lasted for 2 1/2 hr and included multiple experimental procedures.

Upon arriving at the lab, all participants provided informed consent for their participation. The physiological session was initiated with a 10-min baseline procedure, during which participants sat calmly and were asked to refrain from making gross motor movements or closing their eyes. Spouses were measured sequentially: while one underwent the baseline recordings, the other completed a computerized questionnaire in another room.

Couples then completed the support paradigm (Collins & Feeney, 2000). One partner in each couple was randomly assigned to the CG and SS roles (overall, 56 men and 44 women were assigned to be CGs). First, the SS went to a separate room, and the experimenter instructed him/her to think and write about a personal problem (one not involving the partner) currently bothering him/her that she/he could discuss. After writing about the problem, the couple was reunited, and the physiological signals were checked. Next, couples were asked to "discuss the issue (the SS) raised as naturally as possible" for 10 min.

2.3 | Measures

2.3.1 | Attachment style

CGs and SSs completed an 18-item version of the Experiences in Close Relationship Scale (ECR-R; Brennan, Clark, & Shaver, 1998). This 18-item version was adapted from the well-established 36-item version of the scale. Due to the large quantity of questionnaires administrated in the T1 assessment, we sought to use a shorter version of the ECR-R, especially since the ECR has high reliability and validity. Thus, we used the first nine items of each subscale of the original ECR-R, which in this sample demonstrated solid internal consistency: Cronbach's alphas were high for the anxiety and avoidance scales for the sample overall, $\alpha_{anxiety} = .79$ and $\alpha_{avoidance} = .76$, as well as when considered separately for CGs (anxiety: .79; avoidance: .76) and SSs (anxiety: .89; avoidance: .69).

Participants rated the extent to which each item was descriptive of their feelings in close relationships on a 7-point scale ranging from 1 (*not at all*) to 7 (*very much*). Nine items were related to attachment anxiety (e.g., "I worry about being abandoned") and nine items were related to avoidance (e.g., "I prefer not to show a partner how I feel deep down"). The reliability and validity of the scales have been demonstrated repeatedly (e.g., Brennan et al., 1998; Mikulincer & Florian, 2000).

Item ratings on each scale were averaged, with higher scores on each dimension indicating greater anxiety or avoidance and lower scores indicating greater attachment security. The anxiety and avoidance scores were not significantly correlated ($p < .88$). Two participants were missing attachment style data due to a data recording error.

2.3.2 | Perceived partner responsiveness

Following the interaction, SSs completed three items from the Hebrew version of the Perceived Responsiveness Scale ("My partner understands me"; "My partner cares about me"; "My partner was aware and appreciative of what I am capable, thinking and feeling") to assess perceptions of how understood, validated, and cared for they felt while interacting with their partner (Reis, Maniaci, Caprariello, Eastwick, & Finkel, 2011). This scale was translated into Hebrew by Birnbaum and Reis (2012). The items were rated on a 7-point scale ranging from 1 (*not at all*) to 7 (*very much*). The scale was internally consistent ($\alpha = .76$) in our sample. Higher scores indicated greater perceived responsiveness.

2.3.3 | Emotional support

CG responsiveness during the video-recorded interactions was coded using a version of a coding scheme developed by Barbee and Cunningham (1995) and modified by Collins and Feeney (2000). Videotapes were coded by two trained observers (graduate psychology students) who were unaware of the study hypotheses. For this study, we focused our analyses on the emotional support scale, which included the attempt to deal directly with the emotional aspects of the personal problem raised by the SS by providing solace, reassurance, comfort, and empathic remarks. Each of these aspects of the CGs' behavior was rated on a scale ranging from 1 (*not at all*) to 7 (*extremely*). Inter-rater reliability for the emotional support scale was excellent, intraclass correlation (ICC) = .88. The two raters' scores for the emotional support scale were averaged. Data from three dyads were missing due to video recording malfunction.

2.3.4 | Support seekers' emotion disclosure

To index SSs' direct support-seeking behaviors, which have previously been shown to affect CGs' support provision (e.g., Collins & Feeney, 2000), observers rated the amount of SS emotional disclosure during interaction (ICC = .87) as well as crying or pouting behaviors (ICC = .83). The emotional disclosure index was computed as a sum of these two items and was controlled for in our analyses.

2.4 | Physiological data collection and preprocessing

The continuous physiological measures (electrocardiogram [ECG], respiration) were recorded at a sample rate of 2 kHz, using a dyadic telemetric measurement system (Thought Technology, USA). Cardiovascular responses were recorded with an ECG amplifier module and disposable snap ECG electrodes using a modified Lead II configuration. The heart period (interbeat interval or IBI) was assessed using the Mindware HRV 2.16 biosignal processing module (Mindware Technology, Gahanna, OH) by (a) identifying the R–R intervals, and (b) detecting physiologically improbable R–R intervals based on the overall R–R distribution using a validated algorithm (Berntson, Quigley, Jang, & Boysen, 1990). Data were also inspected manually to ensure that R waves were correctly identified. Data that included more than 10% indefinable Rs were excluded from the analysis. Data for the last minute of the interaction was incomplete for a substantial proportion of the sample and was therefore excluded from analysis. RSA time series were calculated for every 60-s bins of these data, using spectral analysis implemented in Mindware HRV Software (frequency band 0.12–0.40 Hz). Baseline RSA scores were quantified by averaging the RSA scores collected during the 10-min physiological baseline.

Video coding of the interaction task suggested that during the first 2 min of the task, the SSs were disclosing what had happening during the stressor; during the final minutes of the task, dyads had typically resolved the issue and had moved on to discussing a new topic. Given that the majority of the support transaction processes occurred during the middle portion of the interaction, we chose to focus on this section of the task, by averaging RSA across Minutes 3 to 7. We further computed RSA reactivity scores for both CGs and SSs by subtracting baseline RSA scores from task RSA scores (using mean scores of Minutes 3 to 7 of the support task), with positive scores suggesting increases in RSA from baseline to the support interaction. We also computed early RSA reactivity scores for SSs by averaging the first 2 min of the interaction, which were used as a covariate in the regression analyses targeting SSs' RSA.

2.5 | Missing data

Since the primary analyses in this study involved dyadic data, an exclusion of one member of a pair due to bad video recordings, incomplete responses to the ECR-R, and noisy or missing RSA signals led to the exclusion of both members from the analysis. The final data set included $N = 64$ pairs in which both dyad members had clean ECG signals, good quality audiovisual recordings, and full attachment scores. To address the missing data, we used multiple imputations with full information maximum likelihood with 40 imputations—we used participants' sex, attachment, baseline RSA, and emotional support to estimate imputed values, and we imputed data only for people for whom we had ECR scores and emotional support data. This resulted in *N*s ranging from 95 to 93 for analyses. The analyses were validated for the original nonimputed data set. The results were similar for all analyses reported in the manuscript.

2.6 | Data analytic plan

We tested all hypotheses using hierarchical regressions in which we controlled for CG gender, CG attachment, SS attachment, and SS emotional disclosure in prior steps of the regression and entering independent variables in the final step of the regression. These factors were previously shown to affect support provision behaviors (e.g., Collins & Feeney, 2000; Mikulincer et al., 2013, 2014; Smith et al., 2011). When examining the effects of caregivers' emotional support on SS RSA reactivity, we further controlled for the within-person effects of SS RSA reactivity by using early task SS RSA reactivity as a covariate. To test hypotheses involving moderation or moderated mediation, we used Hayes (2013) PROCESS Version 2.0 Macro for SPSS, which enables the examination of conditional effects models using 10,000 bootstrapped samples. PROCESS deconstructs conditional effects at low (−1 *SD*), mean, and high (+1 *SD*) levels of the moderator variable.

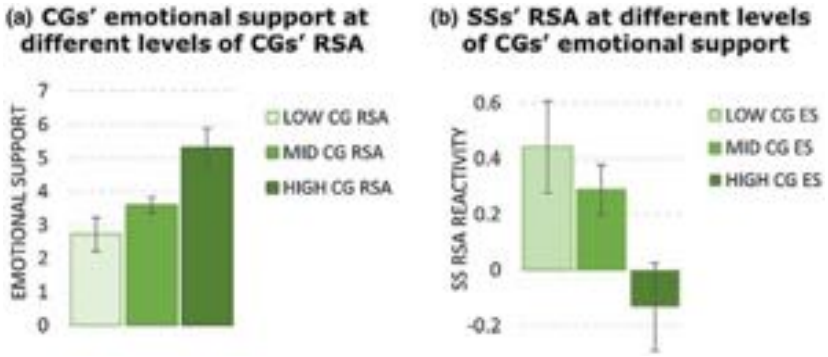

FIGURE 1 (a) Mean levels of CG emotional support (ES) at three levels of CG RSA reactivity: low ($M = -0.74$), mid ($M = 0.12$), high ($M = 1.1$). Higher levels of RSA predicted higher levels of ES. (b) Mean levels of SS RSA reactivity at three different levels of CG ES, low ($M = 1.1$), mid ($M = 3.5$), and high ($M = 6.3$). Higher levels of ES predicted lower levels of SS RSA

3 | RESULTS

3.1 | Preliminary analyses

We first examined whether RSA increase from baseline was indeed a predominant physiological response in SSs and CGs, as predicted by theory (Butler et al., 2006; Smith et al., 2011; Thayer & Lane, 2000). Results showed that CGs increased in their RSA from baseline to interaction at a marginally significant level, $t(102) = 1.94$, $p = .054$. Similarly, SS RSA increased significantly from baseline to interaction, $t(102) = 3.31$, $p < .001$ (see supporting information, Figure S1 for a depiction of CGs' and SSs' moment-by-moment RSA changes during the support interaction).

Descriptive statistics for the main study variables appear in supporting information, Table S1. Zero-order correlations (see Table S2) revealed that CGs reporting greater attachment avoidance had SSs reporting greater attachment anxiety. The degree of CGs' emotional support was positively correlated with SSs' emotional disclosure. SSs' emotional disclosure was negatively correlated with their attachment avoidance. SSs' perceived partner responsiveness was negatively correlated with SSs' attachment anxiety.

3.2 | Examining main effect models

3.2.1 | Does CG RSA reactivity predict the degree of emotional support?

After controlling for CG gender, SS attachment (anxiety and avoidance), CG attachment (anxiety and avoidance), and SS emotional disclosure, $R^2 = .12$, $p = .08$, CG RSA was significantly associated with emotional support provision, $\Delta R^2 = .10$, $p < .002$. CGs with greater increases in RSA showed more supportive behavior, $b = 1.16$, $SE = .36$, $\beta = .31$, $CI_{95\%}$ [0.44, 1.88], $p < .002$. This finding supported our H1 that CGs exhibiting greater RSA activation during the support task would exhibit more emotionally supportive behavior toward the SS (see Figure 1a for a visual depiction of this result).

3.2.2 | Does degree of emotional support predict SS RSA reactivity?

After controlling for CG gender, SS attachment (anxiety and avoidance), SS emotional disclosure, and CG attachment (anxiety and avoidance), $R^2 = .09$, $p = .25$, CG emotional support provision was a significant predictor of SS RSA reactivity, $\Delta R^2 = .08$, $p < .004$. Higher levels of emotional support from CGs predicted smaller increases in SS RSA from baseline, $b = -.11$, $SE = 0.03$, $\beta = -.313$, $CI_{95\%}$ [−0.18, −0.036], $p < .004$.

This result was preserved after including SS early RSA reactivity as a covariate at the first step of the model, $R^2 = .68$, $p < .001$, such that CG emotional support provision remained a significant predictor of SS RSA reactivity, $\Delta R^2 = .015$, $p < .041$. Higher levels of emotional support from CGs predicted smaller increases in SS RSA from baseline, $b = -0.05$, $SE = 0.02$, $\beta = -.135$, $CI_{95\%}$ [−0.09, −.002], $p < .041$.

Post hoc comparisons (see Figure 1b) showed that while RSA levels in SSs receiving low, $M = 0.44$, $SD = 0.75$, $t(22) = 2.80$, $p < .01$, and mean levels of emotional support, $M = 0.28$, $SD = 0.6$, $t(48) = 3.32$, $p < .002$, were significantly higher than baseline, they were not different from baseline in SSs receiving high emotional support, $M = -0.13$, $SD = 0.73$, $t(23) = -0.88$, $p = .39$.

This finding supported H2, suggesting that higher levels of emotional support from the CG were associated with smaller RSA increases in SSs.

3.2.3 | Does degree of emotional support predict SS perceived partner responsiveness?

After controlling for CG gender, SS attachment (anxiety and avoidance), CG attachment (anxiety and avoidance), and SS emotional disclosure, $R^2 = .13$, $p = .06$, CG

emotional support was associated with SSs' perceptions of CG responsiveness, $\Delta R^2 = .12$, $p < .001$. Higher levels of emotional support from CGs predicted SS higher ratings of perceived responsiveness, $b = 0.18$, $SE = 0.049$, $\beta = .37$, $CI_{95\%}$ [0.08, 0.28], $p < .001$. This pattern supported our H3 that emotional support predicted both lower levels of SS RSA and higher levels of SS perception of their partner as responsive to their needs. Notably, these two constructs were associated, as SS RSA was negatively correlated with SSs' partner responsiveness, $r = -.24$, $p < .01$ (Table S2), suggesting that SSs who experienced higher level of partner responsiveness also exhibited lower levels of RSA reactivity.

3.3 | Moderation by attachment insecurity

3.3.1 | Moderation of the link between CG RSA reactivity and CG emotional support, by CG attachment

After controlling for CG gender, SS attachment (anxiety and avoidance), CG avoidance, and SS emotional disclosure, as well as the main effects of CG RSA and attachment anxiety, $R^2 = .25$, $p < .001$, the interaction between CG attachment anxiety and RSA was a significant predictor of emotional support behaviors, $\Delta R^2 = .04$, $b = -.85$, $p < .036$. When CG attachment anxiety was at low, $b = 1.94$, $p < .0003$, or at mean levels, $b = 1.06$, $p < .004$, higher scores (greater increases in RSA from baseline to midtask) were associated with more supportive behavior, but when attachment anxiety was at high levels, $b = .18$, $p = .58$, the two factors were not associated (see Figure 2). Further, the association between CG attachment anxiety and emotional support was significant only when CG RSA reactivity was high, $b = -.64$, $p < .02$.

We conducted the same analysis using CG attachment avoidance as the moderator, and the results did not reveal a significant interaction effect, $\Delta R^2 = .00$, $p = .88$.

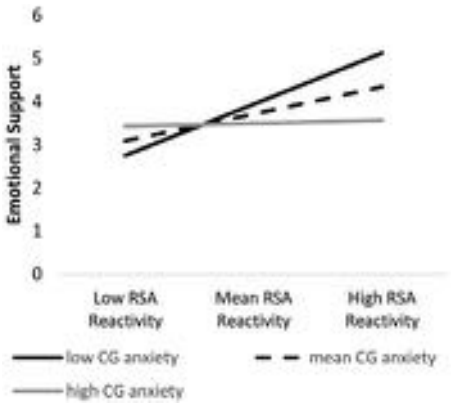

FIGURE 2 Caregivers' attachment anxiety moderates the association between caregivers' RSA reactivity and caregivers' emotional support behavior. CG anxiety = caregiver attachment anxiety

Taken together, these results partially supported our H4, showing that the link between CG RSA and emotional support was moderated by CG attachment anxiety but not by CG attachment avoidance.

3.3.2 | Moderation of the link between CG emotional support and SS RSA reactivity, by SS attachment

Next, we tested whether SS attachment moderated the association between CG emotional support and SS RSA reactivity, controlling for CG attachment, SS early RSA, SS emotional disclosure, and SS gender—the analyses revealed that neither anxiety ($p = .12$) nor avoidance ($p = .20$) were significant moderators of this association. Accordingly, H5 was not supported by the data.

3.3.3 | Moderation of the link between CG emotional support and SS perceived responsiveness, by SS attachment

Controlling for CG attachment, SS emotional disclosure, and SS gender, the results revealed that neither SS attachment avoidance, $p = .91$, nor SS attachment anxiety, $p = .96$, were significant moderators of this association. Hence, H6 was not supported.

3.3.4 | Exploratory moderation analyses

We conducted a series of exploratory follow-up analyses, examining the possible interaction effects between the hypothesized predictors and the covariates included in the models. We examined whether CG emotional support was predicted by the following three interactions: CG RSA × SS Attachment (avoidance: $p = .88$; anxiety: $p = .28$), CG RSA × CG Gender ($p = .36$), and CG RSA × SS Emotional Disclosure ($p = .50$). We further examined whether SS RSA was predicted by CG Emotional Support × CG Gender, which was not significant, $p = .85$; and Emotional Support × SS Emotional Disclosure, which was not significant, $p = .91$. Similarly, SSs' perceived partner responsiveness wasn't predicted by the interactive effects between CG Emotional Support × CG Gender, $p = .30$.

3.4 | Mediation analyses

3.4.1 | Does emotional support mediate the association between CG RSA reactivity and SS RSA reactivity, and is this moderated by CG attachment anxiety?

Using PROCESS Model 7, we tested a moderated mediation model controlling for SS attachment (anxiety and avoidance),

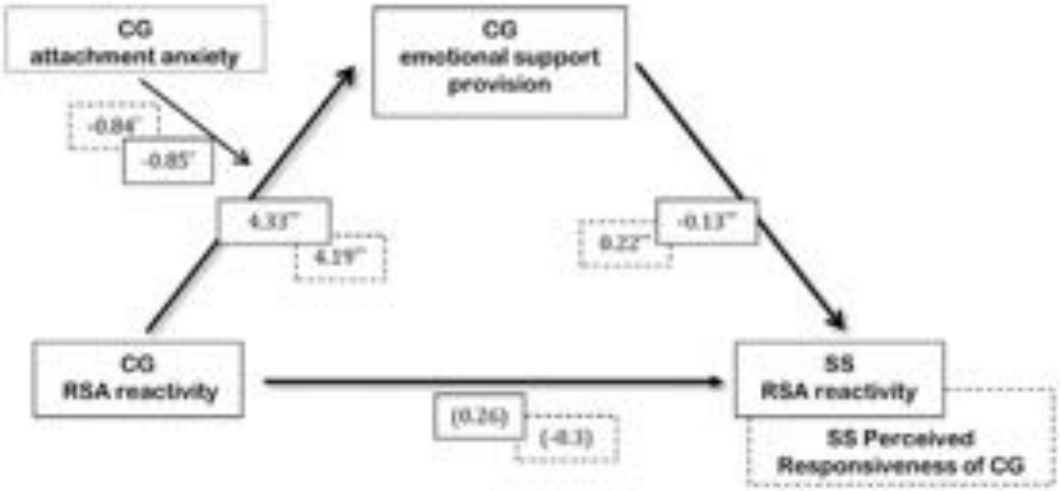

FIGURE 3 Visual depiction of the moderated mediation pathway from CG RSA reactivity to SS RSA reactivity (statistics presented in boxes with solid lines) and SS perceptions of partner responsiveness (statistics presented in boxes with dotted lines). Direct (unmediated) *b* weight in parentheses. *$p < .05$; **$p < .01$

CG attachment avoidance, SS emotional disclosure, and SS gender. Here, we only tested CG attachment anxiety as a moderator of the association between CG RSA and CG emotional support. The full statistical details of the model appear in Table S3.

The effect of CG RSA, $b = 4.33$, $SE = 1.57$, $p < .007$, and the interactive term of CG RSA and CG attachment anxiety, $b = -.85$, $SE = 0.4$, $p < .038$, were significant as was the effect of CG emotional support, $b = -.13$, $SE = 0.04$, $p < .001$, providing support for the moderated mediation effect on SS RSA.

The bootstrapping results further showed that the point estimate of the moderated mediation model was significant, $b = .11$, $SE = 0.06$, $CI_{95\%}$ [0.02, 0.28], with the conditional indirect effects suggesting that the emotional support mediated the negative association between CG RSA and SS RSA for dyads in which CGs reported low, $b = -.25$, $SE = 0.10$, 95% CI [−0.52, −0.09], or mean levels of attachment anxiety, $b = -.13$, $SE = 0.06$, $CI_{95\%}$ [−0.29, −0.04], but not among CGs reporting high levels of attachment anxiety, $b = -.02$, $SE = 0.07$, $CI_{95\%}$ [−0.18, 0.12] (see Figure 3 for a visual depiction of the model). We reran this model controlling for SS early RSA and found that the point estimate was still significant, $b = .04$, $SE = 0.03$, $CI_{95\%}$ [0.01, 0.13].

3.4.2 | Does emotional support mediate the association between CG RSA reactivity and SS perceived partner responsiveness, and is this moderated by CG attachment anxiety?

Using PROCESS Model 7, we examined a moderated mediation model in the prediction of SSs' perceived partner responsiveness (Table S4).

The point estimate of the model was significant, $b = -.18$, $SE = 0.10$, $CI_{95\%}$ [−0.42, −0.02], with the conditional indirect effects suggesting that emotional support mediated the association between CG RSA and SSs' perceived partner responsiveness for dyads in which CGs reported low, $b = .41$, $SE = 0.17$, $CI_{95\%}$ [0.14, 0.83], and mean levels of attachment anxiety, $b = .22$, $SE = .11$, $CI_{95\%}$ [0.06, 0.49], but not high levels of attachment anxiety, $b = .04$, $SE = 0.14$, $CI_{95\%}$ [−0.19, 0.35].

Thus, the results revealed that CG emotional support indirectly linked CG RSA reactivity with SSs' perceptions of partner responsiveness, but only among dyads in which CGs reported mean or lower levels of attachment anxiety.

4 | DISCUSSION

Previous frameworks have suggested that support transactions represent an interpersonal regulation process, and yet the underlying intra- and interpersonal physiological mechanisms of this process have not been studied. The current study addressed this gap by assessing one key autonomic regulatory mechanism—cardiac vagal regulation—in the context of support interaction and by examining its association with emotional support behaviors within and between romantic partners.

4.1 | Support provision is associated with recruitment of cardiac vagal regulation

In line with our hypothesis, we found that CGs with higher RSA reactivity demonstrated higher levels of emotional support toward their partners. This finding lends credence to the argument that support provision is vagally mediated. As such, it has wide implications for the understanding of the functional nature of vagal activation as well as of the physiological mechanisms involved in support provision.

In conjunction with previous research, which showed RSA increases in women engaging in emotion regulation during social interaction (Butler et al., 2006) or during a couple conflict discussion (Smith et al., 2011), our finding adds to the growing body of literature supporting the view that vagal activation plays a regulatory role in social contexts. It further provides clear and novel evidence for the theoretical framework suggesting that a recruitment of parasympathetic vagal regulation in social-emotional contexts may be beneficial for social functioning (Porges, 2003; Thayer & Lane, 2000, 2009). Notably, a closely related, other-oriented attitude (i.e., compassion toward strangers) has been similarly linked with vagal activation (Stellar et al., 2015). Hence, taken together with previous research, our result suggests that cardiovascular vagal regulation is a key correlate of caregiving behaviors, both toward close others and toward strangers in distress. In the current study, we focused on emotional support due to the well-validated links between RSA and emotion regulation. We hope that future studies will investigate the specificity of these effects in terms of the type of support provided by the CGs and its association with the RSA of both CGs and SSs.

Finally, our result underscores the regulatory demands underlying sensitive attending to a partner in need (Gailliot, 2010; Musser, Ablow, & Measelle, 2012). Such regulatory efforts of CGs may be invested in various processes underlying support provision, such as attenuating self-distress and monitoring for partner's distress cues (Mikulincer et al., 2013, 2014).

4.2 | Attachment-related differences in the behavioral correlates of vagal regulatory effort

Importantly, the above-mentioned behavioral correlates of caregivers' vagal activation were dependent upon their attachment style. Specifically, we found that in CGs with high attachment anxiety, increases in RSA during the support interaction were not associated with emotional support provision. Attachment anxiety in social emotional contexts is characterized by maladaptive emotion regulation strategies and behaviors (Shaver & Mikulincer, 2014), enhanced vigilance to negative emotional cues (Fraley, Niedenthal, Marks, Brumbaugh, & Vicary, 2006) and increased empathic distress (Mikulincer et al., 2001). In the context of support, it has been suggested that CGs high in anxiety focus on their own distress rather than that of the partner (Collins & Read, 1994). Our findings extend this previous theory to a physiological domain and demonstrate that when facing partner's distress a recruitment of regulatory resources in individuals high in attachment anxiety does not serve other-oriented goals and may be devoted to regulating their own distress and arousal.

In contrast to attachment anxiety, the caregivers' attachment avoidance did not significantly moderate the links between RSA reactivity and emotional support. People with high avoidance are typically characterized by deactivation strategies when confronted with attachment stress. The lack of significant association between avoidance and RSA reactivity in our study suggests that, when avoidant caregivers do engage in interaction (as evidenced by increases in RSA), this may be associated with support provision to the same degree as people with low avoidance.

Of note is that in contrast to prior studies, including those using a similar paradigm (Collins & Feeney, 2000; Mikulincer et al., 2013, 2014), attachment insecurity was not associated with the overall degree of emotional support provision in this study. This lack of effect may be due to other (unmeasured or untested) moderating variables, such as the topic discussed, the interaction between anxiety and avoidance, or the interaction between caregiver and support seeker attachment. Another possible interpretation for this inconsistency with previous research is the unique nature of the current sample, which consisted of young couples expecting their first child. It can be speculated that the sensitivity of this period for the family unit could have boosted the caring responses in caregivers, overriding the effects of their attachment patterns.

4.3 | The association of emotional support with support seekers' regulatory state and perceived partner responsiveness

Theoretical works highlight the regulatory influence of receiving support (e.g., Bowlby, 1973; Fonagy, Gergely, Jurist, & Target, 2002). Accordingly, we hypothesized that receiving emotional support from a partner would alleviate the need for self-regulation in care seekers. In accordance with this hypothesis, we found a significant negative association between caregivers' emotional support and SSs' RSA reactivity. In other words, receiving emotional support from a partner was associated with lesser demand for one's own regulatory efforts. While SSs receiving lower levels of support evidenced significantly elevated levels of RSA, those receiving high emotional support were not different from baseline.

Importantly, we also found that emotional support predicted SSs' perception of their partner as being responsive to their needs during the interaction. Perceived responsiveness of a partner has been highlighted as a key correlate of the receipt of support (Reis et al., 2004; Reis & Clark, 2013) and has been shown to mediate the beneficial emotional and physical consequences of support (Maisel & Gable, 2009; Selcuk & Ong, 2013). Furthermore, perceptions of partner responsiveness were significantly negatively linked with SS RSA reactivity, supporting the beneficial psychological aspects of SS RSA attenuation.

Taken together, our findings demonstrate that SSs who received emotional support from their partners exhibited lower RSA activation and felt more supported by their partner. This pattern of results complements previous findings that

demonstrate the regulatory effects of receiving support upon mood (Collins & Feeney, 2000) and physiological arousal (Ben-Naim et al., 2013) of SSs. It significantly extends them by demonstrating the correlates of emotional support upon SSs' physiological regulatory investment.

We note that we did not find that SS attachment moderated the association between the amount of emotional support received and SS RSA reactivity or perceived partner responsiveness. This finding resonates with the results of a recent study examining children's responses to the receipt of simulated support from their mothers, finding that those children higher in avoidance are just as receptive to the support as children low in avoidance (Dujardin et al., 2018). The lack of SS attachment effect is encouraging as it suggests that, if provided with support, SSs higher in anxiety or avoidance could derive the same degree of physiological and psychological benefits from the emotional support as their counterparts who are lower in anxiety or avoidance.

4.4 | Within-couple interrelatedness of physiological regulatory efforts

Above and beyond the within-person associations between emotional support and RSA reactivity, we demonstrated that during support interaction autonomic regulatory systems of both partners become inversely associated via support behaviors. These findings build upon a rich base of theory suggesting that partners' emotional and physiological processes are inherently interrelated (Butler, 2015; Sbarra & Hazan, 2008). While the interdependence of partners' physiological processes attracts significant attention in the current research, the majority of work is devoted to a specific form of interdependence (i.e., a coregulation or linkage; Butler, 2011, 2015; Helm, Sbarra, & Ferrer, 2014; Sbarra & Hazan, 2008; Timmons, Margolin, & Saxbe, 2015). Interestingly, while some studies suggest that coregulation of emotional, physiological, and endocrinal processes in couples is beneficial for relationships, others demonstrate negative consequences (see Timmons, Margolin, & Saxbe, 2015, for a review). For instance, some studies have found that lower levels of coregulation or coupling were associated with lower hostility and aggression (e.g., Laws, Sayer, Pietromonaco, & Powers, 2015; Saxbe et al., 2015), more supportive behavior (Ha et al., 2016), and greater relationship satisfaction (Laws et al., 2015; Saxbe & Repetti, 2010). Here, we examined a different mode of interrelatedness and showed that interpersonal emotion regulation in the context of support provision is substantiated by a negative association between partners' regulatory responses. Specifically, we demonstrated that higher levels of RSA activation on behalf of the caregivers was associated with greater levels of emotional support provision to one's partners who, in turn, displayed diminished levels of RSA activation and perceived their caregivers as being more responsive. Importantly, the path from CG RSA to SS RSA as mediated by emotional support was only significant among dyads in which CGs had mean or lower levels of attachment anxiety.

Taken together, our findings have important implications both for theories of interpersonal emotion regulation and for relationship research in general. They suggest that the parasympathetic vagal activation is a key physiological mechanism underpinning support-related processes. They uncover the path of biobehavioral interdependency between partners during support transactions, demonstrating how the regulatory efforts of caregivers are transmitted to physiological states and subjective perceptions of SSs via caring behaviors. They further highlight that, for such a path to occur, the regulatory efforts of the CGs need to be recruited in the service of their partners—as suggested by the lack of beneficial interpersonal associations of RSA activation in high-anxiety CGs. Finally, considering the important role assigned to perceived partner responsiveness in well-being within relationships (Reis & Gable, 2015), our findings suggest that the investment of regulatory efforts on behalf of the caregivers may serve long-standing goals, spanning above and beyond a particular interaction.

4.5 | Limitations

The contributions of the study must be evaluated in light of its limitations. Specifically, our use of a cross-sectional design precludes causal or temporal inferences. While our findings stand to uncover potential physiological processes underlying spontaneously emerging supportive behaviors, they require further validation in future studies, using experimental manipulations of support provision.

Due to our limited sample size, we were not able to model more complex interactions between different relevant dimensions of attachment (e.g., CG Attachment Anxiety × Avoidance), which would render the findings more externally valid.

Finally, the sample itself carries with it some limitations in its homogeneity (all Israeli heterosexual couples). For an initial study of these research questions, the homogeneity may have reduced sampling noise, while at the same time lowering the external validity of the studies. Furthermore, the sample consisted of young romantic couples expecting their first child. The quality of support-seeking interactions may be particularly influential during developmental transitions. For the majority of couples, one such important phase is the transition to parenthood (Cowan & Cowan, 2012; Saxbe, Rossin-Slater, & Goldenberg, 2018), which represents a window in which couples are at risk for declines in relationship satisfaction and psychological well-being (e.g., Jones, Chandra, Dazzan, & Howard, 2014). As a couple's first pregnancy constitutes a unique developmental period within a family's life cycle, these findings may have unique relevance to couples during this stage, while having lower generalizability to couples in other stages.

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ORCID

Yulia Golland https://orcid.org/0000-0003-3041-1890

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Appendix S1
Figure S1
Tables S1–S4

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