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Sara F. Waters, Helena Rose Kamilowicz, Tessa V. West, and Wendy Berry Mendes
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Keep It to Yourself? Parent Emotion Suppression Influences Physiological Linkage and Interaction Behavior

Sara F. Waters
Washington State University Vancouver

Helena Rose Karnilowicz
University of California, Berkeley

Tessa V. West
New York University

Wendy Berry Mendes
University of California, San Francisco

Parents can influence children's emotional responses through direct and subtle behavior. In this study we examined how parents' acute stress responses might be transmitted to their 7- to 11-year-old children and how parental emotional suppression would affect parents' and children's physiological responses and behavior. Parents and their children ($N = 214$; $N_{dyads} = 107$; 47% fathers) completed a laboratory visit where we initially separated the parents and children and subjected the parent to a standardized laboratory stressor that reliably activates the body's primary stress systems. Before reuniting with their children, parents were randomly assigned to either suppress their affective state—hide their emotions from their child—or to act naturally (control condition). Once reunited, parents and children completed a conflict conversation and two interaction tasks together. We measured their sympathetic nervous system (SNS) responses and observed interaction behavior. We obtained three key findings: (a) suppressing mothers' SNS responses influenced their child's SNS responses; (b) suppressing fathers' SNS responses were influenced by their child's SNS responses; and (c) dyads with suppressing parents appeared less warm and less engaged during interaction than control dyads. These findings reveal that parents' emotion regulation efforts impact parent-child stress transmission and compromise interaction quality. Discussion focuses on short-term and long-term consequences of parental emotion regulation and children's social-emotional development.

Keywords: parent-child, stress, physiological synchrony, emotion suppression

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Establishing effective emotional self-regulation is a critical achievement of childhood as these skills underpin psychosocial adjustment, academic success, and risk for psychopathology (Cicchetti, Ackerman, & Izard, 1995; Graziano, Reavis, Keane, & Calkins, 2007). Parents are significant influences on children's developing regulatory skills and large bodies of work have examined parents' explicit socialization of emotional self-regulation as

well as less direct processes like behavior modeling and family emotional climate (Eisenberg, Cumberland, & Spinrad, 1998). Emerging evidence indicates that parents also influence their children's affective states by transmitting parents' own affective states to their children through synchronization of physiological responses (Waters, West, Karnilowicz, & Mendes, 2017; Waters, West, & Mendes, 2014).

In this study, we examined physiological contagion between parent and child to address the fundamental question of whether parents' experiences of negative emotion impact children's emotions. We measured physiological responses and observed behavior during parent-child interactions and addressed the question of whether parents' emotion regulation strategies modified the extent to which the child is influenced by parents' affective states (Dix, 1991). We focused on the effect of suppression (i.e., hiding or masking emotion) on affect contagion because it is an emotion regulation strategy linked to decreased well-being and compromised dyadic interaction quality (Butler et al., 2003; Gross & John, 2003) and yet may be commonly used by parents when interacting with their children (Le & Impett, 2016). Little research to date has investigated the impact of parent gender differences on children's emotional development (Bariola, Gullone, & Hughes, 2011) and parent gender may be particularly relevant with regards to sup-

 Sara F. Waters, Department of Human Development, Washington State University Vancouver; Helena Rose Karnilowicz, Department of Psychology, University of California, Berkeley; Tessa V. West, Department of Psychology, New York University; Wendy Berry Mendes, Department of Psychiatry, University of California, San Francisco.

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Correspondence concerning this article should be addressed to Sara F. Waters, Department of Human Development, Washington State University Vancouver, 14204 North East Salmon Creek Avenue, Vancouver, WA 98686. E-mail: sara.f.waters@wsu.edu

pression because there are well established gender differences in the regular use of suppression (Zimmermann & Iwanski, 2014). Thus, we examined parent gender as it moderated the effects of suppression on physiological stress contagion and parent–child interaction behavior.

Affect Contagion via Physiological Linkage

An individual's neurophysiological responses within a specific context provide "under the skin" insight into their affective experience and the coordination of two social partners' neurophysiological responses during interaction indicates dyadically shared affective states (Butler, 2015; Feldman, 2003). Shared affective states are vital to healthy early development as children learn self-regulation skills, in part, through affective and behavioral synchronization with adult caregivers (Harrist & Waugh, 2002). Among multiple approaches to modeling dyadic physiology, we utilized the actor-partner interdependence model to assess physiological *linkage*, or the extent to which partner A's physiological responses at Time X are influenced by partner B's physiological responses at Time X-1 (Thorson, West, & Mendes, 2018). When an affective state such as acute stress is experimentally induced in one partner, this approach reveals the extent to which one partner "catches" the other person's affective state physiologically.

While there are many physiological responses that co-occur with acute stress, sympathetic nervous system (SNS) activation, measured with pre-ejection period (PEP; Brownley, Hurwitz, & Schneiderman, 2000), is particularly useful in the study of dyadic stress contagion. PEP is sensitive to changes in arousal, effort, and intensity and has a known temporal trajectory between a psychological state and a physiological response (Mendes, 2009). In addition, PEP can be measured continuously and noninvasively on multiple social partners simultaneously, providing "online" insight into shared affective states with minimal disruption to the natural social-emotional dynamics of the interaction (see, e.g., Kraus & Mendes, 2014; West, Koslov, Page-Gould, Major, & Mendes, 2017). In the current study, we induced a stress response in parents and then modeled physiological linkage between parents' and children's PEP responses during conflict-conversation and cooperation tasks, each task designed to require social engagement while being moderately emotionally challenging. These structured tasks were then followed by an unstructured free play episode.

Does Parent Emotion Suppression Affect Stress Contagion or Interaction Behavior?

According to theories of emotion socialization, parents who are less effective at regulating their own emotions or use less constructive strategies to regulate their emotions are likely to have children who are less effective at regulating their emotions constructively (Dix, 1991). Some evidence suggests that this association may be explained, in part, through less positive and collaborative interactions between parents and children (Shaffer & Obradović, 2017). We investigated how parent's attempts at regulating negative emotion, experienced before interacting with their children, affected the degree of physiological stress contagion from parent to child as well as specific parent and child behaviors during subsequent interaction. We focused on suppression, or the deliberate attempt not to externally express or display an emotional

experience (Gross, 1998), because it has been experimentally demonstrated to result in less positive and engaged dyadic interactions as well as increased physiological arousal not only in the suppressors but in the suppressors' naïve social partners compared with nonsuppressors and their social partners (Ben-Naim, Hirschberger, Ein-Dor, & Mikulincer, 2013; Butler et al., 2003; Peters & Jamieson, 2016; Peters, Overall, & Jamieson, 2014). These studies examined group-level changes in suppressors' and partners' physiological responses or as outcomes of the suppression manipulation, but the current work is the first of which we are aware to model physiological responses dyadically in relation to each other. Thus, we are the first to test whether suppressors' physiology is transmitted to (i.e., caught by) the social partner.

The above experimental studies of suppression involved romantic or stranger pairs, but the effects of emotion suppression on dyads are particularly salient to the parent–child relationship. Parents are foundational to children's emotional development and efforts to buffer children from the impact of parents' negative emotions may lead them to rely on suppression when interacting with their children. Indeed, parents' habitual use of suppression has been linked to their dismissive responses to children's negative emotions (Hughes & Gullone, 2010) and to less responsiveness to their children during daily interactions (Le & Impett, 2016). Parents' observed use of disengagement, an emotion regulation strategy putatively related to suppression, during a marital conflict was associated with poorer responsiveness during a subsequent interaction with their children (Low, Overall, Cross, & Henderson, 2019). These studies suggest that parental emotion suppression has negative consequences for children and the current work uses an experimental design to establish casual evidence for this claim. In a separate study drawn from the current sample, parent and child positive mood and responsiveness during a cooperative interaction were lower for dyads in which the parent suppressed their emotions (Karnilowicz, Waters, & Mendes, 2018). In the current study, we drew on Butler and colleagues' (Butler et al., 2003) finding that suppression reduced warmth and liking between previously unacquainted adult dyads and Shaffer and Obradović's (2017) finding that suppression decreased positive orientation and engagement in parent–child dyads to develop observational codes that were particularly relevant to the conflict conversation and cooperation task. We examined whether parent suppression impacted the extent to which parents and children were warm, engaged, and critical toward each other during these two tasks as well as during the free play episode.

Do the Effects of Parent Emotion Suppression Differ for Father- Versus Mother–Child Dyads?

The current investigation was designed to address the need for more developmental research explicitly focused on the impact of fathers on children's emotional development and the ways in which it may differ from mothers' impact. Some evidence suggests that paternal influences on children's emotions can be stronger than maternal influences (Cabrera, Shannon, & Tamis-LeMonda, 2007; McElwain, Halberstadt, & Volling, 2007; Shewark & Blandon, 2015), although this is not always obtained (e.g., Ekas, Braungart-Rieker, Lickenbrock, Zentall, & Maxwell, 2011). One goal of the current work was to investigate whether physiological

stress contagion, which had been previously established in mother–child dyads, was similarly present in father–child dyads.

Comparing mothers and fathers may be particularly salient in the context of parent emotion suppression because men are more likely than women to consistently use suppression as an emotion regulation strategy in day-to-day life (Tamres, Janicki, & Helgeson, 2002; Zimmermann & Iwanski, 2014). Emotion suppression can impair memory (Richards & Gross, 2000) and activate SNS responses (Gross & Levenson, 1993) so children who are regularly exposed to parent emotion suppression may become sensitized to their parents' stress response. To the extent that fathers suppress their emotions more than mothers do, children may be more readily influenced by their suppressing fathers' stress (i.e., stronger linkage and more compromised interactions) than their mothers'. However, more regular exposure to emotion suppression could also result in children's habituation to the experience. If children are more regularly exposed to emotion suppression from their fathers than their mothers, they may be less influenced by their suppressing fathers' stress (i.e., weaker linkage and less compromised interactions). We are not aware of any father–child studies to help elucidate which of these competing hypotheses is the more likely.

The Present Study

In the present study, nearly equal numbers of mothers and fathers completed a laboratory stressor before being randomly assigned to either suppress their emotions or act naturally while interacting with their 7- to 11-year-old child in a conflict conversation, cooperation task, and free play episode. Parent and child SNS responses were recorded continuously throughout the study and specific parent and child behaviors (i.e., warmth, engagement, and criticalness) were coded during the conflict conversation. Based on the existing literature, we expected children to “catch” their parents' physiological stress during the interaction, as evidenced by child-to-parent physiological linkage. Furthermore, we anticipated that stress contagion would be stronger for dyads with a suppressing parent than a nonsuppressing (control group) parent, and for stress contagion to be stronger in the conflict conversation than cooperation task or free play episode because of its proximity to the stress task and its affect intensity. We also expected to observe less warmth, less engagement, and more criticalness between parents and children for dyads with a suppressing parent compared with a nonsuppressing parent. Again, we focused on behaviors during the conflict conversation because of its timing in relation to the stress task and the affective nature of the task. We explored differences in stress contagion and interaction behavior between mother- and father–child dyads overall and as a function of the parent suppression manipulation while remaining uncertain regarding the nature of these potential parent gender differences.

Method

Participants

Parents ($N = 114$; 48% male; $M_{\text{age}} = 40.86$ years, $SD = 6.32$) and their 7- to 11-year-old children ($N = 114$; $M_{\text{age}} = 8.71$ years, $SD = 1.40$; 61% male) were recruited from the San Francisco Bay Area. One coupled mother and father pair each participated with a

separate child. Parents were excluded if they had a body mass index (BMI) over 35, were hypertensive, had a pacemaker, or took cardiac medications. Six dyads consented to participation, but attrited before completing the study. The 108 families who completed the study were racially diverse and predominantly in the middle- and upper–middle class range socioeconomically. See Table 1 for demographic statistics.

As detailed in the section below, the 108 parents who completed the study were randomly assigned to either a suppression ($n = 53$) or control condition ($n = 55$). One dyad completed the study but did not consent to collection of physiological data so the analytic sample was 107. Seven dyads provided physiological data, but did not consent to collection of audiovisual data.

Procedure

An overview of the procedure is provided in Figure 1. Upon arrival at the laboratory, parents provided consent for audiovisual and physiological recording for themselves and their child. Assent was also obtained from the child participants. Research assistants then attached sensors to the parent and child to measure their physiological responses. Parents and children were seated in comfortable chairs and separated by a privacy screen to reduce distraction during the 5-min resting baseline period. They wore headphones through which we played soothing music. While the music does introduce mild stimulation and, thus, is not a “true” baseline, we have found it helps children sit still and relax during the recording. We had parents listen to the same music because we wanted both dyad members' physiological responses to be based on the same protocol. Then research assistants removed the leads from the child's physiological sensors and the child moved to a separate room while the parent completed a modified Trier Social Stress Test (TSST; Kirschbaum & Hellhammer, 1994). They were asked to give a 5-min speech about themselves and answer 5 min of questions in front of two evaluators (one male, one female).

Table 1
Descriptive Statistics of Sample

Variable	Percentage of sample
Race/ethnicity	
Black	8%
Asian American	24%
Latinx	12%
White	52%
Multi-ethnic	4%
Parent relationship status	
Co-habiting	8%
Married	72%
Separated/divorced	10%
Single	10%
Parent education	
High school diploma	22%
Associate's degree	10%
Bachelor's degree	37%
Master's degree/PhD	31%
Annual family income	
Less than \$55,000	21%
\$50,000–\$75,000	15%
\$75,000–\$100,000	20%
More than \$100,000	44%

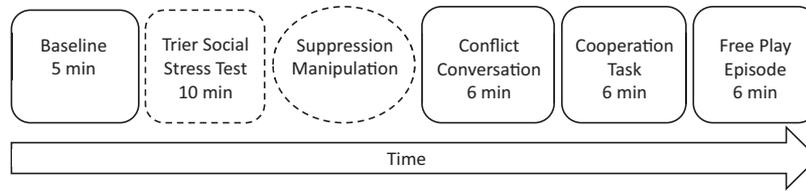


Figure 1. Overview of the procedure. Dashed outline indicates child was not present with parent.

Before giving the speech, parents completed a measure of their current positive and negative affect. To increase feelings of social evaluation, during the TSST the evaluators provided negative nonverbal feedback to the parents, including head-shaking, arm crossing, and frowning. After completing the TSST, parents completed the measure of affect again. Parents were then randomly assigned to the suppression or control condition and told that they would be reunited with their child. In the suppression condition, parents were given the following instructions, based on procedures used by Richards, Butler, and Gross (2003):

During the following interactions with your child, try to behave in such a way that your child DOES NOT KNOW that you are feeling anything at all. Try NOT to show any emotion in your face or your voice. In other words, mask any emotion you may feel so that your child is NOT AWARE of them.

In the control condition, parents were instructed to act naturally with their child, as they would at home. The child then returned to the room, was seated across from the parent, and the research assistant reattached the leads to the physiological sensors. The sensors themselves were not removed or reapplied during the study. Dyads completed a 6-min conflict conversation in which they were given a topic to discuss which had been selected from among lists supplied separately by parent and child of the greatest sources of conflict in their relationship. They were told to discuss the topic for several minutes and that the research assistant would return when the task was done. Then dyads completed a 6-min cooperation task in which they had to work together to build a block structure according to a set of instructions (see Karnilowicz et al., 2018 for a detailed description), followed by a 6-min free play episode. Upon completion of the study, the sensors were removed and dyads were debriefed and compensated. This protocol was approved by the University of California, San Francisco Institutional Review Board.

Measures

Parent-child pre-ejection period reactivity. We measured physiological responses of parents and children using electrocardiography (ECG) and impedance cardiography (ICG; Biopac MP150, Data Acquisition System, Biopac Systems, Inc., www.biopac.com). Specifically, we measured pre-ejection period (PEP), which is the time (in milliseconds) from contraction of the left ventricle to the opening of the aortic valve and is considered a “pure” measure of SNS activation given there are no parasympathetic influences on the heart during this time period. We used a modified lead II configuration of spot sensors placed on the torso to measure ECG. To measure ICG, we used the mylar band electrode system that completely encircles the neck and torso of

participants. Two child participants could not tolerate the mylar bands so in these two cases we used spot sensors. Physiological measures were collected continuously from the dyads during the resting baseline and conflict, cooperation, and free play, and we also collected physiology from the parents during the TSST.

Data were cleaned in 30-s segments using Mindware HRV and IMP v3.0.15. We used 30-s segments in line with guidelines for dyadic physiological data (Thorson et al., 2018) and common practice when collecting physiological data from children. All data were visually inspected off-line by trained research assistants for artifacts and edited as needed. Per the standard in the field, reactivity scores were calculated by subtracting baseline responses (the last 30-s of baseline) from every 30-s segment of the three tasks.

Observed parent and child behavior. Two trained raters, blind to experimental condition, coded parents and children on the same three behaviors, on a 5-point Likert scale from 1 (*not at all*) to 5 (*a great deal*): Warmth (intraclass correlation coefficient, $ICC_{parent} = .84$; $ICC_{child} = .88$), Engagement ($ICC_{parent} = .76$; $ICC_{child} = .89$), and Criticalness ($ICC_{parent} = .54$; $ICC_{child} = .91$) during the conflict conversation. Raters established reliability on 20% of the sample before coding the remaining sample singly.

Parent self-reported affect. We measured parents’ self-reported affect before and after the TSST using the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988). Parents rated themselves on 20 affect states with a 5-point Likert scale from 1 (*not at all*) to 5 (*a great deal*). We calculated positive and negative affect subscales according to convention (α s from .85 to .93). Reactivity scores were calculated by subtracting the pre-TSST positive and negative affect subscales from the corresponding post-TSST subscales.

Data Analysis Plan

Dyadic analysis to examine parent-child physiological linkage. To examine whether dyad members showed physiological linkage from one 30-s interval to the next, we estimated a *stability and influence model* (Thorson et al., 2018) with PROC MIXED in SAS (West et al., 2017). Participants’ PEP reactivity at one point was treated as a function of their own PEP reactivity at the prior time point (i.e., the stability path) and their partner’s PEP reactivity at the prior time point (i.e., the influence or linkage path). Thus, the stability path reflects how strongly a person’s score at time t is predicted by their score at time $t-1$, and the influence path reflects how strongly a person’s score at time t is reflected by their partner’s score at time $t-1$. These paths reflect the average level of stability and influence across all the time points in the study. Moderation by task and the experimental variables reflects whether stability and influence paths are stronger during

some tasks than others, and under certain conditions (see Thorson, Forbes, Magerman, & West, 2019 for an example of how the data are structured for the stability and influence model, and also the OSF link for our data and analyses). The stability and influence model allow for missing data. Please see the online supplemental materials (Method) for a detailed explanation.

We utilized the procedure for estimating a stability and influence model developed by Thorson et al. (2018) in which three sources of variance are estimated at the level of the random effects: variance in the intercept (i.e., participants' PEP reactivity values), in physiological stability, and physiological influence. We also estimated as many within-person and between-person covariances as the model would allow while still achieving convergence: the within-person covariance between intercept and stability (i.e., is a person who starts with higher or lower PEP reactivity more or less stable?), between-person covariances between the intercepts (i.e., is a person's PEP reactivity value associated with the partner's PEP reactivity value?), the stability effects (i.e., if a person's PEP reactivity is stable, is their partner's PEP reactivity also stable?), and between intercept and stability (i.e., if a person starts off with higher or lower PEP reactivity, is their partner's PEP reactivity more or less stable?).

In terms of the fixed effects, we estimated the main effects of stability and influence and we also moderated the stability and influence paths by several variables. For both stability and influence, we examined whether the path was moderated by role (i.e., parent vs. child), experimental condition (i.e., suppression vs. control), task (i.e., conflict conversation, cooperation task, or free play episode), and dyad type (i.e., mother-child vs. father-child). We included all two-way and three-way interactions, and the four-way interaction between condition, task, dyad type, and role for stability and influence, respectively. Thus, the model was saturated at the level of the fixed effects. Degrees of freedom were estimated using the Satterthwaite method, which involves a weighted average of the between-subjects and within-subject degrees of freedom (see Fitzmaurice, Laird, & Ware, 2004; Kenny, Kashy, & Cook, 2006). Degrees of freedom in this method, which can be fractional and vary across different tests, are based on the total number of data points and are adjusted for the nonindependence of observations.

Our hypotheses related specifically to the degree to which the influence path, which measures linkage, would be moderated by role (i.e., whether parents became linked to their children or children became linked to their parents), experimental condition (i.e., whether linkage would be stronger in the suppression condition than the control condition), and task (i.e., whether linkage would be stronger during the conflict conversation than the subsequent tasks). We also examined whether linkage differed as a function of dyad type (i.e., whether linkage was different for mother-child vs. father-child dyads). Additional explanation in online supplemental materials.

Dyadic analysis to examine parent and child observed behavior. To examine whether parents and children exhibited less warmth and engagement and more criticalness, we used the actor-partner interdependence model in which data are analyzed using dyad as the unit of analysis. This approach accounts for the nonindependence between parents and children behaviors. All models included the main effects of role (parent vs. child), condition, parent sex, and all two- and three-way interactions. The data

and syntax to recreate analyses is available from Open Science Framework (https://osf.io/jyvwu/?view_only=cb9a08ed772d4075ac6b3ec84b13be0b).

Power analyses. We conducted several power analyses, focusing on the power to detect linkage effects given that they tend to be small (based on prior research; e.g., Thorson et al., 2019; West et al., 2017). For all analyses, we utilized a simulation method that is illustrated in Lane and Hennes, 2018. With this method, we first provided a range of estimates for each parameter in the model and used these estimates and standard errors to simulate data for 1,000 hypothetical studies. This procedure is ideal for repeated measures physiological data in which there is an expected 10% missing data, on average (Thorson et al., 2018). Our power ranged from nearly 100% to detect effects in a simple model that only included stability and linkage (we specified a large effect of stability and a small effect of linkage) to 58% to detect the Role \times Condition \times Dyad Type interaction effect on linkage during the conflict conversation (we specified $B = 0.045$, $SE =$ between 0.13 and 0.22, to account for potential missing data). Our power to detect child-to-mother linkage and child-to-father linkage for dyads with parents in the suppression condition was between 75% and 93%, respectively (we specified $N = 28$; $B = 0.30$, $SE = 0.05$ and $N = 25$; $B = 0.21$, $SE = 0.06$).

Results

Preliminary Analyses

We began by conducting manipulation check analyses to confirm that parents did in fact experience physiological and psychological stress as a result of the TSST. One-sample t tests revealed a statistically significant decrease in parents' PEP reactivity (i.e., increase in SNS activation) from baseline to the TSST, $t(106) = -10.54$, $p < .001$, $d = 1.0$, and a statistically significant increase in parents' self-reported negative affect reactivity (i.e., change from pre- to post-TSST), $t(102) = -7.01$, $p < .001$, $d = .69$. There was no statistically significant change in parents' self-reported positive affect reactivity, $t(102) = -0.72$, $p = .47$, $d = .07$. We also conducted a one-way analysis of variance (ANOVA) with parent gender as the between-subjects factor and PEP reactivity and self-reported negative and positive affect reactivity as the dependent variables. We found a statistically significant effect of parent gender on PEP reactivity, $F(1, 101) = 7.23$, $p = .008$, $\eta^2 = .07$, indicating that, as commonly noted, men exhibit larger SNS activation in response to the TSST ($M = -19.13$, $SD = 19.35$) than women did ($M = -11.48$, $SD = 8.17$). There was no evidence for a significant effect of parent gender on self-reported negative or positive affect reactivity ($p = .80$ and $.69$, respectively). Thus, the TSST elicited physiological and psychological changes in parents in the intended manner.

Parent-Child Physiological Linkage Analyses

Again, our hypotheses were that stress contagion would occur from parent to child, be stronger for dyads with a suppressing parent than a nonsuppressing one, and stronger in the conflict conversation than in the cooperation task or free play episode; we also wanted to explore whether parent gender would moderate stress contagion, but did not have strong directional predictions for

this possible association. To test these predictions, we examined whether the lagged effect of partner PEP reactivity on respondent PEP reactivity (i.e., linkage) was moderated by role, experimental condition, task, and dyad type. We included all two-way and three-way interactions, and the four-way interaction in the model. A statistically significant Role \times Task \times Dyad Type interaction effect, $t(2,5181) = 13.86, p < .0001$, and a statistically significant Role \times Condition \times Task \times Dyad Type interaction effect, $t(2,5099) = 8.79, p = .002$, were found. We broke down the linkage effects separately for mother-child dyads and father-child dyads (i.e., the effect of dyad type) within each of the three tasks (i.e., the effect of task). Within each of these dyad types, we examined whether linkage was stronger in the suppression or control condition (i.e., the effect of condition) and whether linkage was stronger from parent to child or child to parent (i.e., the effect of role). We present the results for linkage during the conflict conversation below. Consistent with our hypothesis, the results for linkage in the cooperation task and free play episode were not statistically significant (see online supplemental materials).

Mother-child linkage. Within mother-child dyads, we found statistically significant positive child-to-mother linkage effects: mothers' PEP reactivity at one time point predicted their child's PEP reactivity at the following time point. Moreover, this effect varied as a function of mothers' experimental condition.

Consistent with hypotheses, we found that children whose mothers were in the suppression condition showed statistically significant linkage to their mothers' physiology from one time point to the next, during the conflict conversation, $t(1275) = 2.60, p = .009$ ($B = 0.13, SE = 0.05$). In contrast, for children whose mothers were in the control condition, linkage to mothers' physiology was not statistically significant over the course of the conflict conversation, $t(839) = 0.15, p = .88$ ($B = 0.01, SE = 0.05$). We found no statistically significant evidence of children's PEP reactivity positively predicting mothers' PEP reactivity (i.e., positive linkage; see Figure 2a and 2c). We found some statistically significant evidence of negative mother-to-child linkage, however, $t(822) = -1.99, p = .047$ ($B = -0.09, SE = 0.05$). For dyads with mothers in the control condition, the higher the children's PEP reactivity at one time point, the lower the mothers' PEP reactivity at the next time point. Dyads with mothers in the suppression condition did not show this statistically significant linkage, although the direction of linkage was similarly negative, $t(1498) = -1.59, p = .11$ ($B = -0.09, SE = 0.05$).

Father-child linkage. Within father-child dyads, children whose fathers were in the suppression condition did not show statistically significant linkage to their fathers, $t(39.1) = 0.27, p = .79$ ($B = 0.01, SE = 0.03$). Children whose fathers were in the control condition also did not show statistically significant linkage

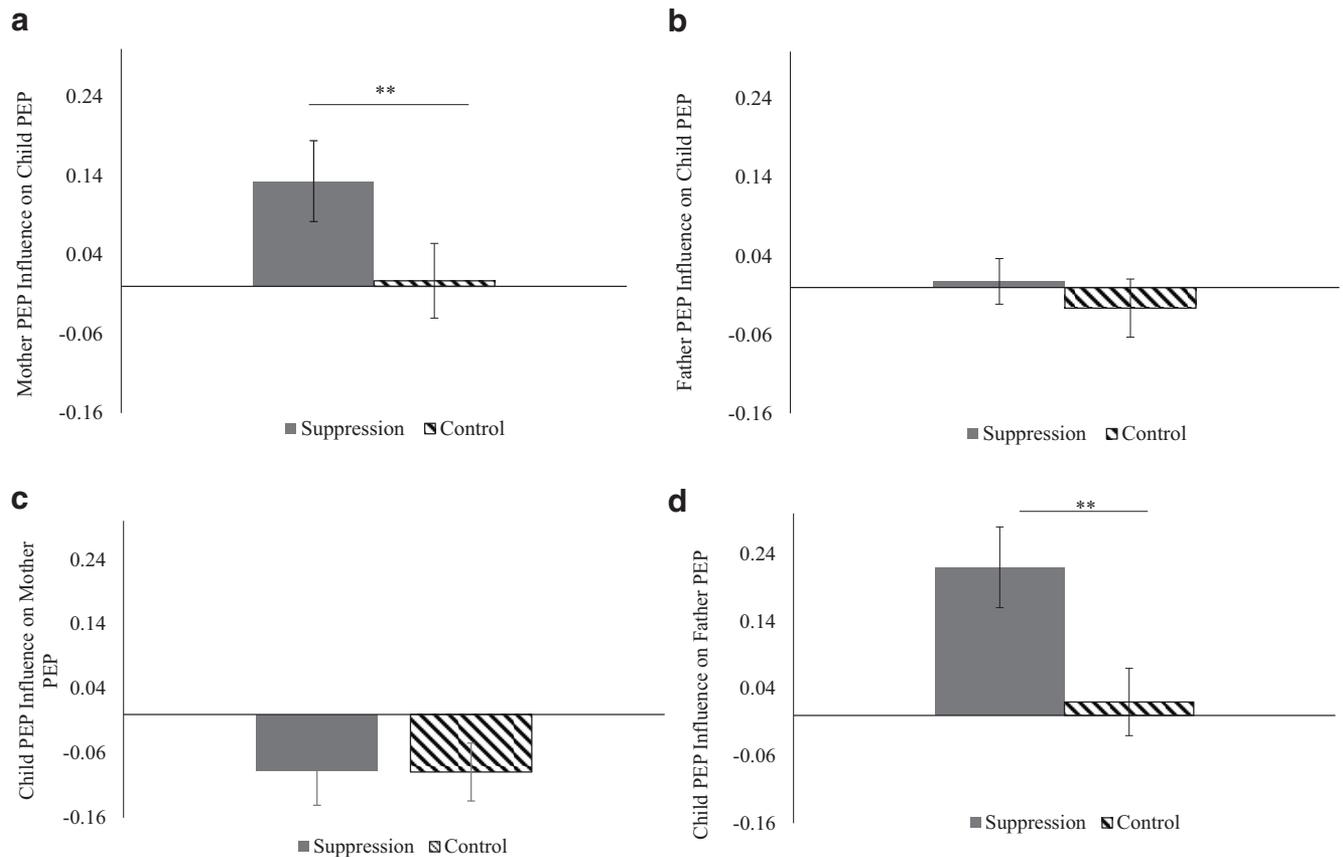


Figure 2. Parent PEP reactivity on child PEP reactivity during the conflict conversation by experimental condition and parent gender (a and b) and child PEP reactivity on parent PEP reactivity during the conflict conversation by experimental condition and parent (c and d). PEP = pre-ejection period. ** $p < .01$.

to their fathers, $t(162) = -0.71, p = .48$ ($B = -0.03, SE = 0.04$)—an effect that is consistent with what we found in mother-child dyads. For dyads with fathers in the suppression condition, we found statistically significant evidence of children's PEP reactivity positively predicting fathers' PEP reactivity (i.e., positive linkage), $t(1161) = 3.33, p < .001$ ($B = 0.22, SE = 0.06$). In contrast, fathers in the control condition did not show significant linkage to their children, $t(656) = 0.50, p = .61$ ($B = 0.02, SE = 0.05$; see Figure 2b and 2d).

Summary. We found partial support for our hypothesis that stress contagion via child-to-parent linkage would be stronger for dyads with a parent in the suppress condition—children whose mothers were in the suppression condition became positively linked to their mothers' physiology during the conflict conversation. However, this effect was not found in father-child dyads as children did not become physiologically linked to their fathers in either condition. Fathers in the suppression condition became positively linked to their children's physiology during the conflict conversation and this unexpected effect was not found in mother-child dyads.

Parent and Child Observed Behavior Analyses

Descriptive statistics and bivariate correlations among observed behavior variables are shown in Table 2. To test our hypotheses that there would be less Warmth, less Engagement, and more Criticalness observed in dyads with a suppressing parent than a nonsuppressing one and to explore the effect of parent gender on these three interaction behaviors, we tested the main effects of experimental condition and dyad type (i.e., mother-child vs. father-child) on the three interaction behaviors in parents and children. We also included the effect of role (parent vs. child), and all two- and three-way interactions in the model. For Warmth and Engagement, statistically significant effects of suppression condition were found, $t(95.95) = -6.40, p < .001$ and $t(95.91) = -3.10, p = .003$, respectively. Parents and children appeared less Warm and less Engaged in the suppression condition ($M = 2.04, SD = 0.90$ and $M = 3.23, SD = 1.03$, respectively) than in the control condition ($M = 3.11, SD = 1.03$ and $M = 3.66, SD = 0.96$, respectively). No other statistically significant effects were found for Warmth or Engagement ($ps > .12$). For Criticalness, a marginally significant effect of parent gender was found, $t(96.11) = -1.73, p = .09$, indicating that mothers appeared somewhat more critical ($M = 2.40, SD = .95$) than did fathers ($M = 2.17, SD = .91$). No

other effects for Criticalness were found, $ps > .11$ (see Figure 3).

In summary and in support of our hypotheses, we found that dyads with a parent in the suppression condition exhibited less Warmth and less Engagement than dyads with a parent in the control condition. Our hypothesis was not supported regarding Criticalness, however. No significant effects emerged for role, indicating that parents' and children's behaviors were similar and comparably affected by condition.

Discussion

In the present study we investigated the extent to which children "catch" their parents' stress during interaction and whether parent emotion suppression impacts the strength of this stress contagion as well as parent-child interaction behaviors. We contributed to the relatively scant developmental literature regarding fathers by recruiting a sample of both mother-child and father-child dyads and exploring how stress contagion and emotion suppression may function differently based on parent gender. The suppression condition, in which parents were instructed to mask or hide their feelings following a stressful event, is akin to real-life situations in which parents must regulate their own emotions regarding a prior negative experience while interacting closely with their children. The current work elucidated how parents' efforts to hide their own negative emotions from children may exacerbate the physiological and behavioral impacts of those negative emotions, contrary to parents' goals.

While prior work has found that emotion suppression increases physiological stress responses in both the suppressor and the nonsuppressing social partner (Butler et al., 2003), ours is the first study of which we are aware to test a critical implication of this phenomenon—that emotion suppression can strengthen shared physiological states (i.e., linkage) between partners. We found that physiological linkage was stronger under parent emotion suppression, albeit in different ways for mothers and fathers. Consistent with our hypothesis that suppression would strengthen stress contagion (via physiological linkage) from parent to child, children became physiologically linked to mothers who were in the suppression condition, indicating that suppressing emotion facilitated the transmission of stress from mother to child.

Suppression led to contagion in father-child dyads as well, but the direction of linkage was opposite of what we found in mother-child dyad: fathers in the suppression condition were physiologically influenced by their children rather than vice versa. This

Table 2
Descriptive Statistics and Bivariate Correlations Among Observed Behavior Variables During the Conflict Conversation

Variable	1	2	3	4	5	<i>M (SD)</i>
1. Observed parent warmth						2.63 (1.15)
2. Observed parent engagement	-.44**					3.43 (0.98)
3. Observed parent criticalness	-.24*	-.07				2.23 (0.87)
4. Observed child warmth	.59**	.19	-.27**			2.60 (1.06)
5. Observed child engagement	.30**	.08	-.35**	.49**		3.47 (1.05)
6. Observed child criticalness	-.04	.11	.07	-.17	.07	2.35 (1.0)

* $p < .05$. ** $p < .01$.

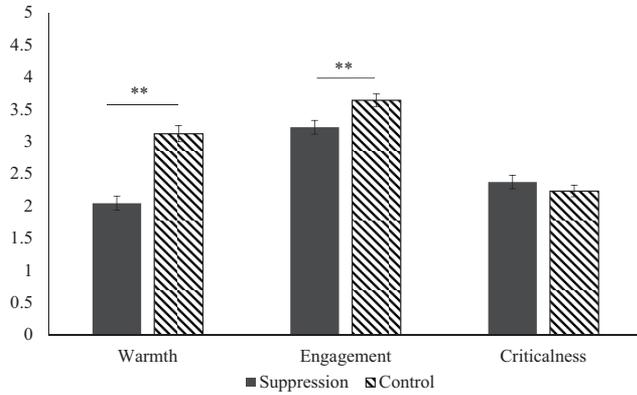


Figure 3. Observed parent and child behavior during the conflict conversation by experimental condition. ** $p < .01$.

finding appears to align with the idea that fathers' more regular use of emotion suppression compared with mothers may result in children becoming habituated to and, thus, less influenced by fathers' suppression compared with mothers' suppression. However, this does not speak to why fathers became linked to their children. We speculate that the fathers in this study may have found the conflict conversation with their children more novel or demanding than mothers did and that combining the challenges of the task with the cognitive demands of suppression may have made fathers particularly susceptible to being influenced by (i.e., linking to) their children's physiology. Empirical investigation of this possibility and alternative explanations await future research, but the importance of including fathers in our study of families and child development is clear.

Our examination of parent-child physiological linkage also contributes to the broader field of dyadic physiological synchrony and its developmental correlates. Perhaps because theory posits that parent-child physiological synchrony early in life underpins healthy bond formation and self-regulation development (Feldman, 2012), many studies test for associations between synchrony and "good" outcomes (e.g., Han et al., 2019; Moore et al., 2009) but our results suggest this perspective does not capture the whole story. The growing body of literature indicates that, to more fully understand the function of physiological synchrony for parents and children, we must consider the relational context and task demands in which it occurs as well as the specific systems (i.e., sympathetic vs. parasympathetic) being measured (Davis, West, Bilms, Morelen, & Suveg, 2018). For instance, while positive synchrony of the SNS during an emotionally challenging dyadic task like a conflict conversation may compromise the quality of the dyad's interaction, synchrony of parasympathetic responses when mothers are relaxed supports a shared state of calm (Waters et al., 2017).

As expected, parent suppression impacted how parents and children related to each other during interaction. The tendency for parents in the suppression condition to appear less warm and less engaged with their children may have been a product of their efforts to suppress all emotion. Despite being uninformed of their parents' direction to suppress emotion, the children of suppressing parents also appeared less warm and less engaged during interaction. This finding aligns with prior work showing that emotional suppression negatively impacts the nonsuppressing social partner

in addition to the suppressor (Butler et al., 2003; Peters & Jamieson, 2016; Peters et al., 2014). It may also be illustrative of the bidirectionality or reciprocity long recognized, but often understudied, in parent-child relationships (Loulis & Kuczynski, 1997; Morelen & Suveg, 2012). Criticalness did not emerge as affected by suppression and this may be due, at least in part, to the relatively low prevalence rates of observed criticalness in either parents or children. In contrast to the physiological linkage findings, the impact of suppression on parent and child behavior did not vary as a function of parent gender. Unpacking why parent gender moderated parent-child physiological stress contagion but not parent-child interaction behavior may be a fruitful avenue for future studies.

There are several limitations to consider with the current work. First, our results cannot speak directly to how parents' stress and suppression may influence children outside of the dyadic context, such as in triadic or larger family systems. The interpersonal nature of emotions and their regulation suggests that the presence of another parent or a sibling could influence the dynamic process of transmission and this is an empirical question (see Saxbe et al., 2014). Second, while gender concordance of the dyad (i.e., mother-daughter vs. mother-son) may be related to emotional processes in the parent-child relationship (Russell & Saebel, 1997), we did not have the power or the distribution of daughters and sons in respective dyads to test for this effect. Future work designed to examine the role of parent-child dyad gender concordance could further elucidate how parent emotion and its regulation influences child emotional outcomes. Third, we do not know whether (or which) parents in the control condition used emotion regulation strategies other than suppression during the conflict task since they were free to interact naturally. While this fact complicates our ability to compare suppression directly to other regulatory strategies, the unmeasured variability in the control group likely detracted from potential differences between groups, strengthening our confidence in the findings.

Parents often attempt to buffer children from negative experiences by suppressing their own emotions in front of their children. This strategy actually strengthens the influence of parents' stress physiology on children's stress physiology, at least in mother-child dyads, and compromises interaction quality between parent and child. The results of the current work underscore the need to include fathers in developmental research alongside mothers and suggest that parents' goals of socializing effective emotional self-regulation in their children may be best served by parents acknowledging their own emotions to their children rather than hiding them.

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