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Physiological and cognitive consequences of suppressing and expressing emotion in dyadic interactions

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ABSTRACT

Engaging in emotional suppression typically has negative consequences. However, relatively little is known about response-focused emotion regulation processes in dyadic interactions. We hypothesized that interacting with suppressive partners would be more threatening than interacting with expressive partners. To test predictions, two participants independently watched a negatively-valenced video and then discussed their emotional responses. One participant (the regulator) was assigned to express/suppress affective signals during the interaction. Their partner was given no special instructions prior to the interaction. Engaging in suppression versus expression elicited physiological responses consistent with threat—sympathetic arousal and increased vasoconstriction—in anticipation of and during dyadic interactions. Partners of emotional suppressors also exhibited more threat responses during the interaction, but not before, compared to partners of emotional expressors. Partner and interaction appraisals mirrored physiological findings. Emotional suppressors found the task more uncomfortable and intense while their partners reported them as being poor communicators. This work broadens our understanding of connections between emotion regulation, physiological responses, and cognitive processes in dyads.

1. Introduction

Imagine that you are debating politics with a close friend (always a pleasant endeavor). Although you may be frustrated that your friend disagrees with your point of view, you try to remain stoic rather than display your displeasure to keep the conversation from escalating into an argument. Or, during a poker game you get dealt a terrible hand but attempt to suppress your emotional response so as to potentially deceive your opponents and win the pot (i.e., bluff). As exemplified above, regulating emotional expressions via suppression is common in social situations (Gross and John, 2003).

A large corpus of research has accumulated demonstrating the effects of antecedent- and response-focused emotion regulation for individuals employing those strategies—the regulators (Gross, 1998, 2002; Gross and Barrett, 2011). However, emotion regulation does not occur in a vacuum. Social–situational factors must be considered. One social function of regulating emotion, especially response-focused strategies such as suppression, is to alter affective signals to others. For example, the person suppressing negative emotions about the political discussion attempts to signal to his friend that he is not dismayed by the differing viewpoint. Or, the poker player maintaining a neutral expression denies her opponents emotionally-relevant information that could be used to inform their behavior. Thus, emotion regulation can impact partners (those interacting with the regulators) as well as the regulators.

The dyadic nature of emotion regulation should be fully considered so as to best understand the effects of regulation on downstream outcomes. However, relatively little is known about how regulation strategies enacted by regulators impact outcomes in partners. The primary goal of the research reported here was to examine expressive suppression in vivo during a dyadic interaction with a focus on motivationally-tuned physiological measures and cognitive appraisals.

1.1. Emotion regulation

The process model of emotion regulation considers the dynamic nature of emotion (Gross, 2002). Experienced emotions can be regulated by altering underlying antecedent psychological, physiological, and situational mechanisms (i.e., the "ingredients" of emotion) occurring more upstream. For instance, altering cognitive appraisals of internal or situational signs of arousal can change subsequent affective experiences (Jamieson et al., 2013b; Mauss et al., 2007). In contrast, response-focused regulation strategies are implemented after emotions have been experienced; the most common strategy being suppression. The poker player in the example above suppressed displays of affect, but this suppression would not be expected to alter the negative affect felt

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from receiving the poor hand. The process model of emotion regulation makes a temporal distinction between regulation strategies. In the research presented here, we focus on response-focused regulation strategies. Suppression, as operationalized here, refers to inhibiting outward displays of affect.

Hallmarks of emotional suppression research are that suppression is effortful and does not alter felt affect because—by definition—it occurs after emotional experiences (Gross and Levenson, 1997; Gross, 1998; Harris, 2001). Downstream, suppression has been linked to myriad negative outcomes. For instance, suppression impairs memory processes (Dunn et al., 2009; Richards and Gross, 2000), predicts psychopathology (Haga et al., 2007; John and Gross, 2004; Moore et al., 2008), and elicits maladaptive physiological responses (Gross and Levenson, 1997; Gross, 1998; Hagemann et al., 2006) to name a few. Suppression also has negative social consequences, such as reducing access to social support resources, lowering "social satisfaction," and harming relationships (Amirkhan et al., 1995; Srivastava et al., 2009; Von Dras and Siegler, 1997). More long-term, engaging in suppression predicts weaker social connections (English et al., 2012). The extant literature—with exceptions in boundary conditions such as cross-cultural comparisons (Butler et al., 2009) and long-term adjustment in response to trauma (Bonanno et al., 2004; Seery et al., 2008)—illustrates that engaging in suppression has negative consequences for affective regulators.

On the other hand, comparatively little research has examined the effects of emotional suppression (and emotion regulation more generally) in partners (i.e., individuals who interact with regulators). Expression of emotion is crucial for interpersonal communication and, when disrupted, can have negative consequences for the interaction (Ben-Naim et al., 2013; Butler et al., 2003; Christenfeld et al., 1997; Glynn et al., 1999; Lepore et al., 1993; Lepore, 1995; Smith, 1992).

However, the specific physiological effects of suppression for partners of emotional regulators remain unclear. For instance, Butler et al. (2006) found that women who regulated their emotions (via reappraisal and suppression) during conversations exhibited increased respiratory sinus arrhythmia (RSA; indicative of increased vagal tone) and reports of negative affect compared to uninstructed controls. However, no differences in RSA emerged for partners who interacted with emotional regulators. This suggests that, at least in terms of parasympathetic nervous system (PNS) activity, partners may be minimally influenced by interacting with suppressive partners. Other research has found increases in blood pressure (BP)—frequently (but not always) diagnostic of sympathetic arousal—in partners who interacted with emotional suppressors (Butler et al., 2003). However, increases in BP can stem from multiple sources (e.g., contractile force of the heart or constriction/dilation of the vasculature), which can index different psychophysiological processes. Contractile force, for instance, increases with sympathetic arousal, but constriction/dilation modulates the delivery of oxygenated blood to the periphery and better maps onto motivational orientation. Additionally, in research with romantic couples, Ben-Naim et al. (2013) found that expressive suppression increased cardiovascular arousal (as indexed by a composite of physiological measures, including interbeat interval (IBI), skin conductance, finger pulse amplitude, finger pulse transit time, ear pulse transit time, and ear pulse amplitude). However, as touched on above, arousal does not directly map onto motivational orientation or affective state.

As outlined above, previous research has laid the groundwork for understanding the interactions between physiological responses and emotion regulation in dyads. The current research extends these findings by using motivationally-tuned physiological measures in a controlled dyadic emotion regulation context to help clarify the mixed physiological and affective findings for partners of regulators reported in previous research. Motivationally-tuned affective and physiological responses were examined in anticipation of and during social interactions in unacquainted, opposite-sex regulators and partners.

1.2. Stress and emotion regulation

Social interactions can be stressful. In fact, social evaluative situations are some of the most reliable means of instantiating stress in the laboratory (see Dickerson and Kemeny, 2004, for a review) and evaluative pressures are key components of social threats (cf. Jamieson and Harkins, 2010). Here, we conceptualize "social stress" as a social situation that disrupts homeostasis (allostasis) by presenting acute task demands that must be addressed. A social interaction in which one individual is suppressing her/his emotional expressions falls in this category. Regulators must expend resources in order to suppress, while partners seek to evaluate the verbal and (lack of) behavioral/non-verbal signals so as to respond accordingly. Examining physiological indexes of stress may provide a window into the affective mechanisms underlying dyadic emotion regulation.

The biopsychosocial (BPS) model of challenge and threat provides a theoretical framework for understanding how cognitive and situational factors interact to shape physiological responses in acutely stressful social situations (see Blascovich and Mendes, 2010, for a review). Briefly, when coping resources exceed situational task demands, individuals experience *challenge*. On the other hand, *threat* manifests when appraisals of demands exceed resources. These differential stress response patterns are important for understanding emotion regulation because they are accompanied by differences in motivationally-tuned physiological responses.

Physiologically, both challenge and threat states are accompanied by increased sympathetic nervous system (SNS) arousal. Challenge states elicit relatively greater sympathetic–adrenal–medullary (SAM) axis activation, increased cardiac efficiency (e.g., higher cardiac output, CO), and dilation of the peripheral vasculature (e.g., lower total peripheral resistance, TPR). Alternatively, threat is associated with relatively greater activation of the hypothalamus–pituitary–adrenal (HPA) axis, decreased cardiac efficiency (little change in or lower CO), and constriction of the peripheral vasculature (higher TPR). Motivationally, the physiological responses observed during challenge signal an *approach* orientation by preparing the body to actively address acute stressors, whereas threat responses signal an *avoidance* orientation in anticipation of damage and defeat (Jamieson et al., 2013a; Mendes et al., 2007, 2008). Couching predictions in the framework provided by the BPS model of challenge and threat will help clarify the limited, ambiguous physiological effects observed in the dyadic emotion regulation literature (Ben-Naim et al., 2013; Butler et al., 2003, 2006).

1.3. Current study

In the research reported here we examined the effects of response-focused emotion regulation on physiological and affective responses, and interaction and partner appraisals. Unacquainted (i.e. strangers), opposite-sex dyads first watched a video intended to induce negative affect. Then participants were informed that they would discuss their emotional reactions to the video with an unacquainted partner. One participant (the regulator) was instructed to either suppress or express outward facial and bodily displays of emotion, while the other partner was given no special instructions. Prior to beginning, partners prepared their thoughts in anticipation of the interaction. We predicted regulators instructed to engage in suppression would experience an anticipatory threat response as indexed by decreased PEP and increased TPR compared to expressive regulators.

The dyadic interaction also allowed for us to examine partners of suppressive and expressive regulators. During the interaction (but not during the anticipatory phase when regulators and partners had yet to meet), we predicted similar physiological and cognitive effects for partners of suppressive regulators. Partners who interacted with suppressive regulators were expected to exhibit more of a physiological threat pattern of responding (decreased PEP and increased TPR) and appraise the interaction and their partners more negatively compared to partners of expressive regulators.

2. Method

2.1. Sample size estimation

We first conducted a power analysis to estimate the number of participants needed to test hypotheses. Although no prior research has used a design identical to this research, we calculated effect sizes from previous dyadic suppression studies that included physiological measures to obtain an estimate (Butler et al., 2003, 2006; Mendes et al., 2003). Using an average of these effect sizes (Cohen's $d = .53$) and a target power level of .80, we required a minimum of 45 regulators and partners to be assigned to each level of the emotion regulation condition (minimum total $N = 180$ participants in 90 dyads).

2.2. Participants

One hundred eighty-two community members and undergraduate students, forming 91 opposite-sex dyads (99 White, 49 Asian, 12 Hispanic, 10 Black, 12 mixed/other) were recruited via an online study pool (SONA) and flyers. Participants were pre-screened and excluded for physician diagnosed hypertension, the presence of a cardiac pacemaker, cardiac medications, and pregnancy/breast-feeding, and compensated $10 or 2-h of course credit ($M_{age} = 19.88$, $SD = 1.40$, 18–27).

2.3. Procedure

Upon arrival participants (one male, one female) were escorted to a private testing room, where they provided consent and completed initial questionnaires. The experimenter then affixed physiological sensors and participants relaxed for a 5-minute baseline recording. After baseline, participants remained in their private testing room and watched an 11-minute clip from a documentary about World War II that originally aired on the BBC titled, “Hiroshima: BBC History of World War II” (from minutes 46:54 to 57:54). Similar videos have been used previously to elicit negative affect in emotion regulation paradigms (see Butler et al., 2003, 2006). Following the video, participants completed questionnaires assessing their affective state.

At this point participants were told they would be discussing their emotional reactions to the video with another participant. One person from the dyad (the regulator) was randomly assigned to receive additional emotion regulation instructions. In the expressive suppression condition, participants were told:

> *Behave in such a way that your partner does not know you are feeling any emotions at all. That is, try not to express your emotions outwardly. Keep stoic even when speaking about your feelings regarding the video.*

In the emotion expression condition participants were instead instructed:

> *Behave in such a way that the emotions you are feeling are clear to your partner. That is, try to express your emotions outwardly. Use expressive gestures and facial expression to convey your feelings regarding the video.*

Please refer to the Supplemental online material (SOM) for full instruction materials.

Participants assigned to the partner role received no additional instructions. They were simply told to converse with their partner about their emotional reactions to the video and were unaware of the instructions given to regulators. After receiving interaction instructions, regulators and partners remained in their private testing rooms for an anticipatory period during which they were given 3 min to “gather their thoughts” and prepare for the upcoming conversation. Sex and regulator/partner role were counterbalanced across dyads. Following the preparation period participants were brought together for the 5-minute conversation. Participants were then escorted back to their private testing rooms, and completed post-task measures.

2.4. Measures

2.4.1. Questionnaires

2.4.1.1. Affective state. Affective state was assessed at two time-points: before and after the emotion induction video using the Positive and Negative Affect Schedule (PANAS; Watson et al., 1988), with a 5-point Likert scale (1 = *not at all*, 5 = *a great deal*). Scores were averaged to form positive (before video: *Cronbach's* $\alpha = .895$, after: $\alpha = .873$) and negative (before: $\alpha = .845$, after: $\alpha = .850$) affect composites.

2.4.1.2. Partner attributions. After the conversation, participants completed measures assessing their attributions of their interaction partner. Specifically, participants rated the extent to which their interaction partner made eye contact, communicated emotions using hand positions and movements, expressed emotion, and would make an excellent communicator on 9-point Likert scales (-4 = *strongly disagree*, 4 = *strongly agree*).

2.4.1.3. Interaction attributions. Participants rated the extent to which they were able to hold back their emotions and whether the interaction was intense, uncomfortable, and difficult on 9-point Likert scales (-4 = *strongly disagree*, 4 = *strongly agree*).

2.4.2. Physiological measures

The following physiological signals were collected at baseline, during anticipation of the conversation, and throughout the conversation: electrocardiography (ECG), impedance cardiography (ICG), and blood pressure. Signals were integrated using Biopac MP150 hardware. ECG and ICG signals were scored offline by trained personnel. Signals were visually examined, and the ensemble averages were analyzed using Mindware software. Reactivity scores were computed by subtracting scores taken during the final minute of baseline (i.e., the most relaxed period) from those collected during the first minute of preparation and the first minute of the conversation (i.e. the most reactive periods).

Analyses focused on pre-ejection period (PEP)—a measure of sympathetic activation—and two measures that allow distinction between approach-motivated challenge and avoidance-motivated threat states: cardiac output (CO) and total peripheral resistance (TPR). PEP indexes the contractile force of the heart by measuring the time from the initiation of left ventricle contraction to aortic valve opening. Greater sympathetic activation is indicated by shorter PEP intervals. CO is the amount of blood ejected from the heart during 1 min and is calculated by estimating stroke volume (the amount of blood ejected per beat) and multiplying by heart rate. Increases in CO indicate improved cardiac efficiency, and typically are observed in challenge states (Mendes et al., 2007). TPR is a measure of overall vasoconstriction/vasodilation. When threatened, the vasculature constricts so as to limit blood flow to the periphery, producing high TPR scores.

2.5. Data analysis plan

One dyad was excluded from analyses because the emotion regulation manipulation was disclosed by the regulator during the interaction, leaving a final sample of 180 participants across 90 dyads. After data processing, artifacts in the physiological signals led to exclusion of seven participants' PEP and CO data, and eleven participants' TPR data. Moreover, five participants did not fully complete pre-task stress appraisals, four participants did not fully complete post-task stress appraisals, and three participants did not fully complete interaction appraisals.

Data were analyzed in 2 (Emotion Regulation Condition: suppression vs. expression) × 2 (Role: sender vs. receiver) mixed ANOVAs. Due to the dyadic nature of the data varying throughout the study—dyads do not form until after the anticipatory phase—data collected before the conversation were treated as independent (see SOM for tests of non-independence), whereas data collected during and after the conversation were analyzed accounting for the non-independence in the data. Planned contrasts (Kirk, 1995) were used to test a priori predictions and decompose interactions.

3. Results

3.1. Questionnaires

3.1.1. Affective responses

PANAS scores were analyzed in 2 (time: pre- vs. post-video) × 2 (Emotion Regulation Condition) × 2 (Role) mixed ANOVAs to assess affective responses to viewing the video. Analysis of negative affect produced the expected main effect for time, $F(1, 178) = 117.32$, $p < .001$, $d = 1.62$. Negative affect reports were higher after watching the video ($M = 2.04$, $SD = .65$) than before ($M = 1.53$, $SD = .50$). Similarly, participants reported less positive affect after watching the video ($M = 2.20$, $SD = .67$) than before ($M = 2.83$, $SD = .77$), $F(1, 89) = 173.21$, $p < .001$, $d = 2.79$.

3.1.2. Partner attributions

Partner attributions were analyzed in 2 (Role) × 2 (Emotion Regulation Condition) mixed ANOVAs (see Table 1 for means, standard deviations, and mean comparisons). Partner attribution measures were collected after the dyad had formed. Thus, non-independence in the data was accounted for by entering Role (regulator vs. partner) as a within-subject factor.[1] Analyses revealed significant Role × Emotion Regulation interactions for reports of: "gestures and movements," $F(1, 86) = 8.50$, $p < .01$, $d = .63$; partners′ emotional expression, $F(1, 86) = 4.22$, $p = .04$, $d = .44$; and partners' overall communication skills, $F(1, 86) = 8.52$, $p < .01$, $d = .63$. Regulators' reports of their partners' behavior did not differ as a function of the emotion regulation condition, $ps > .18$. As expected, however, partners of suppressive regulators reported that they: gestured less, $F(1, 86) = 7.87$, $p < .01$, $d = .61$; expressed less emotion, $F(1, 86) = 5.16$, $p < .01$, $d = .49$; and were worse overall communicators, $F(1, 86) = 7.51$, $p < .01$, $d = .59$, compared to partners interacting with expressive regulators. No significant differences were observed for the eye contact measure, $p > .24$.

3.1.3. Interaction attributions

Again, because the interaction attributions were collected after dyad formation, the non-independence in the data was accounted for by entering Role as a within-subject factor. We observed a main effect of Role for assessments of intensity of the conversation, $F(1, 86) = 11.13$, $p < .01$, $d = .72$. Regulators reported that the conversation was more intense than their partners.

We then examined self-reports of how much participants withheld their own emotions as a manipulation check for the emotion regulation manipulation administered to regulators. We observed main effects for Emotion Regulation Condition, $F(1, 86) = 6.33$, $p = .01$, $d = .54$, and Role $F(1, 86) = 43.70$, $p < .001$, $d = 1.43$, but these were qualified by a Role × Emotion Regulation interaction, $F(1, 86) = 16.34$, $p < .001$, $d = .87$. Consistent with predictions, suppressive regulators reported "holding back" their emotions more so than expressive regulators, $F(1, 86) = 23.22$, $p < .001$, $d = 1.04$, whereas partners did not differ as a function of the emotion regulation manipulation, $p = .36$.

Finally, we examined participants' reports of how comfortable the interaction was. This analysis produced main effects for Emotion Regulation, $F(1, 86) = 7.72$, $p < .01$, $d = .60$, and Role $F(1, 86) = 9.23$, $p < .01$, $d = .66$. Regulators reported the conversation as being more uncomfortable than their partners, and both regulators and partners in the suppression condition reported the conversation as being more uncomfortable than regulators and partners in the expression condition.

We observed no significant effects for reports of conversation difficulty as a function of Emotion Regulation or Role, $ps > .11$.

Table 1
Partner and interaction attributions as a function of the Emotion Regulation Condition and Role. R—emotional regulator; P—partner.

	Emotion Regulation Condition			
	Suppression		Expression	
Measures	*M*	*SD*	*M*	*SD*
Partner attributions				
Eye contact	R: 1.70_{a}	1.88	R: 1.89_{a}	1.63
	P: 1.41_{a}	1.77	P: 1.64_{a}	2.02
Gestures & movements	R: $.93_{a}$	1.91	R: $.39_{a,b}$	1.94
	P: $-.30_{b}$	2.03	P: $.86_{a}$	2.06
Partner expressed emotions	R: $1.25_{a,b}$	1.95	R: 1.00_{a}	1.82
	P: $.95_{a}$	1.89	P: 1.82_{b}	1.76
Partner would make excellent communicator	R: 1.45_{a}	1.53	R: $1.02_{a,b}$	1.30
	P: $.48_{b}$	1.90	P: 1.34_{a}	1.80
Interaction attributions				
Interaction intensity	R: $.11_{a}$	1.67	R: $.14_{a}$	1.84
	P: $-.84_{b}$	2.00	P: $-.91_{b}$	1.99
"Holding back" own emotions	R: 1.91_{a}	1.97	R: $-.14_{b}$	2.09
	P: -1.30_{c}	2.02	P: $-.91_{b,c}$	2.28
Interaction uncomfortable	R: 1.36_{a}	1.78	R: $.07_{b}$	2.41
	P: $-.05_{b}$	2.33	P: $-.59_{b}$	2.34
Discussion difficulty	R: $.41_{a}$	2.32	R: $-.27_{a,b}$	2.24
	P: $-.20_{a,b}$	2.48	P: $-.73_{b}$	2.39

Note: Means not sharing a subscript within a measure differ at $p < .05$.

3.2. Physiological responses

We first examined raw PEP, CO, and TPR scores taken at baseline to examine whether differences might obscure reactivity effects. No differences in baseline measures were observed, $ps > .25$. See Table 2 for means and standard deviations.[2]

3.2.1. Preparation period

Data collected during the preparation period were treated as independent (see SOM for non-independence tests) because the dyad had not yet formed.

3.2.1.1. PEP. As expected, during the anticipatory phase no significant effects for PEP emerged as a function of the Emotion Regulation Condition or Role, $ps > .52$ (see Fig. 1a). All participants exhibited an increase in SNS arousal as overall reactivity was significantly lower than zero where zero indicates no change from baseline and a negative score indicates lower PEP, or more sympathetic arousal (overall $M = -3.64$, $SD = 6.60$), $t(176) = 7.34$, $p < .001$, $d = 1.11$.

3.2.1.2. CO. Analysis of CO reactivity during the anticipatory phase produced no significant effects, $ps > .23$ (see Fig. 1b).

3.2.1.3. TPR. Analysis of TPR during the anticipatory phase produced a marginally significant main effect for Emotion Regulation,

[1] For an alternative data analytic strategy that accounts for non-independent data, multi-level regression analyses were conducted and are presented in the SOM. The findings from this data analytic strategy are consistent with findings presented in the main manuscript.

[2] Some research suggest that gender influences social interactions (Mendes et al., 2003). However, including gender as a covariate or factor had no discernible impact on the physiological findings.

Table 2
Means and standard deviations for raw physiological scores as a function of the Emotion Regulation Condition and Role.

Reactivity scores	Emotion Regulation Condition			
	Suppression		Expression	
	M	*SD*	*M*	*SD*
Baseline				
PEP	R: 92.60	10.15	R: 90.11	11.39
	P: 103.34	13.86	P: 104.78	11.30
CO	R: 6.52	1.78	R: 6.60	1.25
	P: 7.62	2.47	P: 7.07	2.77
TPR	R: 1147.98	331.21	R: 1095.08	258.46
	P: 992.45	327.49	P: 1138.24	446.15
Preparation				
PEP	R: 88.80	11.45	R: 87.97	12.10
	P: 101.06	16.29	P: 101.94	11.10
CO	R: 6.45	1.82	R: 6.51	1.41
	P: 7.31	2.35	P: 6.75	2.50
TPR	R: 1271.20	381.05	R: 1149.74	297.01
	P: 1083.52	347.34	P: 1226.89	428.66
Conversation				
PEP	R: 84.52	11.71	R: 84.60	11.42
	P: 99.49	14.84	P: 99.27	10.30
CO	R: 6.54	2.00	R: 6.49	1.45
	P: 7.14	2.51	P: 6.86	2.82
TPR	R: 1357.92	444.30	R: 1247.08	346.06
	P: 1217.52	525.51	P: 1294.79	483.97

Note: R = regulators, P = partners of regulators, PEP = pre-ejection period, CO = cardiac output, TPR = total peripheral resistance.

$F(1, 169) = 2.92$, $p = .09$, $d = .26$ (see Fig. 1c). No other TPR effects were significant, $p > .30$. To test the a priori prediction that suppressive regulators would exhibit greater vasoconstriction during the anticipatory phase than expressive regulators and partners of both expressive and suppressive regulators, a planned contrast model was run using the following contrast weights: suppressive regulators = 1; expressive regulators, and partners of expression and suppression = −.33. The predicted model was significant, $F(1, 169) = 3.99$, $p = .05$, $d = .31$, suggesting that suppressive regulators had higher TPR reactivity scores than the other three groups.

Taken together, suppressive regulators exhibited a pattern of physiological responding associated with the experience of threat (SNS arousal combined with vasoconstriction) before even beginning the conversation. On the other hand, partners were, as expected, unaffected by the emotion regulation manipulation during preparation since they had yet to interact with the regulators.

3.2.2. Conversation

Participants were introduced (thus the dyad forms) at the start of the conversation. Analyses of all conversation data account for any non-independence resulting from dyad.[3]

3.2.2.1. PEP. As with the anticipatory phase, we observed no significant PEP effects as a function of the Emotion Regulation Condition or Role, $ps > .12$ (see Fig. 2a). During the conversation all participants exhibited increased SNS activation relative to both baseline (overall $M = -9.97$, $SD = 8.17$), $t(175) = 16.14$, $p < .001$, $d = 2.44$.

3.2.2.2. CO. Regulators exhibited higher CO scores ($M = .27$, $SD = .89$) than partners ($M = -.03$, $SD = .88$), $F(1, 83) = 5.29$, $p = .02$, $d = .50$. However, the main effect for Role was qualified by a marginally

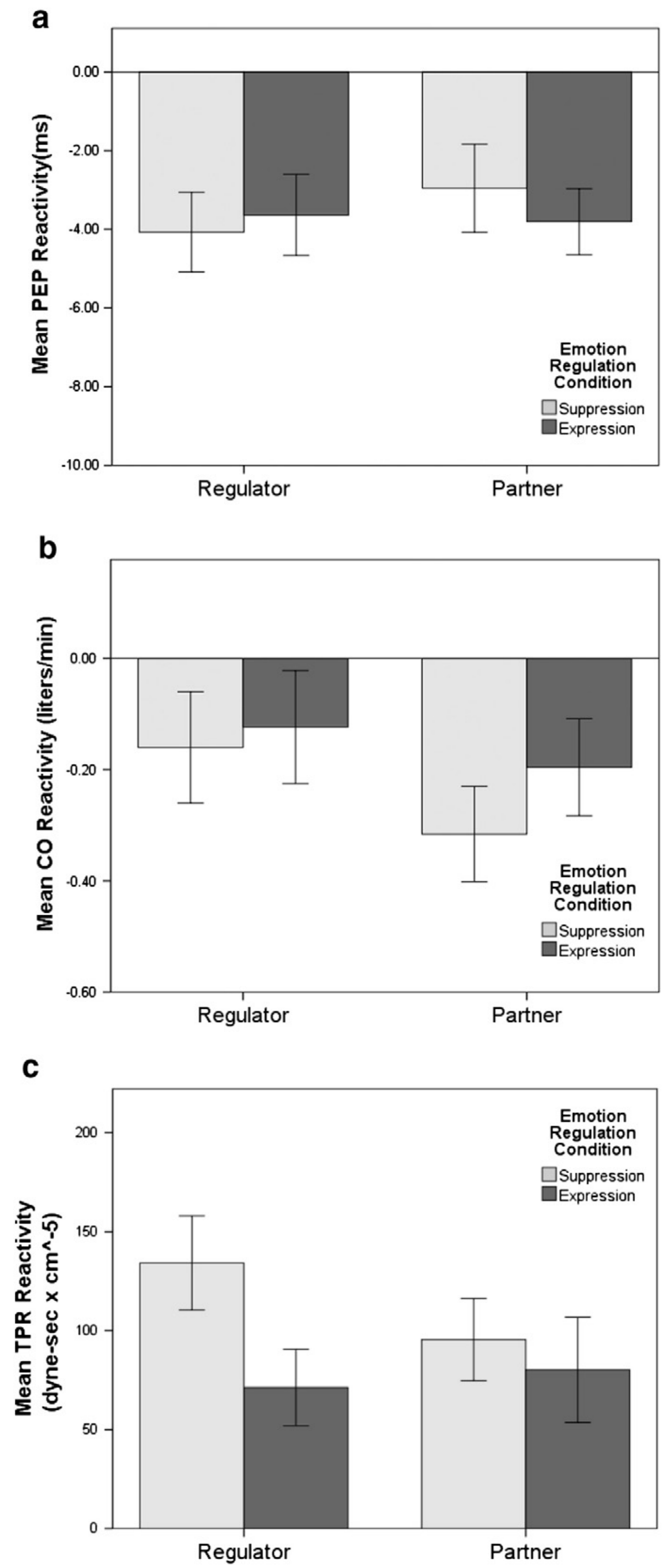

Fig. 1. Mean cardiovascular data and standard errors for participants during the preparation period by Role and Emotion Regulation Condition. PEP = pre-ejection period; CO = cardiac output; TPR = total peripheral resistance. a—preparation PEP; b—preparation CO; c—preparation TPR.

significant Emotion Regulation × Role interaction, $F(1, 83) = 3.82$, $p = .051$, $d = .42$. Planned contrasts were used to test the hypothesis that regulators of suppression *and* their partners would exhibit lower

[3] Despite the analyses suggesting that regulators' and partners' scores on many measures were largely independent (see SOM), we continued to recognize the potential dependence across regulators and partners once the dyad had formed by employing an appropriate, albeit conservative, approach that treated any data collected after the dyad had formed as non-independent.

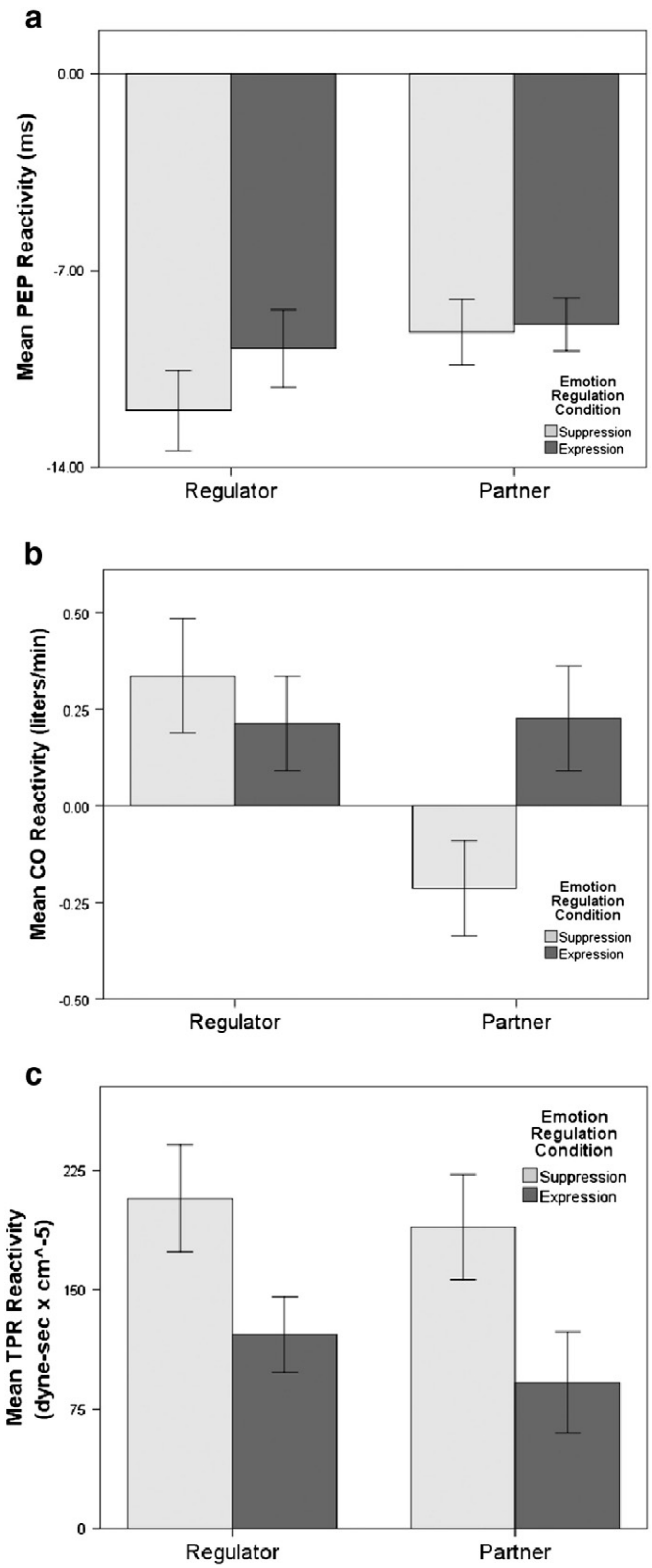

Fig. 2. Mean cardiovascular data and standard errors for participants during the conversation by Role and Emotion Regulation Condition. PEP = pre-ejection period; CO = cardiac output; TPR = total peripheral resistance. a—conversation PEP; b—conversation CO; c—conversation TPR.

CO scores than dyads in the expression condition by applying the following contrast weights: regulators and partners of expression = 1; regulators and partners of suppression, = −1. This model did not fit the observed data, $p = .29$ (see Fig. 2b).

3.2.2.3. TPR. Consistent with predictions, we observed a main effect for Emotion Regulation in our analysis of TPR reactivity during the conversation, $F(1, 82) = 7.08$, $p < .01$, $d = .59$ (see Fig. 2c). Both regulators and their partners in the suppression condition exhibited greater vasoconstriction ($M = 199.95$, $SD = 220.96$) than regulators and partners in the expression condition ($M = 113.91$, $SD = 185.52$). No other effects were significant, $ps > .56$. In sum, participants in social interactions in which one was instructed to suppress affective displays exhibited a pattern of physiological reactivity consistent with the experience of threat (SNS arousal—see PEP data—combined with vasoconstriction).

4. Discussion

This study examined the effects of response-focused emotion regulation (specifically expressive suppression and expression) in anticipation of and during dyadic social interaction on physiological and cognitive responses in regulators *and* partners of regulators. There were several noteworthy findings. First, suppressive regulators reported holding back their emotions more than expressive regulators, and partners who interacted with suppressive regulators (and were unaware of the manipulation) reported that those individuals displayed significantly less emotion, facial expressions, and gestures. The emotion regulation manipulation also had negative consequences for interaction appraisals. Regulators (across both levels of the manipulation) experienced the interaction as more intense and uncomfortable than their partners. More interestingly, partners of suppressive regulators indicated that their partners were worse overall communicators compared to partners of expressive regulators.

Notable effects also emerged in our analyses of individuals' physiological responses. During the anticipatory preparation period, we expected only suppressive regulators (not their interaction partners) to exhibit adverse effects of suppressing affect because the dyad had yet to interact. This prediction was supported. Whereas all participants exhibited SNS arousal when anticipating an emotionally-charged conversation with a stranger, only suppressive regulators exhibited greater vasoconstriction, which is typically diagnostic of threat (e.g., see Blascovich and Mendes, 2010 for a review; Jamieson et al., 2013b, 2012). During the emotional conversation, however, both suppressive regulators and their partners (i.e. the dyad) exhibited maladaptive physiological threat responses: SNS arousal combined with vasoconstriction. The negative effects exhibited by suppressive regulators impacted the physiological responses of their partners. This pattern of findings may have implications for health as threat profiles have been associated with impaired decision making in the short-term and accelerated "brain aging", cognitive decline, and cardiovascular disease in the long-term (Jefferson et al., 2010; Kassam et al., 2009; Matthews et al., 1997).

Taken together, these results provide the first empirical evidence using motivationally-tuned physiological measures that suppression of *negative* emotions has *negative* consequences for cardiovascular responses in both regulators and partners during social interactions (cf., Ben-Naim et al., 2013; Butler et al., 2003, 2006). Lay theories suggest that withholding negative emotions may benefit interactions. As the old adage goes, "if you don't have anything nice to say [or display in this case], don't say anything at all." However, the data presented here indicate that limiting displays of negative affect cannot only harm the quality of social interactions, but can also have deleterious effects for physiological responses. When discussing disappointments, problems, or any general negative event, it may be disadvantageous *not* to display appropriate negative affect. Consistent with a large body of research demonstrating affective signals enhance social communication (Haidt and Keltner, 1999; Keltner and Kring, 1998; Tangney et al., 2013), this research suggests that expressing negative affect when discussing an emotionally-negative topic can promote beneficial responses in both regulators and their partners.

More broadly, the current study advances emotion regulation theory. Down-regulating negative affect has been a primary focus of emotion regulation research since the area's conception (see Gross, 2002, for a review). However, the findings presented here suggest it can be advantageous to express, not limit, negative emotions. Because the situation here was objectively negative (watching a negatively-valenced video), expressing negative emotions during a social exchange facilitated the interaction. Just as it is more adaptive to reappraise stress arousal as functional in acutely stressful situations than to down-regulate SNS arousal (see Jamieson et al., 2013b, for a review), expressing appropriate negative affect is better than withholding affective displays. Thus, situational/contextual information must be considered when determining the effectiveness of different regulation strategies.

When considering these findings, however, limitations should be considered. Importantly, research suggests differences in cultural norms for various emotion regulation strategies. For instance, whereas expressing emotion may benefit Westerners, emotional expressivity has been correlated with worse health outcomes in East Asians (Butler et al., 2009; Soto et al., 2011). Similarly, the race of interaction partners can potentially have a profound effect on physiological responses in social situations (cf., Jamieson et al., 2013a). Despite Asians or Asian-Americans representing over a quarter (27%) of our sample, post-hoc exploratory analyses revealed no differences in any measure as a function of race/ethnicity. However, this research was not designed to test for differences as a function of culture or race/ethnicity. Follow-up research may seek to examine expressive suppression in same- versus cross-race interactions.

Along similar lines, prior studies suggest expressing emotion with an opposite-sex stranger can elicit physiological threat responses (Mendes et al., 2003), and women engage in less suppression than men (Gross and John, 2003). Although gender had no significant effects here, there were several substantial differences between this and previous research. First, the current study had unacquainted, non-confederate strangers interact. Second, we had disparate conceptualizations of expressive suppression. Instead of allowing or delaying a conversation, we manipulated emotional context via expression and suppression of affective signals. These differences open up avenues for future research by varying contextual factors.

Another possible limitation stemmed from the well-controlled nature of the experiment. Regulators were given explicit emotion regulation instructions, which could have created an artificial context. For example, not only were suppressive regulators required to exert effort concealing affective displays, but expressive regulators, too, may have exerted effort trying to maximize affective signaling. The effort exerted in both regulator conditions could have attenuated observed effect sizes for comparisons of suppressive and expressive regulators. In line with this reasoning, Robinson and Demaree (2009) found when participants were viewing a film, exaggeration led to sympathetic arousal (increased skin conductance level (SCL) and shorter PEP intervals), whereas suppression led to the opposite pattern (increased SCL, longer PEP). However, the physiological responses observed here during the anticipatory phase, as well as regulators' and partners' cognitive appraisals suggest that suppression was driving the observed effects rather than the expressive condition up-regulating affective signaling. For example, expressive regulators, partners of expressive regulators, and partners of suppressive regulators all exhibited similar patterns of physiological reactivity during the anticipatory phase. Even though the two partner groups were given no regulation instructions, they responded similarly as the expressive regulators.

These data raise the possibility that the emotion regulation effects observed here could be extended to acquainted interaction partners. Threat-related physiological responses were observed in response to suppressing emotion in unacquainted opposite-sex strangers. Recently, researchers have started to examine emotion regulation processes in acquainted dyads such as romantic couples (Ben-Naim et al., 2013). It is possible that the emotion regulation processes specified here may unfold differently in romantic partners compared to unacquainted partners. For example, partners who are familiar with their partners, but unaware of emotion regulation instructions, may be alarmed at the sudden change in affective signaling leading to exacerbated physiological responses. However, follow-up research is needed to elucidate the physiological and cognitive responses to suppression/expression in couples.

4.1. Conclusion

In sum, this research is the first to examine how response-focused emotion regulation (suppression and expression) impacted motivationally-tuned physiological responses and interaction outcomes in both regulators *and* their partners. Suppressing affective signals led to threat-related physiological and psychological responses for regulators and partners, despite the suppressed emotions being negatively-valenced. More generally, this study demonstrates the utility of using motivationally-tuned physiological measures to tap into underlying processes of dyadic interactions and is part of the burgeoning area of research that seeks to bring the “social” back into social psychology research by examining situational influences in social interactive contexts (Reis, 2008).

Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.ijpsycho.2014.07.015.

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