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Cardiovascular Correlates of Emotional Expression and Suppression: Do Content and Gender Context Matter?

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Three studies examined cardiovascular (CV) responses during emotional expression with empathically responsive strangers. Study 1 demonstrated that self-relevant emotional expression fostered CV reactivity consistent with challenge. Study 2 manipulated content of discussion by assigning participants to 1 of 4 conditions: emotional, nonemotional, emotional suppression, nonemotional suppression. In same-sex dyads, emotional expression elicited CV challenge reactivity whereas emotional suppression evoked CV threat reactivity, both compared with appropriate control groups. In opposite-sex dyads, however, emotional expression engendered CV threat. Because same- and opposite-sex disclosures differed, Study 3 controlled the content of emotional expression while manipulating gender context. Results confirmed findings from the first 2 studies, indicating that both context and content of emotional expression influenced CV effects. Findings are discussed within a theoretical challenge and threat perspective.

Emotional expression can be an intense experience. Although discussing emotional or stressful events may have short-term adverse effects (Mendolia & Kleck, 1993), emotional expression may have long-term health benefits, as reflected in fewer healthcare visits, higher subjective well-being (Pennebaker, 1989, 1997), and enhanced immune function (Esterling, Kiecolt-Glaser, Bodnar, & Glaser, 1994; Pennebaker, Kiecolt-Glaser, & Glaser, 1988). On the other hand, other researchers have found that emotional expression may carry substantial costs, such as more intrusive thoughts (Major & Gramzow, 1999), distress and sustained grief (Bonanno, Keltner, Holen, & Horowitz, 1995), and immunosuppression (Labott, Ahleman, Wolever, & Martin, 1990).

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This variability in findings may reflect differences in the context (to whom one is talking) and content (what one is saying) of emotional expression. For example, some studies obtaining negative effects of emotional expression did not allow participants to choose the topic of emotional expression (e.g., the experimenters were interested in a particular event, such as abortion or conjugal death). Also, because tendencies to disclose vary according to the interpersonal context (e.g., gender of discloser and target [for a meta-analysis, see Dindia & Allen, 1992]; the relationship between discloser and listener), the context may moderate the benefits and costs derived from emotional expression. In the present research, we examined the impact of the interpersonal context and the effect of content on cardiovascular (CV) responses to emotional expression and suppression.

Emotional Expression and Challenge and Threat

A growing body of evidence has indicated that talking or writing about emotional experiences as opposed to suppressing them may promote physical and psychological health (for reviews, see Pennebaker, 1989, 1997; Smyth, 1998). However, the mechanisms responsible for this effect are unclear. Emotional expression may promote health by facilitating insight into the experiences, which can assist in a better understanding of the events in question (Donnelly & Murray, 1991). Another explanation suggests that the act of sharing emotion fosters supportive interaction, which helps to reduce anxiety and distress (Reis & Patrick, 1996; Rimé, Mesquita, Philippot, & Boca, 1991). A third possibility is that emotional expression benefits physical health via direct biological mechanisms, such as reduced blood pressure and muscle tension and increased immune functioning (Esterling et al., 1994; Pennebaker et al., 1988; Petrie, Booth, & Pennebaker, 1998).

The present research focused on the last of these mechanisms for several reasons. Although psychophysiological measurement in emotional-expression research is not novel (e.g., Christensen & Smith, 1993; Cumes, 1983; Mendolia & Kleck, 1993; Pennebaker, 1989; Pennebaker & Beall, 1986; Pennebaker, Hughes, & O'Heeron, 1987), past research typically examined autonomic activity as if it were unidirectional, such that all deviations from baseline were considered pathophysiological. This is an outdated point of view, however (Blascovich & Katkin, 1993). Distinctive patterns of CV response are associated with differential, independently validated motivational states, labeled *challenge* and *threat* (Tomaka, Blascovich, Kelsey, & Leitten, 1993). Rather than assuming that all autonomic reactivity during emotional expression is a sign of distress, challenge and threat theory (Blascovich & Mendes, 2000; Blascovich & Tomaka, 1996) suggests that only those CV responses associated with threat are likely to be pathophysiological; challenge responses, in contrast, are likely to be beneficial. Thus, on the basis of challenge and threat theory, we propose that emotional expression is sometimes challenging and at other times threatening. This distinction, we reason, may help explain the conflicting results in emotional-expression health research.

Challenge and Threat

Blascovich, Tomaka, and their colleagues have identified challenge and threat as discrete motivational states, each of which is associated with distinct patterns of CV reactivity (Blascovich & Mendes, 2000; Blascovich, Mendes, & Seery, 2002; Blascovich & Tomaka, 1996). In validation studies, individuals who evaluated tasks as exceeding their personal coping resources were characterized as threatened, whereas individuals who appraised their resources as exceeding task demands were characterized as challenged (e.g., Tomaka et al., 1993). Later iterations of the theory specify *task demands* to include danger, uncertainty, and required effort, and *resources* as knowledge and abilities, dispositions, and external support (Blascovich & Mendes, 2000). Importantly, these motivational states are associated with different patterns of CV reactivity. Consistent with Dienstbier's (1989) research on psychological "toughness," challenge is associated with sympathetic–adrenal–medullary (SAM) activation, which enhances cardiac performance, particularly left ventricular contractility (VC) and cardiac output (CO); additionally, increases in epinephrine result in vasodilation or decreased systemic vascular resistance (total peripheral resistance; TPR). In contrast, threat is associated not only with activation of the SAM axis, again increasing VC, but also with activation of the pituitary–adrenal–cortical axis, which inhibits vasodilation and often produces vasoconstriction (i.e., increases in TPR; Blascovich & Tomaka, 1996). Challenge reactivity, like the physiologically tough pattern, is characterized by quick CV recovery. Therefore, unless new elements are introduced within a task, participants are expected to habituate quickly during the tasks evaluated as challenging. In contrast, threat reactivity is predicted to recover slower than challenge reactivity (Dienstbier, 1989). Specifically, increases in vascular reactivity recover slower than increases in cardiac reactivity (Kelsey et al., 1999). Because of these differential effects in sustaining and recovering from challenge versus threat reactivity, predictions and main analyses typically focus on the first minute of the task period (see Blascovich, Mendes, Hunter, Lickel, & Kowai-Bell, 2001; Blascovich, Mendes, Hunter, & Salomon, 1999; Mendes, Blascovich, Lickel, & Hunter, 2002; Mendes, Blascovich, Major, & Seery, 2001; Tomaka et al., 1993, 1999).

It is also noteworthy that both challenge and threat produce increases in heart rate (HR), the most common indicator of autonomic activation in past research. Changes in HR indicate that a motivated performance situation exists—that is, an active episode of engagement by the participant in self- or goal-relevant activity requiring instrumental cognitive responses (Obrist, 1981; Wright & Kirby, 2001). Once it has been established that a motivated performance situation exists, the participant's CV responses may be differentiated into the psychologically more meaningful patterns of challenge or threat.

Mounting evidence from researchers explicitly studying challenge and threat states has supported the hypothesis that challenge is a positive energizing state associated with effective coping and the perception of sufficient resources (for a meta-analysis, see Blascovich, Mendes, & Seery, 2002). For example, challenge states have been linked to positive affect, approach orientation, assertiveness, and enhanced performance (Blascovich, Mendes, & Seery, 2002; Mendes et al., 2001; Tomaka et al., 1999; Tomaka & Palacios-Esquivel, 1997), as well as with effective coping during downward social comparisons (Mendes et al., 2001), performance on well-learned tasks in the presence of an audience (Blascovich et al., 1999), social interactions with similar or stereotypical others (Mendes, Blascovich, Hunter, Lickel, & Jost, 2002; Mendes, Blascovich, Lickel, & Hunter, 2002), and athletic success among collegiate baseball and softball players (Blascovich, Seery, Mugridge, Norris, & Weisbuch, 2002). In contrast, threat, a primarily negative state, is associated with negative affect, poorer task performance, behavioral inhibition, and limited focus (Blascovich, Mendes, & Seery, 2002; Hunter, 2001; Mendes, Blascovich, Lickel, & Hunter, 2002; Tomaka, 1994; Tomaka & Palacios-Esquivel, 1997). For example, participants assigned to a threat state recalled more danger-related words than participants assigned to a challenge state (Hunter, Blascovich, & Mendes, 2002).

Other evidence from researchers not explicitly studying challenge and threat has supported the perspective that challenge is a positive, beneficial state and threat is a negative, deleterious state. For example, Gottman and Levenson (1992) found that physiological reactivity during a discussion of marital problems predicted longevity of marriages. Specifically, HR increases coupled with vasoconstriction were associated with marital dissolution and may have served as a marker of hostility toward a spouse. Importantly, this pattern of responses is identical to the threat pattern as defined by challenge and threat theory. Additional evidence from psychoneuroendocrinology has suggested that the appraisal process associated with challenge states (i.e., resources exceeding demands) engenders the release of anabolic hormones, which may provide protection against some bacteria and infections (Epel, McEwen, & Ickovics, 1998). Finally, the experience of *flow* (i.e., the enjoyable sensation of total absorption in an activity) depends on the balance between the challenge of a task and personal skills to meet it (Csikszentmihalyi, 1997). In challenge and threat vernacular, flow would occur when a match between demands and resources was achieved. Challenge and threat theory predicts that CV responses during flow, as that state has been described by Csikszentmihalyi

(e.g., Csikszentmihalyi, 1997), should be characterized by challenge reactivity.

In short, existing empirical research and theory have indicated that challenge is a positive motivational state and threat is a negative motivational state. In the research that follows, we use CV markers of challenge and threat to provide on-line evidence of differential motivational states associated with emotional expression and suppression.

Emotional Expression and Suppression

Emotional Expression

Emotional expression takes many forms, one of which is emotional self-disclosure. Beginning with the pioneering self-disclosure studies of Jourard (1958, 1971) and continuing with the research of Pennebaker and colleagues, cited above, empirical research has supported the contention that emotional expression is beneficial for psychological and physical health (for an overview, see Reis & Patrick, 1996). Most interpretations of this evidence have proposed or assumed that the emotional content of self-disclosure is responsible for this effect. For example, Mendolia and Kleck (1993) found that describing one's feelings about a distressing film, as opposed to factually recounting events in the film or describing a distractor film, was associated with lower autonomic arousal and more positive affect during a second, delayed exposure to the film (see also Strack, Schwarz, & Gschneidinger, 1985). Similarly, Major and Gramzow (1999) reported that among women experiencing relatively more intrusive thoughts following an elective abortion, emotional expression regarding the abortion resulted in less distress.

Nevertheless, the impact of self-disclosure and other forms of emotional self-expression is not always positive. Some theorists have argued that disclosing potentially stigmatizing events may engender negative consequences (Lane & Wegner, 1995; Pennebaker, 1993). For example, in a review of research on self-presentation in psychotherapy, Kelly (2000) concluded that withholding unfavorable information from a therapist is associated with positive outcomes (putatively because it allows the client to maintain a more positive identity in the therapeutic relationship). Costanza, Derlega, and Winstead (1988) found that talking about feelings regarding an anxiety-provoking task increased participants' negative affect compared with talking about coping with the same task, a finding that dovetails with other research showing that emotional expression itself is associated with the experience of negative affect (e.g., Hobfoll & London, 1986). Bonanno et al. (1995) found that among the conjugally bereaved, those who disengaged or avoided emotions regarding their spouses exhibited better adjustment during follow-up visits. In part, these research programs have demonstrated that people tend to express emotions precisely when circumstances tax, and perhaps exceed, their personal coping resources (Stiles, 1987).

Neurobiological research (e.g., Damasio, 1995; LeDoux, 1992) has also been helpful in providing understanding of the downstream effects of emotional expression. To the extent that the context and content of emotional expression are experienced as novel or threatening, it is reasonable to expect that these emotional components are identified by the limbic system, specifically the amygdala (amygdalar activation is typically associated with the presentation of novel or fear-arousing stimuli; LeDoux, 1992). Though the biological concomitants, specifically CV and immunological responses, of amygdalar activation have not been fully explored, the importance of novelty in both CV threat reactivity and amygdalar activation is clear. Thus, when emotional expression is experienced as novel or threatening, co-occurring biological responses would be expected to include amygdalar activation, CV threat reactivity, and the inhibition of certain hormones associated with resistance to disease (e.g., secretory immunoglobin). These biological components are thereby implicated in the emotion expression–health link.

We propose that responses to emotional expression may be mediated by the individual's (conscious or nonconscious) evaluation of that expression. On the basis of the challenge–threat framework described earlier, we suggest that emotional expression will result in a challenge state when the perceived resources associated with expressing outweigh the demands of the task, which may have positive consequences for the individual, whereas emotional expression will result in a threat state when it is perceived as exceeding the resources of the person and may be less beneficial. This reasoning is supported by intervention studies in which participants were asked to provide written narratives describing a personal traumatic experience (Pennebaker & Francis, 1996; Pennebaker, Mayne, & Francis, 1997). Favorable health outcomes were associated with greater use of positive emotion words and insight words but lesser use of negative emotion. These studies did not directly examine participants' evaluations of their emotional experience, however. One goal of the present research, then, was to infer evaluations of an emotional-expression task through direct examination of CV responses that differentiate challenge and threat.

Emotional Suppression

If theorizing about beneficial effects of emotional expression is equivocal, emotional suppression is more uniformly regarded as deleterious. For example, suppressing emotions and other personal thoughts has been hypothesized to impair physical and psychological health and cognitive processing ability (e.g., Gross & Levenson, 1993; Pennebaker, 1993; Richards & Gross, 2000; Wegner, 1989, 1994). Though the nature of the suppressed material differs from one theory to another—some refer specifically to emotion whereas others encompass thoughts in general—common among them is the principle that the mental effort associated with suppression strains psychological resources and may even increase the accessibility of the suppressed material.

It is unclear from existing evidence whether the particular mechanisms associated with emotion suppression differ from those associated more generally with thought suppression and, if they do differ, whether the relevant physiological and psychological concomitants also differ. The failure to differentiate these mechanisms may have obscured the emotion-inhibition–health link, because studies demonstrating harmful pathophysiological responses to emotion suppression have not controlled for the increased cognitive effort that suppressing any self-relevant thoughts entails (regardless of their emotional intensity). Similarly, thought suppression and secrecy studies generally do not control for the emotions that their protocols may induce.

To link emotional suppression unambiguously to pathophysiological mechanisms, it is necessary to explicitly differentiate emotional suppression from nonemotional suppression. That is, if the deleterious effects of emotional suppression depend on the emotional nature of the inhibited material rather than processes involved in suppressing any self-relevant thoughts (such as increased cognitive load), it ought to be possible to identify negative effects unique to (or at least more pronounced in) emotional suppression. A cognitive-load/thought-suppression explanation, on the other hand, would not differentiate emotional from nonemotional content.

We approached this issue by examining challenge–threat responses to the task of suppressing self-relevant emotional and nonemotional material. On the basis of consensus theories of emotion (e.g., Frijda, 1986; Zajonc, 1998), we hypothesized that emotional suppression would be more likely to engender threat responses than nonemotional suppression (or emotional expression) would, because emotional content by definition taps self-relevant thoughts and feelings concerning the implications of environmental circumstances for personal well-being. Emotional suppression should therefore be experienced as a relatively threatening (i.e., taxing of coping resources) state because of the increased demands associated with inhibiting greater self-relevant and potentially more complex thoughts and feelings.

Gender and Emotional Expression

A final factor in this research concerns the influence of the gender context on evaluations of emotional expression. Although dyadic sex pairing is usually controlled in experimental studies of emotional expression, only rarely is it examined explicitly as a variable of theoretical interest. Extensive evidence demonstrates that North American women tend to be more emotionally self-disclosing than men, and that this sex difference tends to be stronger in same-sex rather than in opposite-sex interaction (for reviews, see Dindia & Allen, 1992; Reis, 1998; Reis discussed the issue of cultural context). Although these sex differences seem clear, the question of whether men and women reap the same benefit from emotional expression and whether that benefit depends on gender pairing is less clear. Throughout the life span, but especially in adolescence and early adulthood, social interactions are differentiated in a fundamental way by whether one's partner is same sex or opposite sex (and therefore a potential romantic partner, at least for heterosexual individuals; Laursen & Bukowski, 1997). This pervasive distinction is evident across many important behaviors, such as activity preferences, interpersonal styles, nonverbal behaviors, and romantic–mating concerns.

At least three arguments lead us to predict that emotional expression to a same-sex stranger should be experienced as more challenging (i.e., positive) than emotional expression to an opposite-sex stranger (at least in the Western cultural context in which this research was conducted). First, individuals are likely to be more familiar with same-sex partners, specifically during a peer interaction, than with opposite-sex partners, and people are generally more comfortable sharing private emotions with more familiar than less familiar others (Rimé et al., 1991). Second, actual or perceived similarity with another person facilitates emotional expression and anticipated acceptance by the other, both of which would be expected to be greater for a same-sex stranger than an opposite-sex stranger. Third, concern about potential vulnerability, which may inhibit emotional expression (e.g., Hatfield, 1995), is likely to be greater with partners whose sex at least implies the possibility of a romantic association than with partners who offer no such potential. It follows, then, that evaluations of an emotional-expression task (and possibly also the content of those discussions) may vary fundamentally depending on the sex of the person with whom they share emotional experiences. Although this prediction differs from the aforementioned findings that men tend to be less disclosing in same-sex than in opposite-sex interactions, it is important to note that our research does not so much concern the level or extent of spontaneous emotional disclosure; rather, our research more directly concerns the individual's psychological experience when encouraged emotional expression occurs. Consistent with our prediction, Reis, Senchak, and Solomon (1985) demonstrated that when emotional self-disclosure is explicitly sanctioned and made socially desirable, differences between men and women during same-sex, emotional self-disclosure are largely dissipated.

The Present Research

The three experiments reported here examined the impact of emotional expression and suppression and the gender context in which they take place on challenge–threat states as indexed by patterns of CV reactivity. CV indexes of challenge and threat offer several advantages over other methods (Blascovich, 2000). First, they are not confounded by self-report motives and biases. That is, less consciously controlled measures, such as physiological responses, can provide less contaminated assessments of individuals' psychological and motivational states because the responses cannot be easily and deliberately distorted. Second, they clearly distinguish two different motivational states, challenge and threat, in a way that may not be evident with other methods. Third, because CV reactivity differences presumably have substantially different implications for health and well-being, any observed differences may help clarify mechanisms underlying the link between emotional expression and health.

Hypotheses

On the basis of the literature and propositions discussed above, we formulated three main hypotheses regarding the effects of emotional expression and suppression in Western-culture dyads. First, we predicted that in same-sex dyads, CV responses during emotional expression would be consistent with challenge responses. Second, we predicted that suppressing or inhibiting emotional expression would generate physiological responses consistent with threat. Finally, we predicted that the gender context of the emotional-expression task would influence CV reactivity such that emotional expression to opposite-sex strangers would be consistent with threat responses. Because the challenge and threat model adopts a coping and stress perspective to motivational states, we believe that the identification of these distinct states, vis-à-vis co-occurring CV responses, during emotional expression and suppression can assist in the understanding of psychological and physiological consequences of the experience of emotion and in deconstructing the mechanisms through which positive and negative psychological and health outcomes occur.

Study 1

Study 1 was designed to examine the first hypothesis. This experiment also enabled us to determine whether men and women differ in CV responses during emotional expression.

Method

Overview and Participants

Participants each began the study by meeting a laboratory assistant and experimenter. They were told that they would be talking to the assistant later in the study. After physiological sensors were applied and the participants sat for a baseline period, they heard audiotaped instructions informing them that they would be discussing an emotional topic with the assistant they had met earlier. After a preparation period to allow the participant to gather his or her thoughts related to the emotional topic, the assistant entered the room and the participant began the emotional-expression task. CV responses were recorded throughout the experiment.

Fifteen men and 15 women were recruited from an introductory psychology class or from flyers advertising paid psychology experiments at the University of California, Santa Barbara.[1] Participants received either course credit or $10 for participation.

Measures

CV responses. Cardiac and hemodynamic measures were recorded noninvasively using equipment meeting commercial and hospital standards and following guidelines established by the Society for Psychophysiological Research (Sherwood et al., 1990). A Minnesota impedance cardiograph (ZKG; Minnesota Model 304B, Greenwich, CT), a continuously inflated blood pressure monitor (Cortronics Model 7000), and an electrocardiograhic (ECG) amplifier–coupler (Coulbourn Model S75-11, Allentown, PA) provided physiological signals. Impedance signals were conditioned using amplifiers (Coulbourn Model S79-02, Allentown, PA).

ZKG and ECG recordings provided continuous measures of cardiac performance. Impedance cardiography uses a tetrapolar aluminum–mylar tape electrode system to provide basal transthoracic impedance (Z_0; i.e., the amount of blood circulating in the thoracic cavity) and the first derivative of basal impedance, the change in impedance over time (dZ/dt). Four strips of ZKG tape encircled the participant, one pair around the neck and a second pair around the torso. "Inner" electrodes were placed at the base of the neck and at the thoracic xiphisternal junction; "outer" electrodes were placed on the neck and abdomen, separated from the respective inner electrodes by at least 3 cm. A 4mA AC 100 kHz current was sent through the two outer electrodes and measures of Z_0 were obtained via the two inner electrodes.

ECG recordings were obtained using either an external ECG Standard Lead II configuration (right arm, left leg, and right leg ground) or internally via the impedance cardiograph. The blood pressure monitor provided continuous noninvasive recordings of blood pressure from the brachial artery of the nonpreferred arm. An interactive software program developed by Kelsey and Guethlein (1990) was used to record and score (*ensemble*) cardiac and hemodynamic data.

We used three CV responses to differentiate challenge and threat. First, we examined changes in left VC, which is indexed by a decrease in preejection period—the time from the initiation of left ventricular contraction until the aortic valve opens (reactivity values are multiplied by –1 to indicate increased VC). VC is derived from the combination of the ZKG and ECG waveforms. Specifically, preejection period is identified from the Q point on the ECG wave (the left ventricle contracting) to the B inflection on the ZKG wave (the opening of the aortic valve). Second, we calculated changes in CO, which is the amount of blood being pumped by the heart expressed in liters per minute. CO is derived from impedance cardiograph recordings, and is calculated by multiplying stroke volume and HR. Stroke volume is determined by the height of the ZKG waveform in combination with the opening of the aortic valve (B inflection) and the closing of the aortic valve (X inflection). Third, we examined changes in TPR, which is the amount of overall vasoconstriction or vasodilation occurring in the periphery. TPR is derived from blood pressure and impedance cardiographic recordings using the formula (mean arterial pressure/CO) $\times$ 80. Following Obrist (1981), we confirmed goal relevance (or task engagement) by significant increases in HR reactivity during the task period.

In summary, both challenge and threat are characterized by significant increases in HR from baseline levels. In addition, the challenge pattern is characterized by significant increases from baseline in VC and CO and decreases in TPR (vasodilation). The threat pattern is characterized by significant increases in VC, no changes or decreases in CO, and no changes or increases in TPR (vasoconstriction).

Discussion topics. Participants completed a Topic Ranking Form indicating the extent to which they would feel comfortable discussing three sensitive topics with a stranger: (a) "problems with a past or current relationship," (b) "aspects of yourself that make you feel uncomfortable or embarrassed," and (c) "an event that damaged your sense of self-worth." Participants rank ordered the topics from 1 (*most comfortable*) to 3 (*least comfortable*).

Procedure

Initial meeting and baseline. Four experimenters (two men, two women) and six assistants (three men, three women) were trained and supervised by two female graduate students, who also served as experimenters. Each experimental session began with an experimenter and assistant greeting the participant in the hallway in front of the laboratory. The experimenter and assistant were always the same sex as the participant. In addition, the assistants were White, between the ages of 20 and 23 years, and were chosen for uniformity in attractiveness (slightly above local averages in attractiveness). Furthermore, the assistants were required to dress in stereotypically feminine or masculine attire (i.e., women wore floral dresses, and men wore button-down long-sleeved shirts with khakis or slacks).[2] After introductions, the experimenter told participants that they would be talking to the assistant later on. The assistant then returned to the control room while the experimenter escorted participants to the preparation room. On completion of a consent form and the Topic Ranking Form, the assistant returned to the room with a "Confidentiality Form." This form, the experimenter explained, assured participants that anything they discussed with the assistant was for research purposes only and would not be linked to their identity. Both the participant and assistant signed the form, indicating that they understood the confidentiality requirements. This procedure was implemented to maximize the participant's comfort in discussing potentially embarrassing or emotional events.

The assistant then left the room and the experimenter attached the necessary sensors and transducers. The participant was then seated upright in a comfortable upholstered chair and the experimenter left, leaving the participant alone in the room until the assistant later returned. The participant then heard audiotaped instructions of a same-sex experimenter asking him or her to relax for the next several minutes. A 5-min period then commenced during which baseline levels of CV responses were recorded. Physiological recording continued for the duration of the experiment.

Emotional-expression task. After the baseline period, the participant heard audiotaped instructions explaining that he or she would be discussing one topic from the previous list with the assistant who would be entering

[1] Participants were screened for heart murmur, pregnancy, and cardiac medication.

[2] We also examined participants' responses as a function of being paired with any one individual assistant. In all studies reported here, there were no significant effects of any one assistant compared with other assistants of the same sex.

the room shortly. We always chose the topic that the participant had ranked second. Instructions were adapted from Pennebaker (1989; Pennebaker & Francis, 1996) and were read in a soothing, relaxed voice. An example of these instructions, which necessarily differed as a function of the participants' second chosen topic, follows:

> For this part of the experiment your task is to talk about your very deepest thoughts and feelings about [aspects of yourself that make you feel uncomfortable or embarrassed]. The assistant will be entering the room in a few moments to listen to you discuss your emotions about [these aspects of yourself]. Try to let yourself go and talk continuously about your emotions and thoughts related [to these aspects]. For example, [you can talk about the particular traits that make you uncomfortable, or an event that demonstrates why you are uncomfortable with these aspects]. The primary task is for you to reflect on your most basic thoughts and emotions about [these aspects of yourself that make you feel uncomfortable or embarrassed]. Please take a few moments to gather your thoughts related to this topic before the assistant enters the room.

We gave participants 3 min to prepare, after which the assistant entered the room. The assistant was seated facing the participant with their chairs approximately 1 m apart with the assistant slightly (10°) to the right of the participant. The experimenter then provided final instructions via an intercom. These instructions reminded participants of the topic and again encouraged them to discuss their deepest thoughts and feelings about the topic and reassured them that the audiovisual equipment would be disconnected during the discussion. The intercom and surveillance camera were then disconnected; however, the discussion was recorded surreptitiously via a different and hidden camera located directly in front of participants.

The role of the assistants was most similar to a peer counselor relationship in that the discussion was one sided, and the assistants presented themselves with confidence and assumed authority. Accordingly, assistants were trained to be empathic, to engage listeners, and to keep participants talking continuously and focused on the emotional aspects of the topic. During the emotional discussion task, assistants maintained eye contact, nodded encouragingly, and asked questions to facilitate deeper elaboration. If needed, assistants asked questions such as, "How did that make you feel?" "Do you remember what other emotions you felt?" and "What lasting effects has [this event] had on you?" After 3 min of the task, the experimenter came back on the intercom and told participants they were done with this part of the experiment and that the assistant could leave. (We did not provide forewarning about the length of the discussion and most participants assumed the discussion would be longer.) The assistants thanked the participants for sharing their experiences and left the room. Participants sat alone for several minutes before the experimenter came in to unhook and debrief them.

Debriefing. Once the experimenter had removed the physiological sensors, he or she explained the purpose of the study. Participants were fully debriefed with particular attention to the fact that the recording devices had been on throughout the experiment. Participants were offered the opportunity to erase the videotape if they wished; none did. Finally, participants signed an additional consent form allowing us to use their videotaped disclosure for research purposes and, if appropriate, the experimenter provided telephone numbers of university-sponsored counseling centers. The experimenters used their discretion to determine whether or not they pointed out these university-sponsored services.

Results

The analytic strategy for the CV data had four steps. First, differences between men and women were compared to confirm that CV responses did not significantly differ at baseline. Second, HR reactivity (i.e., differences from baseline) during the emotional-expression task was examined to confirm that the task had been engaging, a necessary precondition to examine challenge and threat differences. Third, a multivariate analysis of variance (MANOVA) examined relative differences between men's and women's CV responses during the expression task, followed by univariate tests of the predicted differences in VC, CO, and TPR. Finally, examination of absolute reactivity at both the group and the individual levels by participant's sex were conducted to confirm challenge and threat reactivity.

We used change scores in our primary analyses because we wanted an index of the absolute amount of change in physiological function, expressed in natural units, that each individual showed. However, it is well known that change scores can, under certain circumstances, produce artifactual results because the absolute amount of change is usually correlated with baseline levels (Cohen & Cohen, 1983). To control this possibility, we repeated all major analyses using regressed change (which eliminates this confound): Baseline responses were entered at the first step of the analysis predicting the task responses, followed by the set of independent variables. Results were nearly identical for all effects. This similarity is not surprising in that absolute and regressed changes are mathematically identical when the correlation between baseline and task scores is 1.00. Reflecting the "law of initial values" (Wilder, 1967), the correlations between baseline and task responses were very high: in this study, .69 for VC, .90 for CO, and .89 for TPR.

Baseline Differences

A multivariate test of baseline CV responses (VC, CO, and TPR) revealed no significant sex differences, $F(3, 24) = 0.55$, *ns*.[3] As is typical when baseline responses do not differ by between-subjects factors, reactivity scores (differences from baseline) were used as the primary dependent variables in subsequent analyses (Kamarck et al., 1992). Reactivity scores were calculated for each CV measure by subtracting the last minute of the rest period from the first minute of the task period.

As is our typical strategy, before we conducted any analyses we examined the distribution of the CV data for outliers. We determine univariate outliers with the Shapiro–Wilks test, which examines the distribution of reactivity scores. If any significant skewing is observed, we then examine the raw data for outliers that are greater than 2 standard deviations from the overall mean, in which case we assign that value a new value equivalent to one unit larger than the next highest value. Traditionally, we identify any analyses in which we have to transform deviant values.[4]

Task Engagement

Univariate tests confirmed that men's and women's HR reactivity during the emotional-expression task was significantly greater than zero; for men ($M = 15.4$), $t(15) = 3.97$, $p < .002$; for women ($M = 17.1$), $t(13) = 7.11$, $p < .0001$. These analyses confirmed that the task was significantly engaging.

[3] Data from 2 female participants were not included because of loss of ECG signal.

[4] Throughout this article, we did not have to transform any deviant values.

Preparation for the Emotional-Expression Task

Prior to the emotional-expression task, participants were provided time to prepare for their discussion. An analysis of CV reactivity during the preparation period yielded a nonsignificant multivariate effect for sex of the participant, $F(3, 24) = 0.84$, *ns*. An examination of the data suggested that for both male and female participants, the preparation period resulted in challenge reactivity—significant cardiac increases and decreases in TPR.

Emotional Expression

The main analysis included examination of CV reactivity data (VC, CO, and TPR) from the task period by sex of the participant. The multivariate effect for sex of participants was not significant, $F(3, 24) = 0.30$, *ns*, $\eta^2 = .04$. Therefore, men and women did not differ significantly in their CV responses during emotional expression (Men: VC: $M = 14.9$, $SE = 4.2$; CO: $M = 0.7$, $SE = 0.3$; TPR: $M = -85$, $SE = 37$; Women: VC: $M = 12.8$, $SE = 2.9$; CO: $M = 0.9$, $SE = 0.2$; TPR: $M = -83$, $SE = 17$). We then examined CV responses to determine if the pattern of reactivity was consistent with challenge, threat, or inconclusive reactivity. Univariate analyses of each CV reactivity measure indicated a constellation of CV responses consistent with the challenge pattern. That is, during the disclosure period, participants exhibited significant increases in VC ($M = 13.9$), $t(28) = 5.37$, $p < .0001$, significant increases in CO ($M = 0.78$), $t(28) = 4.09$, $p < .0004$, and significant decreases in TPR or vasodilation ($M = -84.1$), $t(28) = -3.99$, $p < .0005$.

CV data from the second and third minutes of the disclosure period were also examined. Analyses of these subsequent minutes also revealed no sex differences; Minute 2: $F(3, 24) = 0.51$, *ns*, $\eta^2 = .04$; Minute 3: $F(3, 24) = 0.07$, *ns*, $\eta^2 = .01$. As described earlier, the physiological challenge pattern of reactivity is characterized by quick CV recovery relative to threat reactivity, particularly when additional task demands are not encountered. To test the effects of CV reactivity across the task, three repeated-measures analyses of variance (ANOVAs) were conducted. For all three CV variables, the time effect was significant; VC: $F(2, 52) = 14.36$, $p < .0001$; CO: $F(2, 52) = 14.64$, $p < .0001$; TPR: $F(2, 52) = 15.01$, $p < .0001$. Consistent with challenge and threat theory and Dienstbier's (1989) physiological "toughness" pattern, participants' CV reactivity across the 3 min of emotional expression demonstrated significant recovery (return to baseline). It is important to note that the time effect did not interact with sex of participant (all Fs < 1).

Supplemental Analyses

Individual-level analyses were also conducted to determine whether the pattern of individual reactivity was consistent with the observed mean levels of change.[5] Specifically, we categorized participants into one of three categories: challenge, threat, or indeterminate. Individuals with VC and CO reactivity greater than zero and TPR reactivity less than zero were categorized as *challenged*; those with VC greater than zero, CO below zero, and TPR reactivity greater than zero were categorized as *threatened*. Participants whose data did not fall into either threat or challenge (e.g., positive CO and positive TPR) were categorized as *indeterminate*. We then used these category distinctions to examine the probability of exhibiting one of three possible responses. This analysis yielded 7 participants with indeterminate reactivity (25%), 1 participant in the threat category (4%), and the majority of the participants (71%) in the challenge category.

Following this analysis, a more conservative test was conducted in which the threshold for challenge reactivity was set at 0.20 standard deviations of change above zero for VC and CO and 0.20 standard deviations below zero for TPR to indicate challenge responses; threat responses were categorized using the same formula, except that increases in VC and TPR and decreases in CO were expected. We chose 0.20 as the threshold because Cohen defined this value as a small effect size (Cohen, 1988). Of the 28 participants, the majority were in the challenge category ($n = 20$; 71%) and the remaining 8 (28%) in the indeterminate category. Therefore, no participants using this threshold exhibited CV reactivity that was consistent with the threat pattern during the emotion expression task. An even stricter threshold (medium effect: 0 ± 0.50 standard deviations) yielded the same results. Coupled with the group-level analyses, these results demonstrate that at both group and individual levels, participants exhibited challenge reactivity when disclosing to same-sex assistants.

Discussion of Study 1

Study 1 provided initial evidence that CV reactivity during emotional disclosure was consistent with the positive motivational pattern experienced as challenging. Mean CV responses indicated that during the emotional-expression task, participants exhibited significant increases in cardiac activity (VC and CO) as well as significant decreases in vascular reactivity (TPR). Furthermore, men and women did not differ significantly in the exhibited CV responses during emotional expression.

Study 2

Having established the physiological concomitants of emotional expression (Hypothesis 1), we next sought to explore the potential moderators described above. Specifically, we tested two additional hypotheses: Hypothesis 2 was that emotional suppression, compared with mere thought suppression, would engender CV threat responses; Hypothesis 3 was that gender context would moderate the effects of emotional expression such that expression to opposite-sex partners would result in threat reactivity. To accomplish this, Study 2 had four conditions. The first was an emotional-expression condition that replicated the condition used in Study 1. The second condition required participants to discuss nonemotional topics, thereby controlling for the effect of the interpersonal context (i.e., physical proximity to a stranger during a one-sided verbal discussion) and allowing us to determine more exactly if the

[5] Caution should be observed when comparing these results with other CV results from different laboratories. Differences in instrumentation could yield very different absolute results than those reported here. For example, blood pressure data obtained from continuous blood pressure monitors may on average be lower than blood pressure obtained from noncontinuous monitors that require repeated samplings of occlusive cuffs, which may artificially elevate blood pressure. Therefore, we maintain that the relative differences rather than absolute difference in CV responses is the critical standard for differentiating challenge and threat responses.

results observed in Study 1 were due to the emotional nature of the expression task. The third condition was an emotional-suppression condition, which required participants to prepare to discuss an emotional topic, which we then thwarted via a delay technique. The final condition was a nonemotional-suppression condition similar in all respects to the emotional-suppression condition except that participants prepared to discuss a nonemotional topic, which was again thwarted by the same delay technique. In addition, Study 1 did not permit us to identify the effect of assistant sex (and participant–assistant pairing) on CV reactivity. Therefore, in Study 2 we manipulated the sex of the assistant to permit comparison of same-sex and opposite-sex pairings. Finally, to examine explicitly how content of emotional expression is related to CV reactivity, we used judges to evaluate the content of the discussions from synopses of the emotional-expression condition and rate the extent to which participants disclosed intense and intimate information.

Method

Overview and Participants

Study 2 followed the same general procedures as Study 1. The additional conditions resulted in a 4 (discussion condition: emotional, nonemotional, emotional suppression, and nonemotional suppression) × 2 (participant's sex) × 2 (assistant's sex) between-subjects design. We also assessed participants' and assistants' subjective reactions to the discussion task via self-report.

Participants ($N = 174$; 85 men, 89 women) were recruited from introductory psychology classes or from advertisements for paid participants and either received course credit or were paid $10. Two participants were excluded because of failure to comply with the experimental protocol.

Measures: Postdiscussion Questionnaires

Following the discussion task, participants completed a questionnaire. Four questions with scale anchors of −4 to +4 assessed the extent to which participants thought the discussion was intense, how much they had held back, how uncomfortable they had felt, and how difficult it had been to discuss those issues with a stranger. Laboratory assistants completed a similar questionnaire describing their perceptions of the extent to which the discussion had been intense, how much the participant had been holding back, how comfortable the participant had appeared, and how difficult it had been to get the participant to talk. Assistants also indicated how often they had had to prompt participants to keep them talking.

Procedure

Study 2 began in the same way as Study 1, except that an opposite-sex experimenter and assistant greeted participants assigned to the opposite-sex condition. In the opposite-sex conditions, participants heard audiotaped instructions with the voice of an opposite-sex experimenter. The audiotaped instructions varied as a function of discussion condition.

Some assistants from Study 1 also participated in Study 2. In addition, 1 new male graduate student joined the research team, as did 9 new research assistants (resulting in a total of 12 assistants: 5 men, 7 women).

Emotional-expression condition. This condition was identical to Study 1; participants were encouraged to let themselves go and to talk continuously about the emotional topic they had ranked second.

Nonemotional-expression condition. This control condition was designed to require participants to talk continuously with the assistant about a nonemotional topic. Participants completed a nonemotional Topic Ranking Form that included (a) "duties or responsibilities of a past or current job," (b) "aspects or characteristics that your friends have in common," and (c) "an historical event that you remember well." Participants assigned a 1 to the topic they felt most comfortable discussing and a 3 to the topic in which they felt least comfortable. We always chose the topic "duties and responsibilities from a past or current job" because pretesting revealed it to be the least emotionally intense. To further insure nonemotional discussion, the audiotaped instructions underscored the need to "factually and objectively report" their job responsibilities and to "convey the particulars of the job and your specific responsibilities." As in the other conditions, assistants were trained to be active and interested listeners. If participants needed encouragement to continue talking, the assistants used prompts asking for clarification of their job requirements.

Emotional-suppression condition. The suppression condition was identical to the expression condition until the final instructions to begin. That is, participants ranked the emotional topics and heard instructions asking them to prepare to discuss the second-ranked emotional topic. After the preparation period, the assistant entered the room, sat in front of the participant, and then final audiotaped instructions were played. Whereas in the emotional-expression condition these instructions simply reminded the participant of the topic and further encouraged them to "let yourself go and talk continuously about your deepest thoughts and feelings," in the emotional-suppression condition these instructions asked participants to delay talking about the emotional event they had prepared to discuss. The instructions stated that before talking about the emotional topic, they would "break the ice by discussing duties and responsibilities from a past or current job . . . [and] we will tell you when to move on to [the emotional topic]." Thus, participants were led to believe they would be discussing one of the emotional topics, prepared to discuss it, but at the last moment were instructed to switch to a nonemotional topic. The instructions explicitly stated that sometime later the assistant would instruct them to move on to the prepared emotional topic, though the participant was never instructed to do so.

Nonemotional-suppression condition. We devised a nonemotional-suppression control condition that required participants to prepare to discuss a nonemotional topic, but then just prior to beginning that discussion, we switched to a different but still nonemotional topic. In this condition, participants completed the nonemotional Topic Ranking Form, and after the baseline period, heard instructions asking them to prepare to discuss "an historical event that they remembered well."[6] After the preparation period, the assistant entered the room and sat in front of the participant while the final instructions advised them to "break the ice by discussing the duties and responsibilities from a past or current job . . . [and] we'll let you know when to move on to the other topic."

In summary, in three of the four conditions participants discussed the same topic, "duties from a job"; however, the instructions differed depending on the condition. Only in the emotional-expression condition did participants actually discuss emotionally oriented, self-disclosing topics.

Results

Baseline Differences

A multivariate test for differences in baseline CV responses (VC, CO, and TPR) by disclosure condition revealed no significant

[6] The majority of participants (53%) in this condition completed the experiment prior to September 11, 2001 and thus had prepared to discuss relatively mundane topics as intended. Following the events of September 11th, we changed the topic from "historical events" to a different nonemotional topic, "qualities that your friends have in common." We compared participants who completed the study pre- and post-September 11th and found no significant differences in CV responses during either the baseline period or the discussion period (all Fs < 1).

differences, $F(9, 363) = 0.94$, *ns*.[7] Assistant's sex did not significantly interact with discussion condition, $F(9, 363) = 0.67$, *ns*, nor did participant's sex interact with discussion condition, $F(9, 363) = 0.83$, *ns*.[8] Therefore, reactivity scores were calculated for each CV measure as in Study 1.[9]

Task Engagement

Dependent *t* tests confirmed that all discussion conditions engendered significant increases in HR: emotional ($M = 14.7$), $t(41) = 11.04$, $p < .0001$; nonemotional ($M = 11.5$), $t(40) = 9.91$, $p < .0001$; emotional suppression ($M = 11.2$), $t(46) = 10.5$, $p < .0001$; and nonemotional suppression ($M = 10.7$), $t(36) = 9.08$, $p < .0001$. Thus, all conditions evoked task engagement.

Cardiovascular Responses During Disclosure

Initial analyses consisted of a 4 (disclosure condition) × 2 (participant sex) × 2 (experimenter sex) MANOVA with three CV dependent variables. This analysis revealed the expected significant three-way interaction, $F(9, 355) = 3.52$, $p < .0003$. For clarity, we report simple effects from same-sex dyads and opposite-sex dyads separately.

Same-sex dyads: Emotional versus nonemotional. In same-sex dyads, the main effect for type of discussion was significant, $F(9, 197) = 6.19$, $p < .0001$, partial $\eta^2 = .22$. The main effect for participant sex and the interaction between sex and discussion condition were not significant. To test our specific hypotheses, we conducted simple effects tests comparing the emotional expression with its control condition, followed by the comparison of the suppression condition with its control group.

The emotional-expression versus nonemotional-expression comparison yielded a significant multivariate effect, $F(3, 39) = 9.76$, $p < .0001$, $\eta^2 = .43$. Follow-up univariate analyses revealed that all three CV variables contributed to the multivariate effect for discussion type: VC: $F(1, 44) = 15.67$, $p < .0002$; CO: $F(1, 44) = 16.89$, $p < .0002$; TPR: $F(1, 44) = 23.34$, $p < .0001$. As depicted in Figure 1, the emotional-expression condition resulted in significantly greater challenge reactivity—larger increases in VC, increases in CO, and decreases in TPR—than the nonemotional-discussion condition. Neither the main effect for sex of participant nor the interaction between sex of participant and discussion type was significant, $F(3, 39) = 0.39$, *ns* and $F(3, 39) = 0.64$, *ns*.

Tests for absolute reactivity confirmed, consistent with Study 1, that discussing emotional information with a same-sex assistant engendered CV reactivity consistent with challenge—that is, significant increases from baseline in VC and CO coupled with significant decreases in TPR (see Table 1). As expected, responses in the nonemotional-discussion condition did not qualify either as challenge or threat reactivity. Even though we observed significant increases in heart rate in the nonemotional condition, this was most likely due to the recruitment of metabolic demands associated with speaking. Importantly, participants in the nonemotional-discussion condition did not exhibit significant increases in VC, a necessary condition for both challenge and threat states (see Blascovich et al., 2001; Mendes et al, 2001; Mendes, Blascovich, Lickel, & Hunter, 2002). Hence, the nonemotional condition was neither challenging nor threatening, but instead engendered benign re-

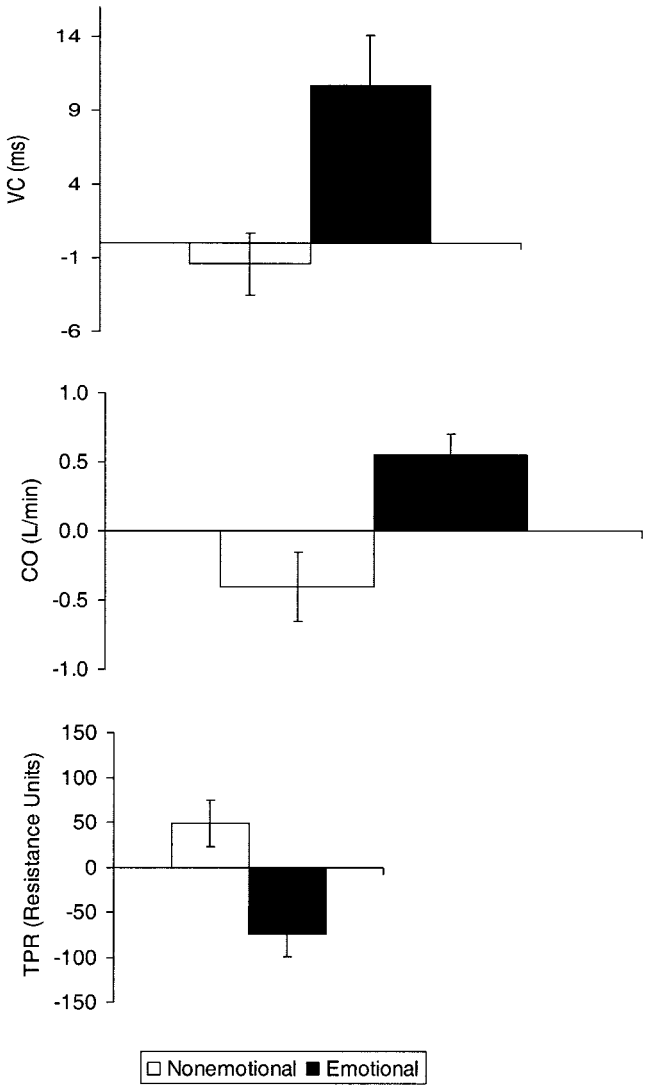

Figure 1. Study 2: Mean cardiovascular reactivity and standard errors from same-sex dyads comparing the emotional expression condition to the nonemotional expression condition. All variables are expressed as change scores from resting levels of response. VC = ventricular contractility; CO = cardiac output; TPR = total peripheral resistance.

[7] CV data from 7 participants were excluded because of inability to ensemble and score their data. Inability to ensemble is typically due to loss of ECG signal, though in some cases inability to accurately identify the B inflection (opening of the aortic valve) on the *dZ/dt* wave is also a reason for exclusion.

[8] The interaction between sex of participant and sex of assistant was significant for baseline CV responses, $F(3, 149) = 2.76$, $p < .05$, primarily because of elevated baseline responses (especially CO) in opposite-sex pairings. Because subsequent analyses examined same-sex and opposite-sex dyads separately, the observed interaction is relatively inconsequential.

[9] For the reasons discussed in the analytic strategy for Study 1, we repeated all major analyses using regressed change to control for the possibility of artifactual results. Results were essentially the same for all effects, again reflecting the high correlation between baseline and task scores. In Study 2, the correlations between baseline and task were .76 for VC, .85 for CO, and .90 for TPR.

Table 1
Study 2: Mean Cardiovascular (CV) Reactivity and Univariate Tests From the Disclosure Task

CV reactivity	Emotional	Nonemotional	Emotional suppression	Nonemotional suppression
		Same-sex dyads		
VC	10.6^{***}_{a}	-1.4_{b}	5.0^{**}_{ab}	3.8^{*}_{ab}
CO	0.5^{***}_{a}	-0.4_{b}	-0.5^{***}_{b}	-0.1_{b}
TPR	-74.3^{***}_{c}	48.9^{*}_{ab}	74.2^{***}_{a}	-1.5_{b}
		Opposite-sex dyads		
VC	6.4^{*}_{a}	$4.8^{\dagger}_{a}$	6.3^{*}_{a}	3.5_{a}
CO	-0.6^{*}_{b}	0.2_{a}	0.0_{a}	0.1_{a}
TPR	108.9^{*}_{a}	-32.2_{b}	11.8_{b}	27.3_{ab}

Note. All condition means were tested against zero to determine significant increases or decreases from baseline. Different subscript letters indicate significant post hoc differences (Tukey's honestly significant difference) across conditions. VC = ventricular contractivity; CO = cardiac output; TPR = total peripheral resistance.
† $p < .10$. * $p < .05$. ** $p < .01$. *** $p < .001$.

sponses that would be expected in mundane or habituated tasks (for similar results, see Blascovich et al., 1993, 1999).

Individual-level analyses following the same criteria as in Study 1 revealed the same pattern of findings as the group-level analyses. Participants ($n = 45$) engaged in either emotional expression or the control condition with same-sex assistants were categorized in one of three categories on the basis of their CV reactivity during the discussion task: challenged: VC > 0, CO > 0, TPR < 0; threatened: VC > 0, CO < 0, TPR > 0; indeterminate: those not falling into either challenge or threat categories. A significant relationship between discussion condition and CV category placement was observed, $\chi^2(2, N = 45) = 13.95$, $p < .001$. An examination of cell probabilities reveals that the majority of those engaged in the emotional-expression task ($n = 25$), 76% ($n = 19$) were categorized in the challenge category, whereas only 2 participants (8%) were categorized in the threat category, and the remaining 4 participants were categorized in the indeterminate category. A very different pattern was observed when examining the CV category distinction of those in the control condition ($n = 20$). The majority of participants ($n = 11$; 55%) in the control condition were categorized in the indeterminate category; of the remaining 9 participants, 4 were categorized as challenged and 5 were categorized as threatened.

Increasing the criterion for challenge and threat responses (setting the threshold for challenged groups at 0.20 standard deviations below zero for TPR and 0.20 standard deviations above zero for CO and VC, and for threatened groups at 0.20 standard deviations above zero for VC and TPR and 0.20 standard deviations below zero for CO) revealed the same pattern of results. Again, category-based CV responses and discussion condition yielded a significant relationship, $\chi^2(2, N = 45) = 7.40$, $p < .025$. The majority of participants engaged in emotional expression were categorized in the challenge group ($n = 15$; 60%) and of the remaining 10 participants, 9 (36%) were categorized as indeterminate, and only 1 participant was categorized as threatened. Among participants in the control condition, the majority ($n = 15$; 75%) were categorized as indeterminate (this was largely due to the lack of VC increases in this condition). Of the remaining 5 participants, only 1 was in the threat category. Increasing the threshold to 0.50 above and below zero resulted in similar findings, $\chi^2(2, N = 45) = 5.08$, $p < .08$.

The second and third minute of the disclosure task also yielded significant type of disclosure condition effects—Minute 2: $F(3, 39) = 3.64$, $p < .02$, $\eta^2 = .22$; Minute 3: $F(3, 39) = 4.07$, $p < .01$, $\eta^2 = .24$—but nonsignificant sex of participant effects and interactions. Even though condition effects remained throughout the entire disclosure period, similar to Study 1, a repeated-measures test revealed time effects for VC, $F(2, 82) = 7.71$, $p < 003$; CO, $F(2, 82) = 12.37$, $p < 0001$; and TPR, $F(2, 82) = 12.19$, $p < 0001$, such that significant decreases in all CV responses were observed. Importantly, the Discussion Type × Time interaction was significant for the cardiac variables, VC: $F(2, 82) = 3.51$, $p < .05$; CO: $F(2, 82) = 4.24$, $p < .02$, and yielded a marginal interaction with the vascular variable, TPR: $F(2, 82) = 2.89$, $p < .06$. The nature of the interaction was such that decreases in CV reactivity were more pronounced in the emotional condition than in the nonemotional condition, most likely because of floor effects associated with the nonemotional condition that were not applicable to the emotional-expression condition.

Same-sex dyads: Emotional suppression versus nonemotional suppression. CV reactivity in the emotional-suppression condition differed significantly from the nonemotional-suppression condition, $F(3, 40) = 4.59$, $p < .01$, $\eta^2 = .25$. Follow-up univariate tests, depicted in Figure 2, indicated that CO and TPR contributed to the multivariate main effect, whereas VC was not significant; VC: $F(1, 45) = 0.18$, *ns*; CO: $F(1, 45) = 8.60$, $p < .005$; TPR: $F(1, 45) = 11.09$, $p < .002$. These results indicate that emotional suppression created significantly greater threat reactivity than the nonemotional suppression condition. A marginal multivariate main effect for sex participant was observed, $F(3, 40) = 2.15$, $p < .11$, $\eta^2 = .14$, but only VC contributed to the multivariate effect, VC: $F(1, 45) = 4.78$, $p < .05$; CO: $F(1, 45) = 0.89$; TPR: $F(1, 45) = 0.13$, *ns*. In general, men exhibited stronger VC reactivity than women. The multivariate interaction between discussion task and sex was not significant, $F(3, 40) = 1.23$, *ns*.

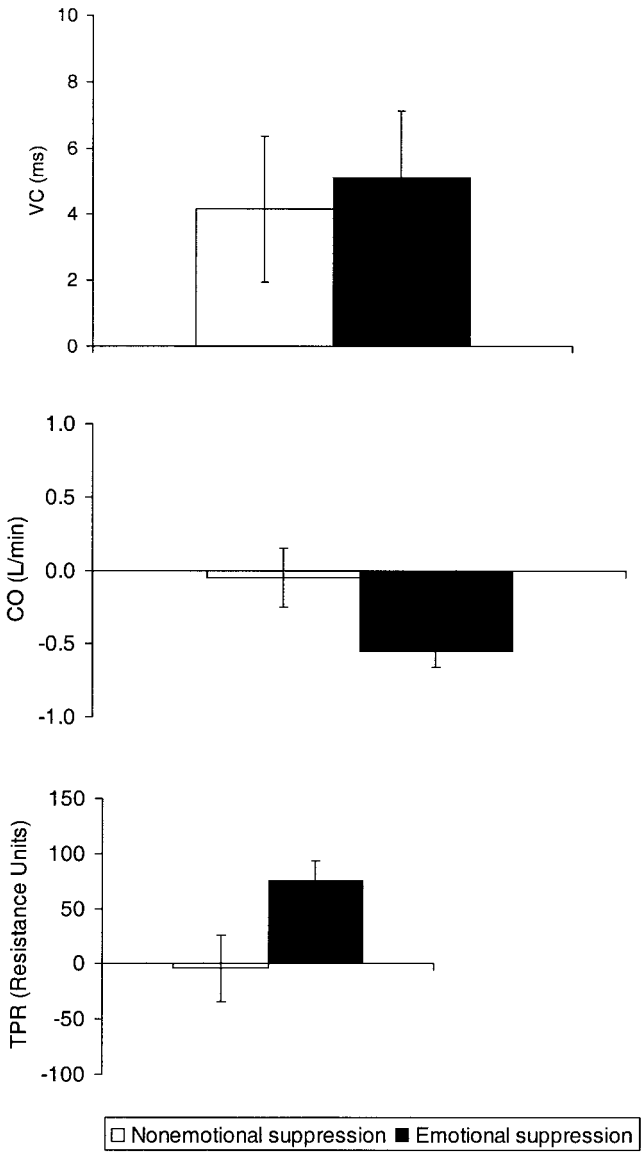

Figure 2. Study 2: Mean cardiovascular reactivity and standard errors from same-sex dyads comparing the emotional suppression condition to the nonemotional suppression condition. VC = ventricular contractility; CO = cardiac output; TPR = total peripheral resistance.

Tests for absolute reactivity also indicated that suppressing emotional expression with a same-sex assistant induced the constellation of threat responses—significant increases from baseline in VC, no changes or decreased CO, and no change or increased TPR (see Table 1). For women, the nonemotional-suppression condition did not result in significant changes from baseline in VC ($M = 0.5$); thus, the pattern of responses would be consistent with the nonemotional-disclosure condition—that is, inconsequential reactivity. For men, reactivity from the nonemotional-suppression condition was more consistent with challenge reactivity (VC: $M = 7.8$; TPR: $M = -30.8$). Because participants in both the emotional-suppression and nonemotional-suppression conditions were speaking on exactly the same topic, that is, duties at a job, the differences in reactivity can be attributed to the effect of suppressing emotional information versus nonemotional information.[10]

Using the initial threshold of greater than zero reactivity for VC and TPR and less than zero for CO reactivity as the defining features for threat states, individual-level analysis revealed a significant relationship between discussion condition (suppression vs. control suppression) and CV category placement, $\chi^2(2, N = 46) = 11.02$, $p < .004$. The nature of the relationship was that participants in the emotional-suppression condition were more likely to be in the threat category ($n = 20$, 77%) than the other two categories (no participants were in the challenge category). In contrast, among those in the control suppression condition, 11 participants (55%) were in the threat category, 7 participants (35%) were in the challenge category, and 2 participants (10%) were in the indeterminate category.

The more conservative threshold (0 + 0.20 standard deviations for VC and TPR reactivity and CO − 0.20 standard deviations for threat reactivity) yielded a significant association as well, $\chi^2(2, N = 46) = 9.65$, $p < .008$. Of the 13 participants in the threat category, the overwhelming majority engaged in emotional suppression ($n = 11$; 85%) as opposed to nonemotional suppression ($n = 2$; 15%). Using the medium effect size standard (0.50) resulted in virtually identical effects, $\chi^2(2, N = 46) = 9.80$, $p < .007$.

CV reactivity data from the second and third minute of the disclosure task revealed significant condition effects: Minute 2: $F(3, 39) = 4.74$, $p < .01$, $\eta^2 = .26$; Minute 3: $F(3, 39) = 5.01$, $p < .01$, $\eta^2 = .28$. The basic finding from the first minute of the discussion task was evident in subsequent minutes—more threat reactivity during emotional suppression than nonemotional suppression. Even though condition effects were evident throughout the disclosure task, repeated-measures analyses demonstrated significant decreases in reactivity across the 3 min: VC: $F(2, 82) = 3.52$, $p < .05$; CO: $F(2, 82) = 6.44$, $p < .01$; TPR: $F(2, 82) = 15.41$, $p < .0001$.

Opposite-sex dyads: Emotional versus nonemotional. In opposite-sex dyads, the emotional versus nonemotional conditions yielded a multivariate main effect for condition, $F(3, 31) = 2.88$, $p < .05$, $\eta^2 = .22$. Univariate analyses revealed significant differences for CO and TPR but not for VC; CO: $F(1, 36) = 4.71$, $p < .04$; TPR: $F(1, 36) = 4.71$, $p < .04$; VC: $F(1, 36) = 0.51$, *ns*. The CO and TPR differences suggest that emotional expression in opposite-sex dyads resulted in significantly greater threat reactivity—lower CO and increased TPR—than in the nonemotional expression condition. Neither the main effect for participant sex nor the interaction was significant.

Tests for absolute reactivity on a measure-by-measure basis confirmed this interpretation. As shown in the bottom half of Table 1, participants engaged in emotional expression with opposite-sex assistants exhibited CV reactivity consistent with threat—significant increases in VC, decreases in CO, and increases in TPR. Male participants in the nonemotional discussion

[10] CV responses from the two control conditions did not differ from each other (multivariate $p > .20$). However, univariate analyses revealed significant VC differences between the conditions. This suggests that nonemotional suppression most likely required more effort than nonemotional disclosure (for a discussion of effort effects, see Wright & Kirby, 2001).

condition did not exhibit significant increases in VC ($M = 3.6$), again suggesting that the nonemotional discussion condition tends to be commonplace and mundane, which results in relatively inconsequential levels of arousal. Female participants, in contrast, did exhibit significant increases in VC ($M = 6.0$) during the nonemotional disclosure task, but the intensity of the CV responses was significantly lower than in the emotional expression condition (e.g., emotional expression TPR: $M = 151.7$; nonemotional expression TPR: $M = -4.2$).

Individual-level analysis confirmed the results from the absolute reactivity analysis. The relationship of category-based reactivity and discussion condition was significant, $\chi^2(2, N = 38) = 9.56$, $p < .008$. Among participants who engaged in emotional expression with an opposite-sex assistant, 67% ($n = 12$) were categorized as threatened. Among those in the control condition, only 4 participants (20%) were categorized as threatened, and the greatest number of participants were in the indeterminate category ($n = 9$; 45%). The more conservative 0.20 threshold yielded a significant relationship between category and discussion condition, $\chi^2(2, N = 38) = 7.04$, $p < .03$. Among participants assigned to the emotion expression condition, none were categorized in the challenge category, 9 (50%) were in the threat category, and the other 50% were in the indeterminate category. In contrast, the majority of participants in the control condition ($n = 11$; 55%) were in the indeterminate category, 5 (25%) were in the challenge category, and 4 (20%) were in the threat category. The 0.50 threshold yielded a significant relationship between category and condition, $\chi^2(2, N = 38) = 9.56$, $p < .008$. Again, the majority of participants engaged in emotional expression with opposite-sex partners exhibited threat, whereas the majority of the participants in the control condition had indeterminate reactivity.

Reactivity during the second and third minutes of the disclosure task yielded only marginal multivariate main effects for condition; Minute 2: $F(3, 31) = 2.01$, $p < .13$, $\eta^2 = .16$; Minute 3: $F(3, 31) = 2.22$, $p < .10$, $\eta^2 = .18$. Similar to the first minute of the discussion task, the emotional-expression condition resulted in reactivity more consistent with threat in subsequent task minutes; however, the differences between conditions in the later minutes revealed that only VC contributed to the multivariate main effect. That is, for participants in the nonemotional-expression condition, VC reactivity returned to baseline values, thus rendering the condition no longer goal relevant, but the emotional-expression condition did engender significant increases in VC, and thus further examination of CV responses indicated threat reactivity.

Opposite-sex dyads: Emotional suppression versus nonemotional suppression. Comparison of emotional and nonemotional suppression conditions was not significant, $F(3, 32) = 1.21$, *ns*. However, tests for absolute reactivity revealed that for both male and female participants, suppressing emotional expression with an opposite-sex assistant exhibited threat responses—significant increases from baseline in VC, no changes or decreased CO, and no change or increased TPR (see bottom half of Table 1). The nonemotional-suppression condition did not engender significant increases in VC for male or female participants. Thus, as observed in same-sex dyads, suppression created an unambiguous threat pattern of CV reactivity when the information being suppressed was emotional rather than nonemotional.

Assistants' Postdisclosure Ratings

Following the discussion task, assistants rated the intensity of the discussion. Confirming that the emotional expression manipulation was successful, assistants rated the discussion as more intense in the emotional-expression condition compared with the other conditions, $F(3, 157) = 18.61$, $p < .0001$. No other effects were observed on this question. We combined the remaining three questions (i.e., difficulty, discomfort, and restraint) to create an index of demands ($\alpha = .72$). A main effect of discussion condition was again observed, $F(1, 157) = 6.58$, $p < .001$. Assistants perceived participants' behavior in the emotional-expression condition as more demanding than in the other three conditions. A main effect for assistant's sex was also obtained, $F(1, 157) = 5.54$, $p < .02$. Male assistants perceived the participants as experiencing more demands than did female assistants (male assistants, $M = 1.7$; female assistants, $M = 1.0$). No other effects were significant.

To provide a semiobjective measure of task demand, assistants reported the number of times they had had to prompt participants to continue talking during the discussion period. The number of prompts yielded a significant main effect for discussion condition, $F(3, 157) = 7.61$, $p < .0001$. Post hoc analyses revealed that the emotional-suppression condition required the most prompting ($M = 5.2$), which differed significantly from the emotional expression ($M = 4.0$) and the nonemotional discussion ($M = 3.2$) conditions. The emotional-suppression condition mean did not differ significantly from the nonemotional-suppression condition ($M = 4.5$), $F(1, 78) = 1.89$, $p = .17$. There was also a significant two-way interaction between sex of assistant and discussion condition, $F(1, 157) = 31.0$, $p < .03$, such that male assistants reported more prompting in the emotional-expression condition ($M = 4.9$) than female assistants ($M = 3.1$), but male assistants reported fewer prompts during the nonemotional-expression condition ($M = 2.7$) than female assistants ($M = 3.7$). No other main effects or interactions were significant.

Postdisclosure Ratings

Following the discussion task, participants completed a four-item questionnaire regarding the discussion they had just completed. A significant discussion type main effect emerged for ratings of the intensity of the discussion, $F(3, 160) = 10.24$, $p < .0001$. Consistent with the assistants' ratings, the intensity ratings from the emotional-expression condition were higher than in the other three conditions, which did not differ significantly from each other (emotional expression: $M = 1.3$; emotional suppression: $M = -1.7$; nonemotional disclosure: $M = -1.4$; nonemotional suppression $= -1.9$). No other main effects or interactions were obtained.

Because the remaining three postdiscussion questions were positively correlated with one another, similar to the assistants' ratings, we created a composite score that reflected the extent to which the participants rated the discussion as demanding ($\alpha = .77$). Demand ratings revealed a main effect for discussion condition, $F(3, 160) = 6.98$, $p < .0002$. Post hoc tests revealed significant differences between the emotional and nonemotional discussion conditions (emotional: $M = -0.2$; nonemotional: $M = -1.9$), with the emotional-suppression and nonemotional-suppression

conditions falling in between (emotional suppression: $M = -1.7$; nonemotional suppression: $M = -1.5$). These results indicate that participants engaged in emotional expression found the task relatively more demanding than did participants in the other conditions. Type of discussion did not interact with participant's or assistant's sex, although there was a marginal two-way interaction between participant's sex and assistant's sex, $F(1, 160) = 2.80$, $p < .10$. The nature of this interaction was such that male participants paired with female assistants reported lower demands than participants in the other three dyad combinations.

Relating Physiological Reactivity to Self-Reports

To examine relationships between self-report ratings and CV responses, we conducted a series of multiple regression analyses. Each CV reactivity measure (VC, CO, TPR) was separately regressed onto five variables: participant's intensity ratings, participant's demand ratings, dyad type (same sex or opposite sex), and two interactions (Dyad Type × Intensity and Dyad Type × Demand). Although the analysis predicting VC only approached significance for the overall model, $F(5, 159) = 1.78$, $p = .12$, intensity ratings did significantly predict VC in a univariate analysis, $F(1, 159) = 6.97$, $p < .01$ (which is consistent with past research showing that sympathetic activation is related to intensity; Bradley, 2000). Regression analyses predicting CO and TPR yielded significant model equations, $F(5, 159) = 5.57$, $p < .0001$, and $F(5, 159) = 4.70$, $p < 001$, respectively. In both cases, the Dyad Type × Demand interaction was significant: CO: $F(1, 159) = 23.04$, $p < .0001$; TPR: $F(1, 159) = 16.08$, $p < .0001$. To further examine these interactions, we conducted simple effects tests within each dyad type and plotted the slopes using unstandardized coefficients in Figure 3.

In same-sex dyads, higher ratings of demand were associated with increased CO ($\beta = .30$, $p < .006$) and decreased TPR ($\beta = -.30$, $p < .005$), indicating that the greater the demand, the greater the challenge response. In opposite-sex dyads, however, greater perceived demand was associated with lesser CO ($\beta = -.38$, $p < .0007$) and higher TPR ($\beta = .38$, $p < .0008$), indicating that greater demands were related to greater threat. Thus, higher task demand ratings translated into greater challenge responses in same-sex dyads, but into greater threat responses in opposite-sex dyads.

Content Analysis of the Emotional-Expression Condition

To better understand the differences observed in the emotional-expression condition between same-sex and opposite-sex dyads, we content analyzed videotapes of participants' discussions. After viewing each recording, an independent judge prepared a brief (three- to five-sentence) synopsis of the participant's discussion, focusing on descriptive content and avoiding evaluative terms that connoted depth or emotional intensity. These synopses were then categorized as trivial or intimate by four judges who were not informed of the participant's or assistant's sex (although in some cases participant sex was obvious from the narrative). The *intimate* category was defined as "topics that are potentially embarrassing, intimate, or contain emotionally charged information." A simple index based on majority agreement (i.e., three out of four judges agreed) revealed that emotional discussions from same-sex dyads were more likely to be placed into the intimate category (76%) than emotional discussions from opposite-sex dyads (45%), $\chi^2(1, N = 37) = 3.81$, $p < .05$.

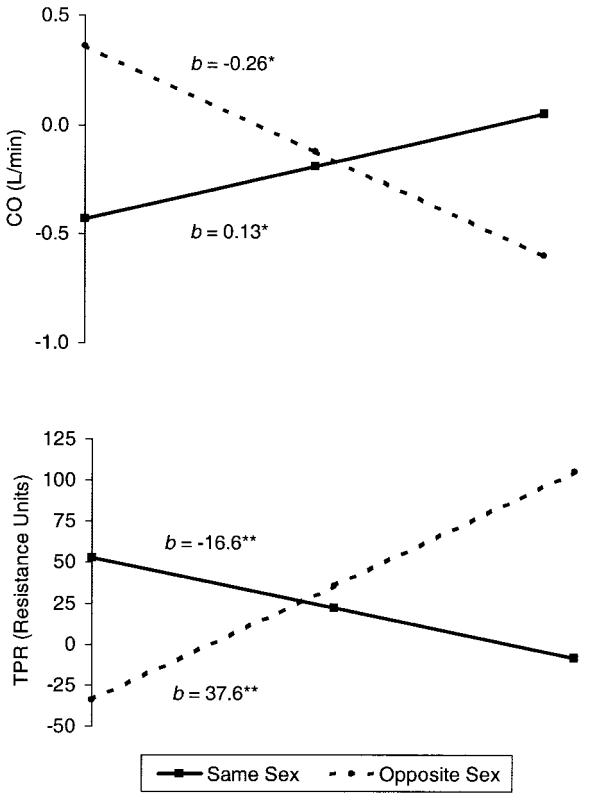

Figure 3. Study 2: Plot of unstandardized regression lines depicting the relationships of post-disclosure "demand" ratings (perceived demands) to cardiac output (CO) and total peripheral resistance (TPR) reactivity by same- versus opposite-sex dyads. Regression lines are plotted using the mean value of demands and 1 standard deviation above and below the mean. * $p < .05$. ** $p < .01$.

A further sample of 37 judges (12 men, 25 women) from a different university was asked to rate each synopsis on six questions regarding how personal, intense, intimate, trusting, potentially embarrassing, and private the disclosures were. Responses were made on scales anchored from 1 (*not much*) to 7 (*very much*). Reliabilities across the 37 judges for the six questions were high (αs = .95–.96). We then combined the judges' averages into a composite score ($\alpha = .97$) to provide an overall index of depth of disclosure.

We first examined whether the ratings of male and female judges differed. Although there was a main effect for judges' sex, $F(1, 35) = 9.03$, $p < .005$, such that male judges on average saw more depth than female judges, judges' sex did not interact with participants' or assistants' sex. However, consistent with the CV responses, we found a significant Participant Sex × Assistant Sex interaction, $F(1, 35) = 4.30$, $p < .05$. Disclosures in same-sex dyads were judged to have greater depth ($M = 4.4$) than disclosures in opposite-sex dyads ($M = 3.8$).

Discussion

This experiment obtained a significant interaction between discussion type and gender context that extends and qualifies findings

from the first study. In same-sex settings, the findings replicated Study 1: Compared with participants discussing nonemotional topics, participants engaging in emotional expression exhibited CV responses consistent with challenge reactivity. Opposite-sex dyads produced a rather different pattern: CV responses during the emotional-expression condition were more consistent with threat reactivity, a pattern evident both in comparisons with the nonemotional condition and in tests of absolute changes from baseline.

Participants' self-report and the assistants' ratings both confirmed that the emotional-expression condition was more intense and demanding than the other conditions. However, these subjective ratings differed from the CV responses in respect to gender context effects. Whereas in same-sex dyads greater demands were associated with more challenge reactivity, in opposite-sex dyads greater demands were associated with more threat reactivity. On the basis of challenge and threat theory, we speculate that participants expressing emotional information to a same-sex assistant may feel that they possess greater coping resources than do participants disclosing to a less familiar, opposite-sex assistant. Perhaps because participants typically have more experience with same-sex interactions, they may perceive that they possess the knowledge and skills necessary to produce an acceptable, supportive response to a greater extent than with the more novel opposite-sex partner.

As hypothesized, in same-sex dyads, emotional suppression engendered greater threat reactivity than did suppression of nonemotional material, although the latter produced some evidence of a relatively lower magnitude threat response. It seems likely that although suppression of any sort requires cognitive work, leading to threat reactivity, the suppression of emotional-laden content engenders a more pronounced threat response. In opposite-sex dyads, the absolute magnitude of change from baseline also indicated a threat response among participants in the emotional-suppression condition, although the difference from the nonemotional-suppression condition was not significant. Considering the large threat response observed during the emotional-expression task in opposite-sex dyads, we speculate that participants in the emotional-suppression condition may have been relieved to not have to disclose to the opposite-sex assistant, thus resulting in lesser threat than had been observed in the same-sex emotional-suppression condition.

Regarding the suppression results, it is important to note that although our suppression results are entirely consistent with Gross's work of the effects of suppression (e.g., Gross, 2002), our experimental procedures greatly differed from his. Typically, Gross and colleagues have used passive stressors (i.e., watching video clips of emotion-eliciting film) and then instructed participants to mask or inhibit emotional expression during the film clips. In contrast, because challenge and threat markers are context bound and only occur in active situations that require instrumental cognitive responses, we used an active stressor (i.e., discussion task) to study suppression. Even though these procedural differences are prodigious (for a discussion of CV differences during active and passive stressors, see Obrist, 1981), the autonomic effects of suppression as Gross theorized were consistent across research paradigms, demonstrating the generalizability of Gross's theory of emotional suppression in both motivational- and emotional-oriented domains and across different types of stressors.

We also observed a significant discussion type effect for the number of prompts the assistants had to provide to keep participants speaking continuously. The emotional-suppression condition required the most prompting, significantly more than in the emotional-disclosure and nonemotional-disclosure conditions. At least two explanations may help explain this result. First, suppression of any sort invokes ironic processing (Wegner, 1989, 1994), which brings into awareness information that competes with the topic participants were discussing. Highly self-relevant emotional content may simply be more potent in this regard than nonemotional content. An alternative explanation is that participants in the emotional-suppression condition may have been eager to move on to the promised emotional-disclosure task. Though we cannot reconcile these explanations, both suggest that emotional suppression in an interpersonal context may interfere with interactional fluency.

The content analyses of participants' emotional disclosures suggest an alternative explanation for our gender context findings. Perhaps the differences we observed were not due to the effect of gender context per se but rather to differences in the nature and depth of what participants discussed. Inasmuch as participants were judged by two separate sets of raters to have discussed less intimate topics when paired with an opposite-sex than with a same-sex partner (possibly a form of emotional suppression in and of itself), it is possible that the obtained CV reactivity differences reflected the nature of their disclosures rather than the gender context in which they took place. To disentangle effects of context and content within an emotional-expression setting, we conducted a third experiment in which we controlled the content of disclosure.

Study 3

Overview

Study 3 was designed to explicitly examine the gender context effects of emotional expression. However, to control the emotional-expression topic, we modified our protocol in two key respects. First, we required that participants commit to a specific emotional topic before the assistant–listener entered the room. Second, we led participants to believe that they would be talking to a same-sex assistant, but after they had committed to a topic and before they had started their emotional-expression task, we switched assistants. In half of the sessions we switched to a different but still same-sex assistant; in the other half we switched to an opposite-sex assistant. This paradigm allowed us to examine CV responses during emotional expression when the topic of the discussion was controlled, but the context was varied. Otherwise, Study 3 was similar to the first two studies. In this final study, we also used judges who viewed the videotapes of the emotional-expression conditions and rated the content of the expression (i.e., the extent to which participants disclosed intense and intimate information) and how comfortable the participants appeared during the disclosure.

Method

Participants

Participants ($N = 49$) were recruited from the introductory psychology course and were either paid $10 or received course credit for their participation.

Procedure

Study 3 used a subset of the laboratory team used in Study 2 and 5 new assistants (13 assistants total: 6 men, 7 women). The experiment began similarly to the previous studies except that, as in Study 1, the experimenter, the first assistant, and the participant were always same sex. Participants again completed the consent form and the emotional Topic Ranking Form while alone and then signed the confidentiality form in the presence of the first assistant. After sensors were applied, participants sat for a 5-min baseline period and then heard instructions to prepare to discuss one topic from the emotional Topic Ranking Form. In this study, we provided participants with blank paper and a pen. They were instructed to write the topic of their discussion and a general outline of the material they planned to discuss. After 3 min of preparation, the experimenter and a different assistant entered the recording room. The experimenter explained that the first assistant had had to go to class and asked if the participant would mind talking to a different assistant. All participants agreed. After receiving an affirmative response, the experimenter left the room and the new assistant sat down facing the participant. Final instructions were played and the emotional-expression task began. The assistant began by asking the participant what he or she had written as the discussion topic. This ensured that the participant would not stray from the topic originally intended for discussion. The study continued as in the previous studies.

Half of the time the new assistant was the same sex as the first assistant (and therefore the participant), whereas the other half of the time the new assistant was the opposite sex of the first assistant (and therefore the participant). Thus, all participants in Study 3 disclosed to a different person than they had met at the beginning of the experiment.

Results

Baseline Differences

A multivariate test for differences in baseline CV responses by sex of participant, sex of the new assistant, and their interaction did not yield a significant multivariate effect for new assistant, $F(3, 42) = 0.35$, *ns*,[11] nor a significant interaction, $F(3, 42) = 1.36$, *ns*.[12] As in the previous studies, reactivity scores were calculated for each CV measure.[13]

Task Engagement

Univariate tests confirmed that the disclosure task in all four conditions engendered significant increases in HR (for male participants: male assistants, $M = 15.4$; female assistants, $M = 18.1$; for female participants: male assistants, $M = 19.5$; male participants, $M = 17.5$). Thus, participants were engaged in all four conditions.

Preparation for Emotional-Expression Task

We examined CV reactivity during the preparation period to determine if any sex differences during the preparation period were evident. Male and female participants did not differ in their CV reactivity during the preparation period, $F(3, 38) = 0.51$, *ns*. The nature of the CV reactivity was consistent with challenge responses (significant increases in VC and CO co-occurring with decreased TPR). Because the manipulation of switching the assistants had yet to take place, participants should not have differed in their CV reactivity during the preparation period on the basis of the sex of the switch assistant, and they did not, $F(3, 38) = 0.76$, *ns*. The multivariate interaction was also not significant, $F(3, 38) = 1.1$, *ns*. Therefore, on average, male and female participants exhibited challenge responses during the preparation period in which they all believed they would be disclosing to a same-sex assistant.

CV Responses During Disclosure

If threat reactivity observed in opposite-sex dyads in Study 2 was attributable to the blunted emotional intensity of the specific topics they disclosed, requiring participants to commit to the topic prior to meeting the assistant should eliminate differences between same-sex and opposite-sex dyads. If the difference remains, however, then something else about the gender context would be implicated. To evaluate these competing hypotheses, we conducted a MANOVA using CV reactivity from the emotional-expression task and two independent variables, participant's sex and new assistant's sex. This analysis yielded nonsignificant main effects and the predicted significant multivariate interaction, $F(3, 42) = 8.27$, $p < .0002$, $\eta^2 = .37$. Follow-up univariate tests indicated that all CV variables contributed to the multivariate interaction: VC, $F(1, 47) = 8.87$, $p < .01$; CO, $F(1, 47) = 19.95$, $p < 0001$; TPR, $F(1, 47) = 18.31$, $p < .0001$. Figure 4 shows that during emotional expression to opposite-sex assistants, participants exhibited lower VC and CO and higher TPR—indicating threat reactivity—than participants disclosing to same-sex assistants.

Similarly, univariate tests for absolute reactivity demonstrated that participants exhibited challenge reactivity during emotional expression to same-sex assistants. Participants disclosing to same-sex assistants exhibited significant increases in VC and CO and significant decreases in TPR (see Table 2 for summary of means). In contrast, participants disclosing to opposite-sex strangers exhibited significant increases in VC, no changes or small decreases in CO, and significant increases in TPR—a pattern consistent with threat.

Individual-level analysis again confirmed results from the absolute tests for reactivity. Using the most liberal criterion (negative TPR reactivity coupled with positive VC and CO reactivity categorized as challenge) to determine challenge, threat, and indeterminate reactivity resulted in a significant relationship with dyad type (same-sex vs. opposite sex), $\chi^2(2, N = 48) = 18.89$, $p < .001$. The majority of participants disclosing to same-sex assistants were categorized in the challenge group ($n = 16$, 73%), whereas the majority of participants disclosing to opposite-sex assistants were categorized in the threat group ($n = 18$, 69%). Using the 0.20 standard deviation threshold yielded a significant relationship, $\chi^2(N = 48) = 21.53$, $p < .001$. Again, most participants disclosing to same-sex assistants ($n = 16$, 73%) were in the challenge group, and 17 participants (65%) disclosing to opposite-sex assistants were in the threat group. Finally, increasing the threshold to a

[11] Data from 1 participant were not used because of loss of ECG signal, leaving a total of 48 participants (23 men and 25 women).

[12] There was, however, a significant univariate difference in CO such that men exhibited higher resting CO than women.

[13] Again, we repeated all major analyses using regressed change to control for the possibility of artifactual results. Results were essentially the same for all effects, reflecting the high correlation between baseline and task scores. In Study 3, these correlations were .75 for VC, .87 for CO, and .86 for TPR.

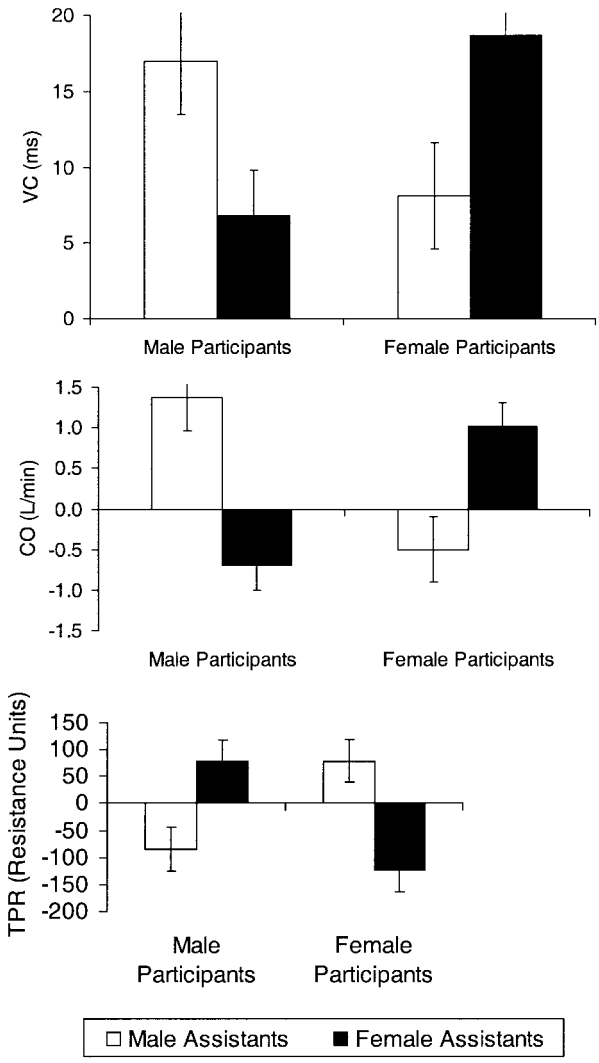

Figure 4. Study 3: Mean cardiovascular data and standard errors during emotional expression by sex of participant and sex of assistant. VC = ventricular contractility; CO = cardiac output; TPR = total peripheral resistance.

medium effect (0.50) resulted in similar effects, $\chi^2(N = 48) = 16.91$, $p < .001$. The majority of same-sex pairings resulted in challenge, and the majority of opposite-sex pairings resulted in threat.

Examination of reactivity across the emotional-expression task revealed a marginal multivariate interaction for Minute 2, $F(3, 42) = 2.49$, $p < .07$. However, all univariate tests were significant: VC: $F(1, 47) = 5.24$, $p < .05$; CO: $F(1, 47) = 4.82$, $p < .05$; TPR: $F(1, 47) = 5.98$, $p < .02$. Similar to the first minute of disclosure, participants disclosing to same-sex assistants exhibited challenge responses, whereas participants disclosing to opposite-sex assistants exhibited threat responses. The multivariate interaction was not significant during Minute 3, $F(3, 42) = 0.94$, *ns*.

Postdisclosure Ratings

We again combined the participant's postdisclosure questions to provide an index of perceived demands following the emotional-expression task ($\alpha = .73$). The main effect for participant's sex was significant, $F(1, 45) = 4.38$, $p < .05$. Women ($M = -0.1$) were more likely than men ($M = -1.3$) to say that the emotional-expression task was demanding. Neither the main effect for assistant's sex nor the interaction was significant. The intensity question yielded no significant effects for participant's sex, assistant's sex or the interaction (opposite sex: $M = 5.2$, 95% confidence interval [CI] 4.22–6.18; same sex: $M = 5.4$, 95% CI 4.56–6.24).

Assistants' postdisclosure ratings of the discussion intensity yielded marginal main effects for both participant's sex and assistant's sex, $F(1, 44) = 3.20$, $p < .08$, and $F(1, 44) = 3.24$, $p < .08$, respectively, and a nonsignificant interaction. Assistants rated female participants as engaging in more intense discussions than male participants, and female assistants tended to rate discussions as more intense than did male assistants. Importantly, the interaction was not significant in this experiment; that is, committing to the topics forced participants to disclose equally intense material regardless of the pairing with same- or opposite-sex assistants.

Consistent with the CV data, the number of times assistants had to prompt participants yielded a significant interaction, $F(1, 44) = 5.72$, $p < .02$. Assistants paired with opposite-sex participants reported more prompting than assistants paired with same-sex participants.[14] No other significant effects were observed.

Judges' Ratings of the Disclosure Task

To evaluate differences in the nature of participants' self-disclosures, 11 judges at a different university who were unaware of the study's hypotheses viewed videotapes of the disclosures. Each judge independently rated all videotapes on six rating scales regarding the personal nature and emotional depth of self-disclosures and on two rating scales regarding the participant's discomfort and forthcomingness. Separate ratings were obtained for the first minute of disclosure (corresponding to the CV data) and for the full 3 min.

Reliability across the 11 judges was high. For the six disclosure-depth questions, alphas ranged from .87 to .93 for the first minute and from .91 to .92 for the full 3 min; for the two comfort questions, alphas ranged from .77 to .95 for the first minute and .78 to .96 for the full 3 min. After averaging across coders, the six disclosure-depth items were summed into a single index ($\alpha = .95$ for first minute, $\alpha = .98$ for 3 min). A similar sum for the discomfort questions yielded $\alpha = .77$ for the first minute and .64 for the full 3 min.

There were no significant differences in depth of disclosure by participant's sex, assistant's sex, or the interaction for either the first minute or the full 3 min (first minute: same sex: $M = 3.4$, 95% CI 3.07–3.73; opposite sex: $M = 3.4$; 95% CI 2.98–3.72). That is, judges did not detect condition differences in the content of participants' disclosures. Ratings of how comfortable the participant appeared produced a marginal interaction; first minute: $F(1, 46) = 3.35$, $p < .07$; 3 min: $F(1, 45) = 3.29$, $p < .08$. Similar to

[14] To determine if the repeated effects of prompting were responsible for the observed CV effects, we conducted a MANCOVA in which we repeated the main analyses with the inclusion of prompting as a covariate. Even though this analysis resulted in a smaller effect of dyad type compared with the main model, $F(3, 38) = 5.10$, $p < .005$, $\eta^2 = .29$, the dyad effect was not eliminated with the inclusion of prompting by the assistant.

Table 2
Study 3: Mean Cardiovascular (CV) Reactivity and Univariate Tests From the Disclosure Task

	Sex of participants–sex of assistants			
CV reactivity	Male–male	Male–female	Female–male	Female–female
VC	$17.0^{***}{}_{a}$	$6.8^{*}{}_{b}$	$8.1^{*}{}_{b}$	$18.7^{*}{}_{a}$
CO	$1.2^{*}{}_{a}$	-0.6_{b}	$-0.6^{*}{}_{b}$	$0.9^{*}{}_{a}$
TPR	$-77.4^{*}{}_{b}$	$56.8^{**}{}_{a}$	$99.0^{*}{}_{a}$	$-112.8^{*}{}_{b}$

Note. All condition means were tested against zero to determine significant increases or decreases from baseline. Different subscript letters indicate significant post hoc differences (Tukey's honestly significant difference) across conditions. VC = ventricular contractivity; CO = cardiac output; TPR = total peripheral resistance.
* $p < .05$. ** $p < .01$. *** $p < .001$.

the pattern observed with the CV data, participants disclosing to opposite-sex assistants were perceived as less comfortable than participants disclosing to same-sex assistants.

Relationships Between CV Responses and Judges' Ratings: Regression Analyses

To examine associations between CV reactivity and judges' ratings of discomfort and self-disclosure, we conducted a series of regression analyses predicting CV reactivity from discomfort ratings, self-disclosure depth, dyad sex pairing, and two interaction terms (Discomfort × Dyad and Self-Disclosure × Dyad). For all three variables, the depth of disclosure main effect was significant or marginally significant: VC: $F(1, 46) = 19.89$, $p < .0001$; CO: $F(1, 46) = 6.24$, $p < .02$; TPR: $F(1, 46) = 2.96$, $p < .10$. Greater depth of disclosure was associated with higher VC and CO and lower TPR, providing further evidence of a link between emotional-disclosure depth and challenge reactivity. The main effect for discomfort was not significant, nor was the Discomfort × Dyad interaction once depth of disclosure was included in the model. Importantly, the Depth of Disclosure × Dyad Type interaction was significant for all three variables: VC: $F(1, 46) = 8.20$, $p < .01$; CO: $F(1, 46) = 4.97$, $p < .05$; TPR: $F(1, 46) = 4.37$, $p < .05$.

To clarify the significant interactions, we conducted regression analyses separately for same-sex and opposite-sex dyads. Unstandardized regression slopes are displayed in Figure 5. Same-sex dyads yielded significant slopes for all three CV variables (VC: $\beta = .68$, $p < .001$; CO: $\beta = .47$, $p < .03$; TPR: $\beta = -.63$, $p < .001$), indicating greater challenge reactivity associated with more depth of disclosure. In opposite-sex dyads, however, there was a significant positive slope for VC ($\beta = .42$) but nonsignificant slopes for CO and TPR. In other words, a depth of disclosure/challenge reactivity association was only observed in same-sex dyads, and no significant relationships between depth of disclosure and CV reactivity were observed in opposite-sex dyads, though the trend suggested that greater intimacy during emotional expression with opposite-sex partners resulted in greater CV threat reactivity.[15]

Discussion of Study 3

Study 3 provided evidence that the gender context effects observed in Study 2 were not solely due to the selection and discussion of different topics according to the assistant's sex. Though all participants anticipated disclosures with same-sex assistants and thus prepared their disclosure with this expectation in mind, only those who ultimately expressed emotions to a same-sex assistant actually exhibited challenge reactivity during the discussion task; participants who ultimately engaged in emotional expression with an opposite-sex assistant exhibited CV responses consistent with threat reactivity. Because all participants disclosed to a different assistant than the one they originally met, we can rule out the possibility that familiarity generated in the initial meeting prompted more positive responses in same-sex than in opposite-sex pairings.

We also observed more need for prompting by the assistants in opposite-sex pairings relative to same-sex pairings. If we assume that prompting provides a rough indication of restrained discussion, then we can conclude that opposite-sex pairings were experienced as more demanding by participants than same-sex pairings.

Judges did not perceive significantly differential disclosure depth between same-sex and opposite-sex pairings. Forcing participants to commit to their disclosure topic before the assistant–sex manipulation was revealed resulted in disclosures of relatively similar intensity across assistants' sex conditions. Although participants' choice of disclosure topics was perceptibly similar in terms of its emotional depth regardless of the context, which was our intention, judges nevertheless perceived differences in participant comfort, reflecting the context in which the disclosure took place. Participants in same-sex pairings appeared more comfortable than participants in opposite-sex pairings.

The most compelling data, however, relate the independent judges' ratings to CV reactivity, which implicates disclosure depth as a critical factor in the expression–challenge link. Even after controlling for perceived comfort, we observed main effects between CV reactivity and depth of disclosure, such that the greater the depth of disclosure, the greater the challenge reactivity. This finding was qualified by the significant Dyad × Depth interaction. Follow-up simple-effects tests revealed that the association between challenge reactivity and depth of disclosure was significant

[15] We repeated the study's main analysis using a MANCOVA with the addition of depth of disclosure and discomfort as covariates. Even though depth of disclosure was a significant covariate, $F(3, 41) = 4.23$, $p < .01$, $\eta^2 = .24$, the main effect for dyad was still significant, $F(3, 41) = 10.13$, $p < .0001$, $\eta^2 = .43$.

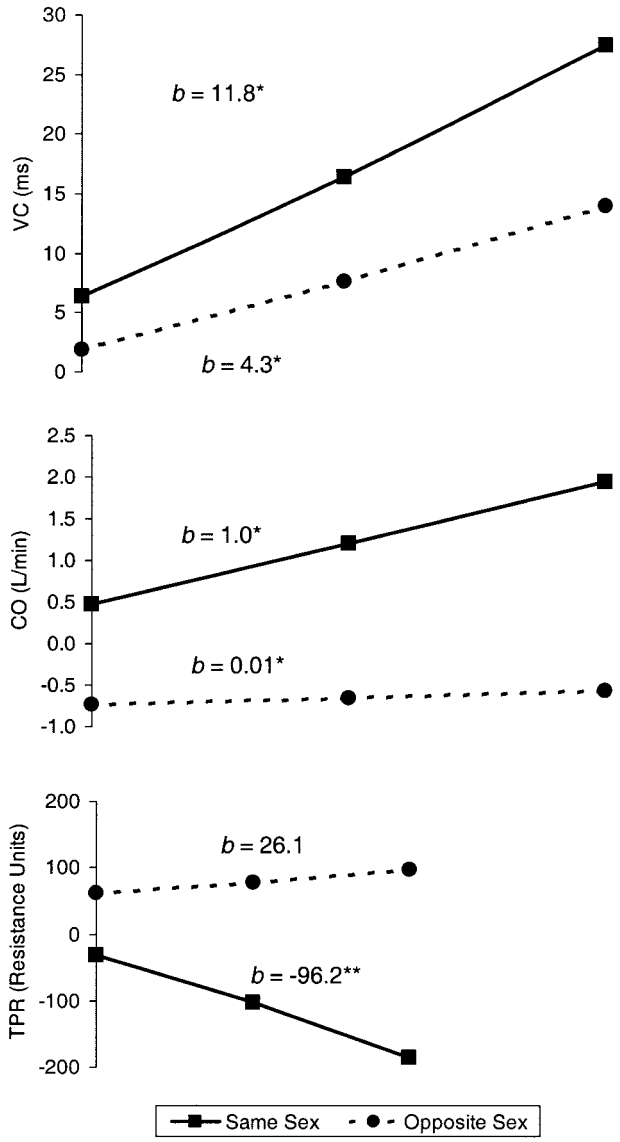

Figure 5. Study 3: Plot of unstandardized regression lines depicting the relationships between cardiovascular reactivity and judges' ratings of depth of disclosure by same- versus opposite-sex dyads. Regression lines are plotted using the mean value of depth of disclosure and 1 standard deviation above and below the mean. VC = ventricular contractility; CO = cardiac output; TPR = total peripheral resistance. * $p < .05$. ** $p < .01$.

only in same-sex dyads. In opposite-sex dyads, though VC reactivity was related to depth of disclosure, the relationships between CO and TPR and depth of disclosure were not significant. Therefore, the depth of disclosure/challenge reactivity association was only observed when participants were disclosing in the more familiar, same-sex context.

General Discussion

This research had three general goals. First, we sought to determine whether CV responses during emotional expression to an empathic stranger are better characterized as a challenging or a threatening process. All three experiments found clear and consistent evidence for the challenge pattern of CV reactivity, at least with same-sex partners. Evidence for the challenge pattern was found both in comparisons across conditions and in terms of absolute deviations from baseline. This finding is important for several reasons. One is that prior research has been somewhat equivocal, with some studies demonstrating positive effects and others demonstrating negative effects. An important advantage of the current research is its reliance on objective, psychophysiological indicators as a complement to prior research, which has relied almost invariably on subjective self-reports.

Second, although we did not assess health, these findings nonetheless suggest a pathway that may help explain the previously noted association between emotional expression and health (e.g., Pennebaker, 1993, 1997). In prior research, challenge reactivity has been linked empirically to enhanced performance, greater positive well-being, and more approach-related behaviors (e.g., Blascovich, Mendes, & Seery, 2002). Theoretically, challenge responses have been implicated in a variety of protective and possibly resilient physiological mechanisms (although the long-term physical and psychological benefits of challenge reactivity remain to be verified). For example, psychoneuroendocrinologists have explicitly identified CV challenge reactivity as part of a constellation of responses that may be linked to increased anabolic hormones (e.g., insulin-like growth hormones), which ultimately can be protective in terms of susceptibility to illness (Epel et al., 1998). Thus, this line of reasoning suggests that the health benefits of emotional expression may be mediated by the pattern of challenge reactivity that participants in the same-sex conditions of all three experiments showed. Of course, direct evidence for this speculation is needed.

Our second goal was to examine the moderating effect of the interpersonal context—specifically, the gender match of the participant and empathic listener—on challenge and threat reactivity. The results of Study 2 indicated that emotional expression to opposite-sex assistants was threatening, both relative to control conditions (and same-sex listeners) and in terms of absolute CV reactivity. However, in this study, participants chose topics affording less emotional depth when paired with an opposite-sex listener, suggesting an alternative explanation for our findings. Therefore, we controlled the expression topic in Study 3 by committing participants to a topic prior to their discovering that the listener would be an opposite-sex assistant. This experiment found the same result as Study 2: challenge when disclosing to a same-sex partner, threat when disclosing to an opposite-sex partner. Thus, the gender context of emotional expression moderated CV reactivity. However, the content of emotional expression was also identified as an important factor during emotional expression. For participants engaged in more intimate and intense discussions with same-sex partners, CV reactivity was consistent with stronger challenge responses. In contrast, the relationship between intensity and CV responses for participants paired with opposite-sex partners was suggestive of greater intimacy leading to greater threat responses (though not significantly).

Just what process best explains this moderator effect remains an open question. One likely possibility is the greater familiarity of same-sex interaction, which would tend to reduce uncertainty about the partner's expected reactions and thereby lessen the perceived demands of the task, a critical component of challenge

and threat theorizing. Additionally, participants likely had greater self-perceived knowledge and abilities in same-sex interaction. This shared reality may have contributed to greater appraised resources. A further factor adding to the relatively more threatening nature of the opposite-sex context is the potential for romantic undertones inherent in opposite-sex interaction among college-age students. Specifically, because assistants were all slightly above local averages in attractiveness, attraction may have functioned to increase demands of the situation that, coupled with the discussion task, resulted in greater threat. Thus, the additivity in various demands may have resulted in greater threat. (For a similar perspective, see Hobfoll, Freedy, Green, & Solomon, 1996.)

Although the findings of Study 2 may seem to be at odds with prior research showing that men tend to be more self-disclosing with female than with male partners, the differences can be reconciled in several ways. First, our experimental context not only sanctioned emotional expression, it required it. Reis et al. (1985) demonstrated that when emotional disclosure is made situationally appropriate, sex differences in same-sex interaction tend to become nonsignificant. Second, our assistants had been trained in being "good" (i.e., responsive) listeners. It is possible that men's lesser self-disclosure to other men in natural settings is due to the listener. Third, we examined physiological responses to emotional self-expression elicited by the situational context rather than by differences in spontaneous self-disclosing behavior. Fourth, we examined these physiological responses only in the first 3 min of interaction. It is possible that sex differences may emerge later in interaction, as emotional content becomes "deeper" and more elaborated. That is, in the early stages of interaction it seems possible that the effects of greater familiarity and similarity with same-sex others would be relatively more salient than the greater empathic responsiveness that women possess in a natural interaction.

Our third goal was to evaluate CV responses during emotional suppression, both to examine emotional suppression's effects on challenge–threat reactivity and also to determine whether the effects of suppression are common to any self-relevant content or are specific to emotional material. In this regard, we note that past research has generally not controlled for self-relevant nonemotional information being suppressed. In same-sex dyads, we obtained strong support for our hypothesis that emotional suppression would engender threat reactivity (although nonemotional suppression also engendered some, albeit weaker, threat reactivity). The effect of emotional suppression in opposite-sex dyads was less clear. Although emotional suppression resulted in threat in absolute terms, results in this condition did not differ significantly from its control condition. On the basis of the findings from the opposite-sex disclosure condition, we speculate that the emotional-suppression condition, which allowed the participants to delay a task that typically resulted in threat, may have engendered feelings of relief from the apparently more threatening task of disclosure to an opposite-sex assistant.

Limitations and Conclusions

Our results indicate that the effects of emotional expression and suppression are evident at the level of psychophysiological responses. If nothing else, these results suggest one mechanism that may help account for the impact of these behavioral processes on health. These effects were not invariant or uniform, however, as some theorists have maintained. Rather, the CV effects of emotional expression and, to a lesser extent, suppression depended on the gender context of interaction. Gender context is an important factor not only in all social interactions but particularly with regard to emotional expression (Dindia & Allen, 1992; Reis, 1998). Of course, our findings are limited to the context of interactions with empathic strangers. Although, not incidentally, most self-disclosure research has been conducted with strangers, emotional self-expression tends to occur most often among acquainted individuals—friends and partners in ongoing relationships. It will be important to determine in future studies whether similar moderator effects would be obtained with interactions involving close friends. In challenge and threat terms, same-sex and opposite-sex close friends (including romantic partners) may be more similar to each other with regard to familiarity, suggesting that differences might be minimized. On the other hand, even in very close relationships, expectations of responsive support are known to differ between same-sex and opposite-sex others (e.g., Reis, 1998). Furthermore, disclosing to close others often involves increased vulnerability and psychological risk, especially when there are questions about commitment and divided loyalties. This vulnerability tends not to be present with strangers. One benefit of the paradigm we used was the perception of anonymity, which is thought by some to increase the intensity of emotional disclosure (Pennebaker, 1989). Another benefit is that we standardized, to the extent possible, the response of the listener–assistant, a factor that may influence challenge and threat reactivity. Also, the paradigm we used focuses directly on the process of emotional expression as it occurs. In ongoing relationships, the meaning (and hence psychological impact) of an emotional expression is often substantially influenced by the partners' prior knowledge about each other, their interaction history, and their expectations about future interaction. Examining the relative roles of familiarity, vulnerability, and one further factor that we controlled to avoid additional complexity in our theorizing and methodology—reciprocity of emotional expression—on challenge and threat reactivity during emotional disclosure represents an important priority for future research.

Our findings may also be limited to the extent that all topic choices of emotional expression involved elements of vulnerability, potential embarrassment, and self-exposure. Though we deliberately chose topics with the same underlying theme so as to minimize differences in expressed or experienced emotions (Trierweiler, Eid, & Lischetzke, 2002), this intentional circumscribing of the topics does limit the generalizability of the findings reported here. We would argue, however, that we chose topics that would be the least likely to engender positive emotions, and thus we applied the most conservative test of potentially positive autonomic reactions associated with emotional expression. Still, it remains to be empirically examined whether the results obtained here would generalize to emotional expressions that focused on, for example, positive aspects of the self or past experiences that are associated with anger. Related to this limitation is the problem that the physiological effects that we observed in these studies may be merely capturing the effects of non-normative behavior. That is, non-normative behavior may always be more threatening in the presence of opposite-sex versus same-sex partners (for this partic-

ular population). Though this question cannot be reconciled here, we hope other researchers will consider this particular factor in future studies.

Another limitation of our design is the use of North American college-student participants. Early adulthood is a time during which romantic possibilities are particularly salient, which may have added to the threat inherent in the opposite-sex context. Furthermore, during the college years, patterns of social interaction tend to shift from greater emphasis on same-sex interactions to relatively more balance between same- and opposite-sex partners (Laursen & Bukowski, 1997). In an older sample we might expect fewer familiarity-based differences in challenge and threat responses, commensurate with experience. Also, whether the effects observed here are generalizable to other cultures is an empirical question. However, Rimé et al. (1991) found that Western and non-Western cultures alike engaged in emotional sharing of similar frequency.

In conclusion, we believe that a biopsychosocial approach to the study of coping with potentially stressful and arousing activities provides a useful paradigm for differentiating psychological states without relying exclusively on self-reports. At present, the challenge and threat motivational categories offer relatively broad indications of underlying appetitive and aversive states. It will be useful in future research to use physiological markers of more specific emotion, such as the shame that emotional disclosure sometimes engenders. Still, the challenge–threat distinction offers a valuable window into the mechanisms by which interpersonal and behavioral circumstances can come to influence health and well-being. Better understanding of these mechanisms offers compelling possibilities for future research.

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