Emotion

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Working Through Emotions: Sadness Predicts Social Engagement and Physiologic Linkage for Men and Disengagement for Women in Dyadic Interactions

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We investigated whether sadness leaves an "emotional residue" by inducing sadness in one individual and testing its transfer to an unaware new acquaintance. Participants ($N = 230$; 115 dyads) completed cooperative tasks in same-gender dyads. Before meeting, participants recalled a personal event. In half the dyads, one participant (sad actor) recalled a sad event, while their partner (sad-paired partner) recalled a neutral event. In control dyads, both participants recalled neutral events. We examined self-reported emotions, affective language, behavior, and measures of sympathetic arousal to capture physiologic linkage—the degree to which one partner's physiology at one moment, predicted their partner's physiology the next moment. Men in the sad actor condition exhibited greater engagement (smiled more, gestured more) and their partners showed stronger physiologic linkage than men in the control condition. Conversely, women in the sad actor condition were less expressive than women in the control condition (smiled less), and their partners showed weaker physiologic linkage to them compared to dyads in the control condition. These findings have important implications for how men and women regulate negative affect and respond to others' affective cues.

Keywords: affect, physiologic linkage, interpersonal influence, dyadic interaction, gender

Emotions are inherently social—expressions of distress signal to others when we need to be consoled, and expressions of joy facilitate social bonds (Shiota et al., 2004). Research often focuses on the *intra*personal experience of emotion, exploring questions such as how emotions shape behaviors (Gross, 2002). However, our social interactions often rely on *inter*personal influence or the bidirectional influence between two people. For example, a distressed individual might confide in another person, consequently eliciting empathy and influencing the listener's behavior (Klimecki & Singer, 2012), or an empathic person may respond physiologically when watching a partner experience a stressor, like giving a stressful speech (Brown et al., 2021).

Although sharing our feelings and watching others experience emotions are common, we may feel compelled to bury our emotions in certain contexts. For instance, imagine learning sad personal news right before leading an important presentation at work. "Breaking script" to emotionally disclose to coworkers not only may feel inappropriate but also can come with social costs; emotional disclosures can violate norms of how people should behave, be ill-timed, or lead to negative first impressions that are difficult to correct (Black & Vance, 2021; Hall et al., 2016; Pasupathi et al., 2009; Rabin & Schrag, 1999). In interactions like these, you may still experience sadness, but the subtle behavioral cues that "leak out" during the interaction might reflect your attempt to regulate the emotion as much as the emotion itself, inadvertently influencing the dynamics of the dyad (Buchanan et al., 2012; Butler, 2011; Butler et al., 2003; Gross, 1998; Hall et al., 2016; Soto & Levenson, 2009; West et al., 2017; West & Mendes, 2023). Research exploring the

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The authors report all manipulations, sample size justification, measures, and exclusions in this study. All data and analysis code for this study are publicly available at https://osf.io/es2ug/?view_only=125797f18ac64a28ad602df2ca01a9a6 (del Rosario et al., 2024). Data were analyzed using R Version 4.2.2 (R Core Team, 2022), SPSS v29, and SAS 9.4. This study's design and analysis were not preregistered.

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influence of emotion in social interactions has largely concentrated on high-arousal negative emotions often within female dyads (Brown et al., 2021; Stemmler et al., 2001; West et al., 2014). Women are often more motivated than men to accurately detect other's emotions (Eisenberg & Lennon, 1983; Löffler & Greitemeyer, 2023) and tend to exhibit greater emotional expressiveness compared to men, making high-arousal negative emotions, such as those associated with stress, more readily noticeable and discernible (Coker & Burgoon, 1987; Thorson et al., 2018). Consequently, the effect of one individual's stress on their partner has been a central theme in previous investigations. However, this focus on stress leaves a gap in our understanding of the influence of less conspicuous emotions, such as low-arousal emotions, that are more subtle and less immediately noticeable. Our research aims to broaden the scope by examining the influence of low-arousal negative emotions in dyadic interactions and exploring potential gender differences in response patterns.

We turn our attention to sadness, which is characterized by social withdrawal and may be challenging to detect when interacting with a stranger (Kreibig et al., 2007; Schaafsma et al., 2015). We test the hypothesis that sadness experienced prior to an interaction leaves an emotional residue, which carries over into a subsequent social interaction and can be detected by observers. Furthermore, we consider the potential influence of gender. Sadness expression is considered less normative for men, who are inclined to regulate their emotions by suppressing them (Cassano et al., 2007; Waters et al., 2020), distracting themselves (Rivers et al., 2007), or expressing other emotions, like anger (Timmers et al., 1998). In general, the inclination to regulate emotions using these kinds of strategies can have unintended consequences and result in compensatory behaviors and greater physiologic arousal (Gross & Levenson, 1993). For instance, individuals interacting with a stigmatized partner (e.g., a confederate with a fake facial birthmark) will try to avoid appearing uncomfortable by engaging in over-the-top friendly behaviors, such as smiling and laughing more than those interacting with a confederate without the birthmark (Blascovich et al., 2001; Mendes & Koslov, 2013). Given the divergent gender norms in the emotion literature, it is possible that in a novel interaction, men will actively avoid appearing sad and engage in compensatory behaviors (e.g., signaling engagement by smiling and gesturing during conversation). Conversely, women, for whom emotion expression is more socially acceptable, may display behaviors that are characteristic of sadness (e.g., signaling withdrawal by smiling and gesturing less).

Physiologic Linkage

The sympathetic nervous system is responsive to changes in affect and effort, providing valuable insight into social dynamics. Physiologic linkage refers to the degree to which one individual's physiologic response at one time point predicts their partner's at the following time point (Palumbo et al., 2017; Thorson et al., 2018). In dyadic interactions, partners can become linked in their physiologic responses, when one partner (the "sender") expresses behaviors to which the other partner ("receiver") attunes, including body movements (e.g., gesturing with hands, fidgeting), facial expressions (e.g., smiling), speech, odor, and touch (Ravreby et al., 2022; West & Mendes, 2023). In this study, we use physiologic linkage to capture attunement between dyad members, assessing whether individuals pick up on an interaction partner's sadness and become physiologically linked during a cooperative interaction. To capture linkage, we measure preejection period (PEP) which is an estimate of the time between the left ventricle contracting to the aortic valve opening and is thought of as sensitive to arousal states, like shifts in attention and effort, but is neither negatively nor positively valanced (Kelsey, 2012; Pilz et al., 2023; Plain et al., 2021). PEP is particularly relevant in actively engaging interactions where dyad members are motivated to cooperate, such as during a team-building exercise (Mendes, 2016; Thorson et al., 2018). In these types of interactions, noticing one dyad member's affect (e.g., tensing their muscles when anxious) can prompt changes in the other dyad member's physiologic responses as they become attuned to their partner (Waters et al., 2020; West et al., 2017; West & Mendes, 2023). Furthermore, PEP is a continuous measurement that captures momentary changes in affective states (Mendes, 2016), making it useful to measure moment-to-moment physiologic influence.

Whereas previous studies have mainly focused on the influence of high-arousal affective states, which typically are displayed through behavioral indicators of those states (e.g., social anxiety, expressed through fidgeting, avoiding eye contact), our study uses physiology to investigate: (a) whether a sadness induction affects physiologic states during a later interaction and (b) whether interacting with a sadness experiencer engenders changes in the observer's physiology, suggesting that they are attuned to that person's affective states. Traditionally, low-arousal states, like sadness, are associated with the parasympathetic nervous system with measures like respiratory sinus arrhythmia (RSA) linked to social responsiveness, bonding and emotional coregulation (Muhtadie et al., 2015; Stellar et al., 2015; Waters et al., 2014). The primary focus of this study, however, is to test whether experiencing sadness influences engagement during a cooperative interaction, in which individuals are motivated to work together. For this reason, we focus on sympathetic responses to tap into the effects of sad experiences on attunement and engagement. Given the link between parasympathetic responses and low-arousal emotion, we examine RSA linkage in an exploratory analysis. Moreover, considering that sadness is less stigmatized for women compared to men (Barrett & Bliss-Moreau, 2009; Cassano et al., 2007; Chaplin et al., 2005), we test whether linkage is moderated by gender. We explore the following questions: When interacting with a sad individual, are men and women equally attuned to that person or are there differences in the degree to which they engage with a sad individual? Does recalling a sad experience influence men and women differently and is it reflected in their physiology? Given the distinct behavioral profiles of high-and low-arousal negative emotions and predominance of research on high-arousal emotions in social contexts, it is less clear how sadness manifests in dyadic interactions.

Overview of the Present Study

The primary goal of this research was to examine whether experiencing sadness prior to an interaction lingers and subsequently affects engagement during the interaction with a stranger who is not made aware of the experiencer's affective state. Newly acquainted same-gender dyads were placed in one of two conditions prior to meeting each other: "Sad dyads" had one dyad member who recalled a time in which they felt sad (sadness induction), and the other dyad member recalled a neutral experience (control condition); "control dyads" had both partners recall a neutral experience. Following the emotion induction, participants were introduced and then completed a series of cooperative tasks together, all while unaware of their partner's assigned condition.

To capture the various dimensions of emotion and engagement, we used a multimethod approach assessing affective language, physiologic linkage, behavioral displays of engagement, and self-reported emotion. Autonomic nervous system responses were recorded continuously from each dyad member, which were then used to calculate linkage. Additionally, we coded behavioral indicators of sadness and engagement (e.g., gesturing and smiling during conversations) during the interaction. Given the nonnormative nature of expressing sadness for men, we examine the idea that men may compensate by displaying more signals of engagement, drawing their partner's attention. In contrast, women may exhibit withdrawal behaviors, leading their partner to disengage.

Method

Design and Participants

Participants were recruited through a combination of ads, snowball sampling, and outreach through community listservs from the San Francisco Bay Area; 242 participants (121 unacquainted same-sex dyads) were initially recruited for participation in 2017. Three dyads were removed from the sample prior to analysis. One dyad was removed, because a computer malfunction corrupted the physiologic data for the entire study; one dyad was removed, because the participants knew each other; and one dyad was removed, because one participant was uncooperative. Three other dyads were excluded, because of missing data due to technical difficulties with either physiologic collection or experimenter error. Of the remaining 115 dyads, participants ranged from 18 to 45 years old ($M_{\text{age}} = 27.4$, $SD_{\text{age}} = 6.18$). All participants had lived in the United States since at least age 7 and considered English their primary language. Participants were asked to abstain from caffeine consumption, smoking, eating, and vigorous exercise for at least 4 hr prior to their lab visit, because these activities can alter physiologic responses. The study was approved by the University of California, San Francisco Ethics Committee (Institutional Review Board 16-18539).

We aimed to run 110 dyads (220 participants) based on a power analysis using simulations of repeated observations data (e.g., physiologic data) within dyads (Lane & Hennes, 2018; Thorson et al., 2018). We had a secondary goal of running an additional 10% to account for missing data. For laboratory data in which physiologic responses are obtained, we typically observe approximately 10% data missing completely at random, leaving us with a final sample of 115 dyads (230 participants). Participants ($M_{\text{age}} = 27.80$, $SD_{\text{age}} = 6.81$) identified as the following: White (45.65%), Black (6.52%), Asian (26.09%), Latino/a (12.17%), other (7.83%), and 1.74% did not report their race. Of the 118 participants in the sad dyad condition (one sad actor and a neutral partner), 78 identified as female ($N_{\text{dyads}} = 39$) and 40 identified as male ($N_{\text{dyads}} = 20$). The control dyad condition included 112 participants of which 56 identified as female ($N_{\text{dyads}} = 28$), and 56 identified as male ($N_{\text{dyads}} = 28$).

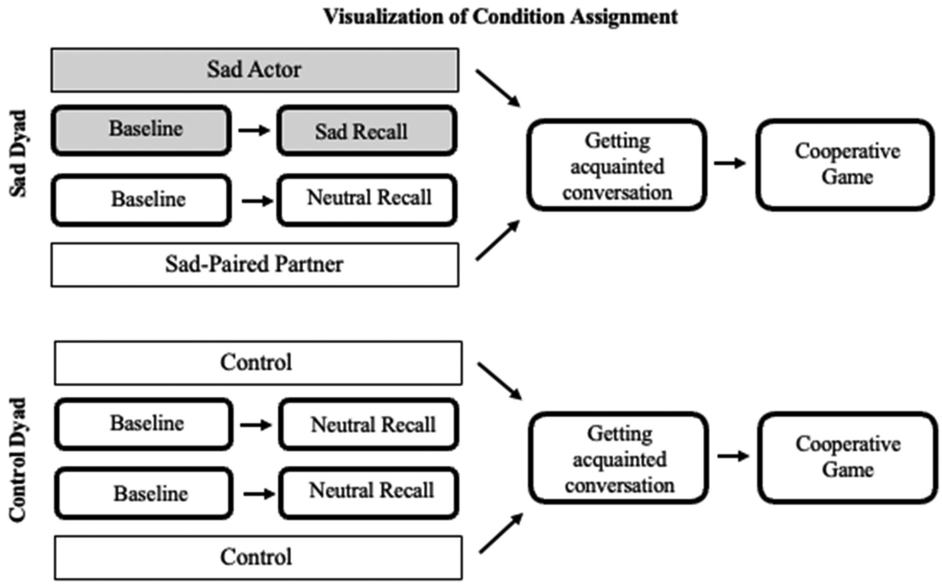
Procedure

Prior to the laboratory visit, participants completed an online screening questionnaire and were matched with same-gender stranger of a similar race/ethnic background and who was within 5 years of their age to avoid confounds due to demographic differences (Human & Mendes, 2018; Tan et al., in press). At the beginning of the laboratory session, all participants provided written consent. Participants were placed in separate experimental rooms; they were not informed that this was a two-person study. Following consent, an experimenter attached physiologic sensors to the participant. Four impedance cardiography tapes were applied—two encircled the neck and two on the torso below the sternum. Electrocardiogram (ECG) sensors were placed in a modified Lead II configuration (under the right clavicle and lower left rib). Participants then relaxed alone in a seated position for a 5-min baseline recording of physiologic responses at rest. After baseline, participants were told that for the rest of the study they would be interacting with another participant and were asked to give verbal consent that they were willing to continue. Researchers turned on a television monitor that projected a live video feed from the other experimental room, allowing participants to see and hear one another. Participants were introduced to one another and asked whether they knew each other. For participants who knew each other, the study ended at this point. Researchers mentioned that the two would be together in the same room to complete some joint tasks. Following this the experimenter turned off the live feed.

Participants then completed the emotion induction task. For dyads in the sad condition, one participant (sad actor) was instructed to recall, "a specific experience from your past when you experienced overwhelming sadness; a time when you felt completely alone and completely depressed." The other participant (sad-paired partner) was instructed to "describe what you have done since you woke up this morning." For dyads in the control condition both participants described what they did since they woke up that morning (see Figure 1). Participants were given 2 min to privately prepare for the task. The researcher then returned to the room and participants were instructed to describe the experience they recalled to a researcher. All participants in the sad condition (person who completed the sadness induction) and one participant from each control dyad were recorded as they responded to their prompts. One control dyad member was always recorded to maintain consistency with the protocol for dyads in the sad condition. If participants stopped speaking before the end of the task, researchers prompted them with follow-up questions. Participants were told that they had 4 min to talk. If they stopped early, researchers prompted them to give more details until they had spoken for at least 2 min. Following the emotion induction, one participant was escorted to the larger experiment room to join their partner for the remainder of the experiment. All participants were instructed to not discuss their prompts during the interaction.

We designed the study so that the dyad would have different tasks to complete that had distinct emotional and cognitive demands to manifest varied physiologic reactions (West & Mendes, 2023). The first task consisted of a 4-min "getting acquainted" conversation with the aid of a list of questions. After, the dyad had a free-form conversation for four additional minutes. Next, participants completed a cooperative word-guessing game, based on the game Taboo, which has been used in prior dyadic research (Tan et al., in press; West et al., 2017). To motivate participants to be engaged and pay attention to their partner, we offered a $9 bonus to incentivize them to try their best (all participants received the bonus). In this game, participants took 1-min turns trying to get their partner to guess words, without being able to use any of five "taboo" words, which are listed on their prompt cards (e.g., if the word to be guessed was "birthday," the

Figure 1
Condition Assignment and Study Timeline



Note. Participant condition was split into three levels: (1) sad actor (sadness induction); (2) sad-paired partner (neutral induction, paired with sad actor); (3) control dyad (actor and partner roles are indistinguishable and thus not meaningful within control dyads).

clue giver could not say "happy," "anniversary," "candles," "cake," or "presents"). The game lasted for 6 min, giving each participant three turns as a guesser or prompter. At the end of the game, the participants were told that their interaction was over and were moved to separate experimental rooms. Both participants were debriefed separately by their experimenters and then compensated $49 and escorted out of the laboratory.

Measures

Affective Language in the Emotion Induction

We coded the emotion induction recordings for valence and intensity. The emotion inductions were transcribed and coded using two methods: trained coders and sentiment analysis in R (Liu, 2012; Maryame et al., 2020). To ensure that participants in the sad condition did indeed recount a sad event during the emotion induction, two coders listened to the audio recordings of the emotion induction (N = 115) and coded affect. Coders were trained on practice recordings and discussed any areas of disagreement (Heyman et al., 2014). Once their interrater reliability was high, coders rated all recordings independently. We estimated interrater reliability by calculating the single-measures intraclass correlation (ICC) for each measure between coders. Based on the guidelines from Cicchetti (1994), the resulting ICCs were in the "good" range (ICC ≥ .60). This threshold is commonly used to evaluate interrater reliability in cases where the ratings involve gestalt judgments, such as tone or dominance (Hadley et al., 2013; Roels et al., 2022). Response options were on a 1 (*not at all*) to 5 (*a great deal*) scale. We refer to coders' ratings as subjective emotion ratings. Sentiment analysis is a natural language processing technique commonly used in psychological research to evaluate valence in text.

Subjective Emotion Ratings. Coders rated the perceived intensity of the emotions the participant described (e.g., bummed vs. devastated; ICC = .66) and perceived sadness (ICC = .65).

Sentiment Analysis. We also conducted a sentiment analysis in R using the Bing and AFINN dictionaries (Hu & Liu, 2004; Nielson, 2011). The Bing dictionary computes the number of valence words in each recall and the AFINN lexicon captures the emotional intensity by ranking the valence of each word (−5 extremely negative to +5 extremely positive). For the Bing dictionary ratings, we computed the total number of negative words for each participant and divided that number by the total number of words in the recall, creating a ratio score that represented the number of negative words relative to total words.

Self-Reported Affect

Affect was measured at multiple points during the study using the Positive and Negative Affect Schedule (PANAS; Watson et al., 1988). The PANAS includes 10 positive and 10 negative affect items, which participants completed after the emotion induction and getting acquainted interaction. Responses ranged from 1 (*strongly disagree*) to 5 (*strongly agree*). We then created a separate subscale representing the low-arousal negative affect items (distressed, upset, and alone), which showed sufficient reliability at each measurement (postinduction: α = .75; postinteraction: α = .68). We selected the PANAS, because it is routinely used in emotion research, although we recognize that the alpha was relatively low.

Behavioral Coding

Four coders watched videos of the getting acquainted interaction and Taboo to code gesturing and smiling during the interaction, as behavioral cues of engagement, as well as sadness (i.e., appearing withdrawn and despondent). Coders were unaware of the study hypotheses and participant condition. To ensure high reliability, coders were trained according to the guidelines of Heyman et al. (2014). Training took place over two phases. First, coders independently rated practice videos (i.e., dyads that had been excluded from the experiment). Although the video showed both dyad members, coders were instructed to first code the actor and then the partner. Coders were unaware of the "actor" and "partner" roles. Note that in the control condition, these roles were indistinguishable. For the first half of the dyads, the actor was displayed on the right side of the screen, then switched to the left side of the screen for the second half of the dyads.

Following each training video, the coders discussed any areas of disagreement. Coders then recoded these videos in pairs, discussing each rating in depth. Once the ratings were no more than 1 point apart, coders rewatched the training videos and rated the behaviors independently. Coders rated the first four dyads in pairs—first, with the same coder they had been paired with before, then with a different coder. After establishing high agreement between coders, all four coders independently rated the first 17 dyads. The coding team was then divided into two groups of two—one group of two coded the first half of the dyads and the other group coded the remaining half of the dyads. Together, 14% of the videos were rated by all four coders, 48% of the dyads were rated by the first group and the remaining 38% of the dyads were rated by the second group.

Coders rated indicators of engagement and sadness items during the getting acquainted and Taboo tasks, which were rated on a 1 (*not at all*) to 5 (*a great deal*) scale. ICCs were significant indicating acceptable interrater reliability ($p < .001$; Cicchetti, 1994; Hallgren, 2012; Thorson et al., 2019).

Gesturing. Gesturing was defined as nonrandom, expressive hand movements while talking (Coker & Burgoon, 1987). Gesturing is a form of expressivity that indicates feeling at ease and signals engagement during conversation (Harper, 1985; Tellier et al., 2013; $ICC_{acquainted} = .55$; $ICC_{taboo} = .66$).

Smiling. Coders rated how often participants smiled throughout the conversation. Smiling could indicate positive emotion or nervousness/anxiety. We originally asked coders to rate positive smiling and nervous smiling separately, but we were unable to reliably distinguish the two types of smiling. Therefore, we measured smiling as a single behavior ($ICC_{acquainted} = .62$; $ICC_{taboo} = .59$; P. Ekman & Friesen, 1969; Harper, 1985).

Sadness. Coders rated perceived sadness, which was defined as withdrawn posture, frowning, and eye contact avoidance (Kreibig et al., 2007). Because most participants did not exhibit behavioral signs of sadness during the social interactions, there was little variability and the models did not converge. Therefore, we excluded this measure from our final analyses.

Sympathetic Nervous System Reactivity

Participants' physiologic responses were obtained during baseline, emotion induction, and all tasks with the partner. We measured ECG and impedance cardiography using Biopac hardware (ECG and NICO modules) sampled at 1,000 Hz. To edit and score the data, we used Mindware software (IMP 2.6) and visually inspected the placement of all critical points on the $\Delta z/\Delta t$ waveform in 30-s segments. To determine length of the ensemble window (or epochs), we followed the recommendation of using shortest epoch length possible without compromising the signal quality (Ahonen et al., 2018; I. Ekman et al., 2012; Palumbo et al., 2017; Thorson et al., 2018). Shorter segments are more precise in capturing fluctuation, and for peripheral physiology, which responds within a few seconds, an epoch length of 30 s is considered sufficient to capture time-lagged linkage (Brown et al., 2021; Helm et al., 2018; Kraus & Mendes, 2014; Marzoratti & Evans, 2022; Thorson et al., 2019; West et al., 2017). This process yields PEP, which is the primary physiologic measure for linkage (West & Mendes, 2023).

Analysis Strategy

Variable Coding

In the analyses that precede the interaction, both the condition (control recall: −1, sad recall: 1) and gender variables (female: −1, male: 1) are effect-coded. Although the sad-paired partner and control dyad experienced the same neutral induction, interacting with a sad actor might influence responses. Thus, we needed to distinguish between sad-paired partners and control dyads for the measures that occur after the dyad is introduced. We divided participant condition into three levels: sad actor (recipient of sadness induction), sad-paired partner (partner of sad actor), and people in control dyads (both participants complete neutral induction; see Figure 1). We note that with this operationalization of the experimental variables, the "sad dyads" had distinguishable members, with one person in the sad condition and the other in the neural condition, and the control dyads had indistinguishable members, with both partners in the neutral condition.

For all analyses following the interaction, condition is represented by three separate dummy variables, each defining a different reference group: one with the control condition as the reference against sad actors and partners, another with the sad actor as the reference, and the third with the sad-paired partners as the reference. This approach allows for direct comparisons between groups when decomposing interactions. For assessing the simple effect of condition (e.g., comparing sad actors to sad-paired partners), we effect-code gender assigning female dyads −1 and male dyads 1. As such, a negative coefficient indicates a stronger effect for female dyads relative to the average gender effect, while a positive coefficient suggests the effect is stronger for male dyads. To analyze the condition by gender interaction, we dummy-code both variables to isolate the simple effects (e.g., female sad-paired partners compared to female sad actors). Given the multiple comparisons by gender and condition, all pairwise comparisons used a Holm correction (Eichstaedt et al., 2013).

Self-Report and Linguistic Analyses

Self-report measures were taken at two time points: after the emotion induction (before meeting their partner) and after the getting acquainted interaction. Given prior work suggesting that men and women may respond to sadness inductions differently, we tested whether the effect of condition (sad induction/neutral induction) was moderated by gender. All analyses of the emotion induction (i.e., subjective coding and sentiment analysis) and the self-report measures taken prior to the interaction were analyzed using a 2 × 2 analysis of variance, while self-report measures that followed the interaction were analyzed with multilevel modeling

$$Y_{ijt} = \gamma_{00} + \gamma_{10}(\text{Condition}_{ij}) + \gamma_{01}(\text{Gender}_j) + \gamma_{11}(\text{Gender}_j)(\text{Condition}_{ij}) + u_{1j}(\text{Condition}_{ij}) + u_{0j} + e_{ijt}. \quad (4)$$

(MLM). We used MLM for self-reported affect taken after they met their partner to account for the nonindependence of the dyads' responses (Kenny et al., 2006).

Behavior

Behavior was measured at two time points—during the getting acquainted interaction and Taboo. We used a two-level crossed model with MIXED function from SPSS v29 to account for the interdependence within the dyad, allowing for correlated variances between each person's behavior across time points, as seen in (West, 2013). This approach treats participants as nested within dyad, and given that dyad members completed the same tasks at the same time, the behaviors are crossed (see Figure 2). The model accounts for both the correlation of each person's behavior over time (e.g., sad actor at Time 1 and Time 2) and between dyad members within the same time point (e.g., sad actor at Time 1 and sad-paired partner at Time 1). We then created an ID that linked responses within-person and between dyad members (see West, 2013). This ID variable is then entered in the REPEATED statement in SPSS to ensure that the residual structure accounts for the nonindependence between these observations (see Equations 1–4; Table 1).

Level 1

$$Y_{ijt} = \beta_{0j} + \beta_{1j}(\text{Condition}_{ij}) + e_{ijt}, \quad (1)$$

Level 2

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{Gender}_j) + u_{0j}, \quad (2)$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11}(\text{Gender}_j) + u_{1j}. \quad (3)$$

Combined model

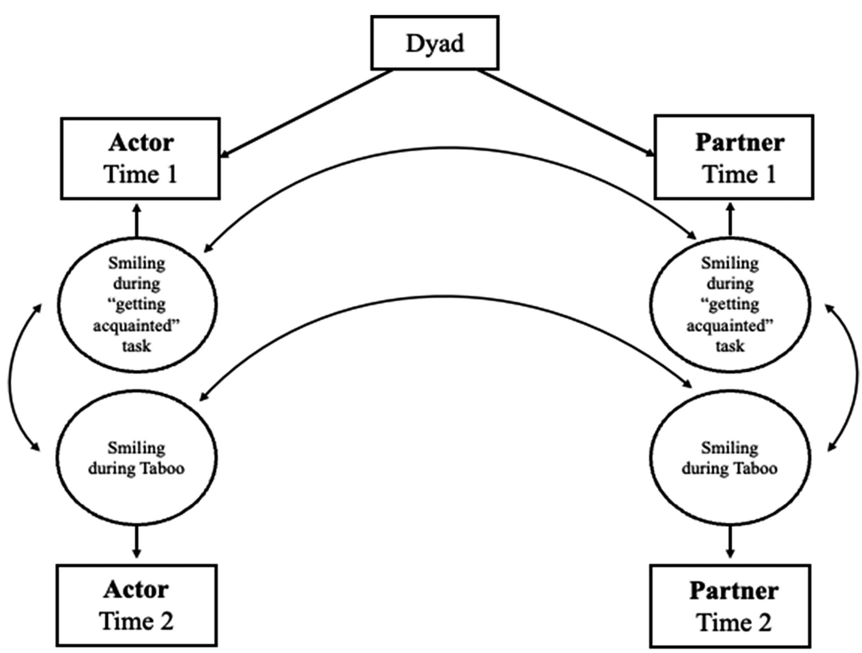
(see Equation 4 above)

Physiologic Reactivity

Physiologic reactivity scores were obtained by subtracting PEP during the task from PEP during the last minute of baseline, such that negative values (shortening of the time from the ventricle contracting to the aortic valve opening) indicate greater reactivity. Reactivity was measured at two time points: during the emotion induction and across the interactions. We first analyzed reactivity during the emotion induction, testing the effect of participant condition and gender on reactivity over time using MLM to account for the repeated measurements of reactivity within person. Note that condition was treated as a two-level variable (sadness vs. neutral induction), because participants had not yet been paired into dyads, and thus we did not need to account for the nonindependence of the dyad. For the interactions, we ran an MLM that did account for the nonindependence of the dyad, treated condition as a three-level

Figure 2

Conceptual Visualization of the Two-Level Crossed Model



Note. This model links the within-person responses together (i.e., Participant 1 at Time 1 and Time 2) as well as the within-dyad responses at each time point (e.g., Participant 1 and Participant 2 at Time 1).

Table 1
Terms for Equations 1–4

Term	Description
Condition_{ij}	Condition of person i in dyad j
Gender_j	Gender of dyad j
Y_{ijt}	Smiling for person i in dyad j at time t
β_{0j}	Intercept representing the average smiling for dyad j
β_{1j}	Slope for the effect of condition on smiling for dyad j
e_{ijt}	Residual error for person i in dyad j at time t
γ_{00}	Intercept for average smiling across dyads
γ_{01}	Slope for gender across dyads
γ_{10}	Slope for condition across dyads
γ_{11}	Interaction slope for Gender × Condition
u_{0j}	Deviation for dyad j from the overall intercept
u_{1j}	Deviation of the slope for condition from the overall average slope for dyad j

Note. These equations represent the two-level crossed model. The behavioral outcome *smiling* is used as an example, but the same equations apply to analysis for *gesturing*.

variable (sad actor, sad-paired partner, and control dyad), and tested whether reactivity was moderated by task (getting acquainted vs. Taboo).

Physiologic Linkage

Physiologic linkage was estimated using the stability and influence model, which assesses a person's physiologic response, accounting for the influence of their own physiology and their partner's physiology at a prior time point (see Equations 5–11; Tables 2 and 3; Kashy & Kenny, 2000). PEP was measured in 30-s bins with a one-bin lag, examining an individual's physiology as predicted by their own physiology at a prior time point (stability) and their partner's physiology at a prior time point (influence). By adjusting for each dyad member's own stability, which is often the strongest predictor of reactivity, the model provided a conservative estimate of their partner's influence or physiologic linkage (Thorson et al., 2018). The dyads were treated as indistinguishable, meaning that the error variances for the two dyad members were the same (Kenny et al., 2006). Because these data were measured over time, and the time points for each dyad member were the same, we used a two-level crossed model.

Level 1

(see Equation 5 below)

Level 2

$$\beta_{0j} = \gamma_{00} + \gamma_{01}(\text{Gender}_j) + u_{0j}, \tag{6}$$

$$\beta_{1j} = \gamma_{10} + \gamma_{11}(\text{Gender}_j) + u_{1j}, \tag{7}$$

$$\beta_{2j} = \gamma_{20} + \gamma_{21}(\text{Gender}_j) + u_{2j}. \tag{8}$$

$$\beta_{3j} = \gamma_{30} + \gamma_{31}(\text{Gender}_j) + u_{3j}, \tag{9}$$

$$\beta_{4j} = \gamma_{40} + \gamma_{41}(\text{Gender}_j) + u_{4j}, \tag{10}$$

$$\beta_{5j} = \gamma_{50} + \gamma_{51}(\text{Gender}_j) + u_{5j}. \tag{11}$$

Transparency and Openness

We report all manipulations, sample size justification, measures, and exclusions in this study. All data and analysis code for this study are publicly available at https://osf.io/es2ug/?view_only=125797f18ac64a28ad602df2ca01a9a6. Data were analyzed using R Version 4.2.2 (R Core Team, 2022), SPSS v29, and SAS 9.4. This study's design and analysis were not preregistered.

Results

Emotion Induction

Subjective Coding of Emotional Intensity

A main effect of condition was found indicating that sad actors' responses ($M = 2.89$, $SD = 0.92$) were perceived as more emotionally intense than control participants ($M = 1.06$, $SD = 0.19$), F (1, 109) = 187.12, $p < .001$, $\eta_p^2 = .65$. There was no effect of gender suggesting that the emotional intensity of women's recalls ($M = 2.22$, $SD = 1.23$) was similar to men's recalls ($M = 1.72$, $SD = 0.94$), $F(1, 109) = 2.40$, $p = .124$, $\eta_p^2 = .02$. There was not a significant Condition × Gender interaction, suggesting that within sad actors, women's recalls were not more emotionally intense ($M = 3.03$, $SD = 0.97$) than men's recalls ($M = 2.63$, $SD = 0.78$), $F(1, 109) = 2.40$, $p = .124$, $\eta_p^2 = .02$.

Examining ratings of sadness, coders rated sad actors as more sad ($M = 3.36$, $SD = 0.87$) than controls ($M = 1.04$, $SD = 0.21$), $F(1, 109) = 335.29$, $p < .001$, $\eta_p^2 = .76$. We did not find a main effect of gender on perceived sadness, indicating that men ($M = 1.99$, $SD = 1.27$) and women ($M = 2.44$, $SD = 1.36$) were perceived as similarly sad, $F(1, 109) = 0.93$, $p = .338$, $\eta_p^2 = .003$. There was not a significant Condition × Gender interaction on perceived sadness, indicating that for sad actors, women's recalls were rated as similarly sad ($M = 3.42$, $SD = 0.85$) to men's recalls ($M = 3.25$, $SD = 0.92$), $F(1, 109) = 0.70$, $p = .405$, $\eta_p^2 = .006$. Overall, sad actors' recalls were perceived as more emotionally intense and sadder than control participants' neutral recalls, and this effect did not vary by gender.

Sentiment Analysis

Using the Bing dictionary, we found a main effect of condition on the proportion of negative words used, indicating that participants in the sad condition used more negative words ($M = 0.14$, $SD = 0.06$) relative to those in the control condition ($M = 0.04$, $SD = 0.03$), $b = 0.11$, $SE = .01$, $t(101) = 8.86$, 95% CI [0.09, 0.14], $p < .001$, $R_\beta^2 = .66$. The number of negative words in the recalls did not vary as a function of gender, suggesting that men ($M = 0.07$, $SD = 0.06$) and women ($M = 0.11$, $SD = 0.08$) used a similar number of negative

$$\begin{aligned} Y_{ijt} = {} & \beta_{0j} + \beta_{1j}(\text{Stability}_{ij(t-k)}) + \beta_{2j}(\text{Influence}_{mj(t-k)}) + \beta_{3j}(\text{Condition}_{ij}) \\ & + \beta_{4j}(\text{Condition}_{ij} \times \text{Stability}_{ij(t-k)}) + \beta_{5j}(\text{Condition}_{ij} \times \text{Influence}_{mj(t-k)}) + e_{ijt}. \end{aligned} \tag{5}$$

Table 2
Terms for Equation 5

Term	Description
Y_{ijt}	Physiologic reactivity for person i in dyad j at time t
β_{0j}	Average reactivity within dyad j
β_{1j}	Slope for stability within dyad j
Stability$ij(t-k)$	Stability value for person i in dyad j at $t-k$, where $k=1$
β_{2j}	Slope for influence within dyad j
$\text{Influence}_{mj(t-k)}$	Influence value for person m in dyad j at $t-k$, where $k=1$
β_{3j}	Slope for condition within dyad j
Condition_{ij}	Condition of person i in dyad j
β_{4j}	Interaction slope for Condition × Stability in dyad j
$\text{Condition}_{ij} \times \text{Stability}_{ij(t-k)}$	Interaction value for Condition of Person i × Stability for Person i in dyad j
β_{5j}	Interaction slope for Condition × Influence in dyad j
$\text{Condition}_{ij} \times \text{Influence}_{mj(t-k)}$	Interaction value for Condition of Person i × Influence of Person m in dyad j
e_{ijt}	Residual error for person i in dyad j at time t

words, $b = 0.003$, $SE = .01$, $t(101) = 0.19$, 95% CI [−0.24, 0.03], $p = .853$, $R^2_\beta = .02$. Furthermore, we did not observe a Condition × Gender interaction, indicating that the difference in the number of negative words between men and women in the sad condition was not statistically significant, $b = -0.02$, $SE = .02$, $t(101) = -1.181$, 95% CI [−0.06, 0.02], $p = .240$, $R^2_\beta = .12$.

Next, we analyzed the recalls using the AFINN dictionary to determine whether sad actors' recalls contained more negatively valenced words relative to the control recalls on a −5 (very negative) to +5 (very positive) point scale. In contrast to the Bing dictionary, AFINN assigns valence scores to each word and captures the intensity of the negative or positive valence. There was an effect of condition on valence, such that participants in the sad condition used language that was rated as more negative ($M = -15.38$, $SD = 18.02$) than those in the control condition ($M = -.64$, $SD = 7.66$), $b = -17.54$, $SE = 3.71$, 95% CI [−24.91, −10.18], $SE = 3.71$, $t(101) = -4.73$, $p < .001$, $R^2_\beta = .43$. Men ($M = -5.23$, $SD = 10.86$) and women's recalls ($M = -10.62$, $SD = 18.39$) were similarly valenced, $b = -1.75$, $SE = 3.99$, 95% CI [−9.66, 6.16], $SE = 3.99$, $t(101) = -.44$, $p = .662$, $R^2_\beta = .04$. We also did not find a significant Condition × Gender interaction, suggesting that men and women in the sad condition showed similar affective intensity, $b = 7.75$, $SE = 5.72$, 95% CI [−3.60, 19.10], $SE = 5.72$, $t(101) = 1.36$, $p = .178$, $R^2_\beta = .13$.

Across distinct but conceptually related approaches, the sad condition resulted in more observer-rated sadness and greater sadness language compared to the control condition. Furthermore, we did not find an overall effect of gender on sentiment. To ensure that the nonsignificant gender and interaction effects were not due to insufficient power, we conducted equivalence tests following the two one-sided t tests method (Lakens et al., 2018). All equivalence tests were significant, indicating that differences in sentiment between men and women, including gender differences across conditions, were negligible (see additional online material for analyses at https://osf.io/ptker?view_only=125797f18ac64a28ad602df2ca01a9a6). In sum, we observed significant differences in sentiment across conditions, and men and women's recalls were similarly valenced.

Table 3
Terms for Equations 6–11

Term	Description
γ_{00}	Overall intercept for reactivity scores across all dyads
γ_{01}	Average slope for gender
Gender_j	Gender of dyad j
u_{0j}	Deviation for dyad j from the overall intercept
γ_{10}	Average slope for stability
γ_{11}	Average interaction slope for Gender × Stability
u_{1j}	Deviation for dyad j from the average slope for stability
γ_{20}	Average slope for influence
γ_{21}	Average interaction slope for Gender × Influence
u_{2j}	Deviation for dyad j from the average slope for influence
γ_{30}	Average slope for condition
γ_{31}	Average interaction slope for Gender × Condition
u_{3j}	Deviation for dyad j from the average slope for condition
γ_{40}	Average interaction slope for Condition × Stability
γ_{41}	Average three-way interaction slope for Condition × Stability × Gender
u_{4j}	Deviation for dyad j from the average interaction slope for Condition × Stability
γ_{50}	Average interaction slope for Condition × Influence
γ_{51}	Average three-way interaction slope for Condition × Influence × Gender
u_{5j}	Deviation for dyad j from the average interaction slope for Condition × Influence

Note. These equations represent the stability and influence model for the physiologic linkage analyses.

Physiologic Reactivity During the Emotion Induction

We tested whether participants who recalled a sad event in the emotion induction showed differences in physiologic reactivity relative to those who recalled a neutral event. Consistent with a meta-analysis on emotion and physiologic reactivity (Siegel et al., 2018), we did not observe a statistically significant difference between participants in the sad condition ($M = -5.91$, $SD = 9.23$) compared to those in the neutral condition ($M = -4.94$, $SD = 9.10$), $F(1, 197.839) = .05$, $p = .833$, $R^2_\beta < .001$. We did not find a main effect of gender, indicating that there was no evidence of a significant difference in PEP reactivity between men ($M = -4.39$, $SD = 9.93$) and women ($M = -5.74$, $SD = 8.55$) during the recall, $F(1, 197.839) = 1.76$, $p = .186$, $R^2_\beta = .009$. We also did not find a significant Condition × Gender interaction, $F(1, 197.839) = 2.74$, $p = .100$, $R^2_\beta = .01$. Equivalence tests were significant, suggesting that differences between groups were negligible (see online Supplemental Material).

Self-Reported Negative Affect Following the Emotion Induction

Sad actors reported greater negative affect following the induction ($M = 2.19$, $SD = 0.99$) compared to participants in the control condition ($M = 1.47$, $SD = 0.68$), $F(1, 220) = 27.94$, $p < .001$, $\eta^2_p = .14$. There was not a significant main effect of gender, but overall women directionally reported higher negative affect ($M = 1.71$, $SD = 0.89$) than men ($M = 1.57$, $SD = 0.73$), $F(1, 220) = 3.75$, $p = .054$, $\eta^2_p = .003$. A Condition × Gender interaction emerged, $F(1, 220) = 5.60$, $p = .019$, $\eta^2_p = .02$, indicating that for female dyads, the difference in negative affect between female sad actors ($M = 2.36$, $SD = 1.00$) and female control participants ($M = 1.44$, $SD = 0.68$) was significant, $b = .924$, $SE = .15$, $t(220) = 6.25$, 95% CI [0.63, 1.22], $p < .001$, $\eta^2_p = .15$. However, for male dyads, the difference between male sad actors ($M = 1.85$, $SD = 0.89$) and male controls ($M = 1.50$, $SD = 0.67$), was not significant, $b = .35$, $SE = 0.19$, $t(220) = 1.84$, 95% CI [−0.02, 0.73], $p = .066$, $\eta^2_p = .02$. When comparing men and women, women in the sad condition reported greater negative affect compared to men in the sad condition, $b = .52$, $SE = 0.21$, $t(220) = 2.47$, 95% CI [0.10, 0.93], $p = .014$, $\eta^2_p = .03$. There was not a significant difference in negative affect between men and women in the control condition, $b = -.05$, $SE = .12$, $t(220) = -0.44$, 95% CI [−0.29, 0.18], $p = .659$, $\eta^2_p = .001$. An equivalence test confirmed this result, indicating that negative affect levels were similar between men and women $p = .012$. In short, women in the sad condition reported significantly greater negative affect relative to women in the control condition whereas the difference between men in the sad condition and control condition did not yield a large difference. It should be noted that negative affect ratings were relatively low across all participants.

Although participants who recalled a sad event exhibited similar physiologic reactivity to participants who recalled a neutral event, the sentiment analysis, subjective coding, and self-report show that sad actors convey and report greater negative affect following the emotion induction relative to those who recalled a neutral event. To test whether negative affect carried over into a social interaction, we examined actors' and partners' self-reported negative affect, behavior, and physiologic linkage during the dyadic interaction.

Dyadic Interaction

Self-Reported Affect Following the Interaction

After the getting acquainted interaction, we obtained PANAS ratings from both the actors and partners. We did not find a main effect of condition on negative affect, indicating that sad actors ($M = 1.15$, $SD = 0.30$), sad-paired partners ($M = 1.20$, $SD = 0.39$), and control dyads ($M = 1.22$, $SD = 0.50$) did not differ in negative affect, $F(2, 139.62) = 0.281$, $p = .756$, $R^2_\beta = .004$. There was not a significant difference in negative affect between men ($M = 1.26$, $SD = 0.53$) and women ($M = 1.14$, $SD = 0.32$), $F(1, 110.94) = 3.334$, $p = .071$, $R^2_\beta = .03$. We did not find a significant Condition × Gender interaction, suggesting that the effect of participant condition on negative affect following the interaction did not vary by gender, $F(2, 139.62) = 0.003$, $p = .997$, $R^2_\beta < .001$. To interpret the nonsignificant findings, we conducted equivalence tests, which confirmed that the differences in negative affect between condition and gender was negligible, ps < .001. These findings suggest that condition and gender did not generate significant differences in self-reported affect, and overall, negative affect was low for all participants.

Behaviors

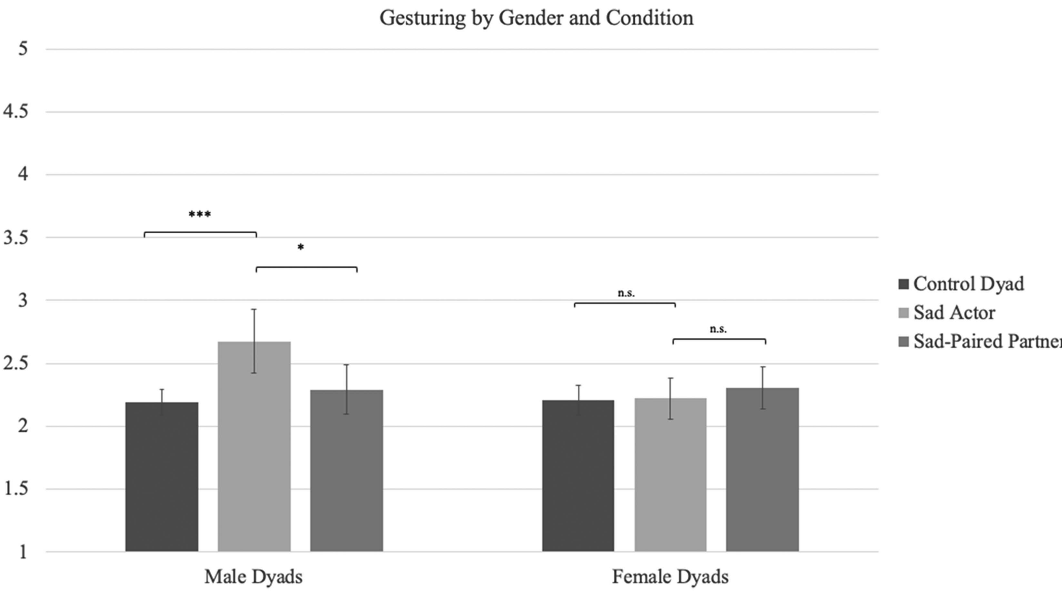
Gesturing

Gesturing—nonrandom, expressive hand movements during conversation—was used as a measure of engagement in the interaction. We used a two-level crossed model, where we tested the effect of condition on gesturing in the getting acquainted interaction and Taboo by treating "gesturing" as a repeated measure and included gender as a moderator.

There was a main effect of condition indicating that sad actors ($M = 2.36$, $SD = .54$), sad-paired partners ($M = 2.31$, $SD = .52$), and control dyads ($M = 2.21$, $SD = .50$) showed differences in gesturing during the dyadic interactions, $F(2, 157.85) = 3.88$, $p = .023$, $R^2_\beta = .05$. Overall, sad actors gestured more than control dyads, $b = 0.247$, $SE = 0.089$, $t(169.518) = 2.774$, 95% CI [0.032, 0.461], $p = .019$, $R^2_\beta = .21$, but there was no significant difference in gesturing between sad actors and sad-paired partners, $b = .149$, $SE = 0.092$, $t(478.286) = 1.618$, 95% CI [−0.073, 0.371], $p = .213$, $R^2_\beta = .007$. We also did not find a significant difference in gesturing between sad-paired partners and control dyads, $b = 0.097$, $SE = 0.090$, $t(173.756) = 1.083$, 95% CI [−0.120, 0.314], $p = .280$, $R^2_\beta = .08$. The main effect of gender was not significant, $F(1, 95.84) = 2.72$, $p = .103$, $R^2_\beta = .03$, but there was a significant Condition × Gender interaction, $F(2, 157.85) = 4.43$, $p = .013$, $R^2_\beta = .03$ (Figure 3). For female dyads, there was no statistically significant difference in gesturing between female sad actors ($M = 2.22$, $SD = .08$) and female sad-paired partners ($M = 2.31$, $SD = .08$), $b = 0.08$, $SE = 0.10$, $t(474.16) = 0.82$, 95% CI [−0.164, 0.332], $p = 1.00$, $R^2_\beta = .04$ or control dyads ($M = 2.21$, $SD = .07$), $b = -0.01$, $SE = 0.11$, $t(154.45) = -0.11$, 95% CI [−0.275, 0.251], $p = 1.00$, $R^2_\beta = .009$. The findings did not reveal a significant difference in gesturing between female sad-paired partners and female control dyads, $b = 0.096$, $SE = 0.11$, $t(154.47) = 0.89$, 95% CI [−0.167, 0.360], $p = 1.00$, $R^2_\beta = .07$. In contrast, male sad actors ($M = 2.67$, $SD = .12$) gestured more often during the interactions compared to male sad-paired partners ($M = 2.29$, $SD = .12$), $b = .38$, $SE = 0.15$, $t(480.09) = 2.50$, 95% CI [0.015, 0.751], $p = .025$, $R^2_\beta = .11$, and male control

Figure 3

Ratings of Across the Getting Acquainted Interaction and Taboo by Condition and Gender



Note. n.s. = not significant.
$^{*}p < .05$. $^{***}p < .001$.

dyads (M = 2.19, SD = .07), b = .48, SE = 0.14, t(179.41) = 3.42, 95% CI [0.141, 0.821], p = .002, R^2_β = .25. We did not find a significant difference in gesturing between male sad-paired partners and men in control dyads, b = .098, SE = 0.14, t(186.366) = .686, 95% CI [−0.247, 0.443], p = .494, R^2_β = .05. Male sad actors also gestured more than female sad actors, b = .45, SE = 0.15, t(233.83) = 3.07, 95% CI [0.161, 0.739], p = .002, R^2_β = .20. There was no significant difference in gesturing between male sad-paired partners and female sad-paired partners, b = .017, SE = 0.15, t(240.793) = .115, 95% CI [−0.276, 0.310], p = .908, R^2_β = .007, nor did we find a statistically significant difference between male control dyads and female control dyads, b = .019, SE = 0.101, t(93.694) = .185, 95% CI [−0.181, 0.218], p = .854, R^2_β = .02.

Smiling

There was no significant main effect of condition on smiling, F(2, 157.75) = 0.50, p = .605, R^2_β = .006. There was a main effect of gender, indicating that women smiled more (M = 2.68, SD = 0.06) than men (M = 2.35, SD = 0.09), F(1, 95.33) = 9.82, p = .002, R^2_β = .17. There was also a significant Condition × Gender interaction, F(2, 157.75) = 5.55, p = .005, R^2_β = .07 (Figure 4). Female sad actors smiled marginally less often (M = 2.59, SD = .09) than female sad-paired partners (M = 2.73, SD = 0.09), b = −.15, SE = 0.06, t(475.19) = −2.35, 95% CI [−0.297, 0.003], p = .057, R^2_β = .11, but female sad actors smiled as often as female control dyads (M = 2.72, SD = 0.09), b = −.13, SE = 0.13, t(108.45) = −1.04, 95% CI [−0.1437, 0.175], p = .601, R^2_β = .009. There was no difference in smiling between female sad-paired partners and female control dyads, b = .016, SE = 0.126, t(108.045) = .126, 95% CI [−0.290, 0.322], p = .900, R^2_β = .01. For male dyads, sad actors smiled more often (M = 2.43, SD = 0.13) than male sad-paired partners (M = 2.21, SD = 0.13), b = .22, SE = .09, t(475.19) = 2.42, 95% CI [−0.40, −0.04], p = .048, R^2_β = .11. There was no difference in smiling between male sad actors and control dyads (M = 2.40, SD = 0.10), b = .02, SE = .16, t(113.10) = .15, 95% CI [−0.361, 0.407], p = .884, R^2_β = .01, nor was there a difference in smiling between sad-paired partners and control dyads, b = .198, SE = .158, t(113.064) = 1.253, 95% CI [−0.581, 0.186], p = .426, R^2_β = .12. When comparing sad actors, men and women showed a similar amount of smiling, b = .16, SE = .16, t(124.23) = 1.02, 95% CI [−0.15, 0.47], p = .311, R^2_β = .07, but when comparing sad-paired partners, women smiled more than men, b = .53, SE = .16, t(124.23)= 3.38, 95% CI [0.22, 0.83], p = .001, R^2_β = .29. Women in the control condition also smiled more than male control dyads, b = .313, SE = .128, t(94.976) = 2.435, 95% CI [0.058, 0.567], p = .017, R^2_β = .24.

Together, these results suggest that male and female sad actors behaved differently in the interaction. Sad men smiled and gestured more often relative to control dyads, whereas sad women smiled less compared to their partners. We did not find a difference in gesturing within female dyads. Most equivalence tests were indeed significant, indicating that for these null findings, groups showed similar levels of gesturing and smiling. However, the difference in smiling between male sad-paired partners and male control dyads did not reach significance, p = .101. As such, we cannot conclude that these two groups are equivalent in smiling behavior (see online Supplemental Material for comparisons).

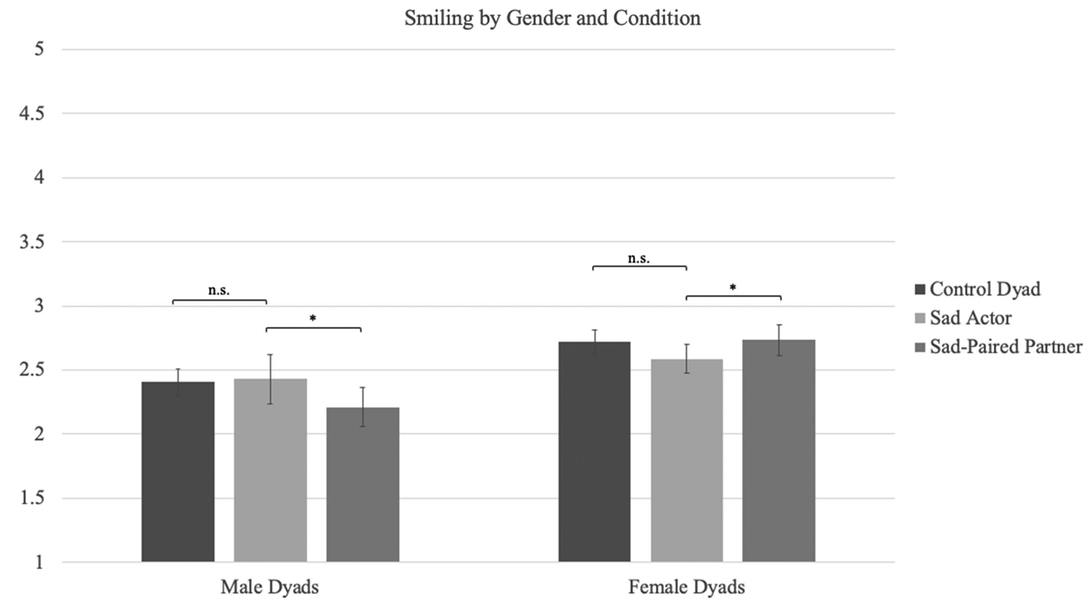
Physiologic Responses

Reactivity During the Interaction

PEP reactivity did not vary by condition, F(2, 157) = 0.44, p = .643, R^2_β = .006, or gender, F(1, 105) = 0.57, p = .452, R^2_β = .004. There was also not a significant Condition × Gender interaction, F(2, 157) = 1.17, p = .312, R^2_β = .01. There was a main effect of

Figure 4

Ratings of Smiling Across the Getting Acquainted Interaction and Taboo by Condition and Gender



Note. n.s. = not significant.
$^*p < .05$.

task on reactivity, indicating that participants exhibited greater PEP reactivity during Taboo ($M = -6.96$, $SE = .20$) relative to the getting acquainted interaction ($M = -4.37$, $SE = .173$), $F(1, 2906) = 478.54$, $p < .001$, $R^2_\beta = .14$.

Physiologic Linkage

We found a main effect of respondent prior PEP on respondent current PEP, indicating that participants were stable from one moment to the next, $F(1, 186) = 721.87$, $p < .001$, $R^2_\beta = .80$. In addition, a main effect of lagged partner PEP was found, indicating that overall, participants showed positive physiologic linkage to their partners, $F(1, 164) = 27.34$, $p < .001$, $R^2_\beta = .14$. We did not find a significant two-way lagged partner PEP × Condition interaction, suggesting that physiologic influence was similar across all conditions, $F(2, 158) = 0.46$, $p = .635$, $R^2_\beta = .005$. The effect of lagged partner PEP, however, was qualified by a two-way lagged partner PEP × Gender interaction, suggesting that male and female dyads showed differences in physiologic linkage, $F(1, 164) = 6.18$, $p = .014$, $R^2_\beta = .04$. Moreover, there was a three-way lagged partner PEP × Gender × Condition interaction, $F(2, 158) = 3.68$, $p = .027$, $R^2_\beta = .04$. The significant three-way interaction indicates that physiologic linkage, or the effect of partners' prior PEP on the participants' PEP, varied by condition and gender. Below, we decompose the three-way interaction, first looking at male dyads.

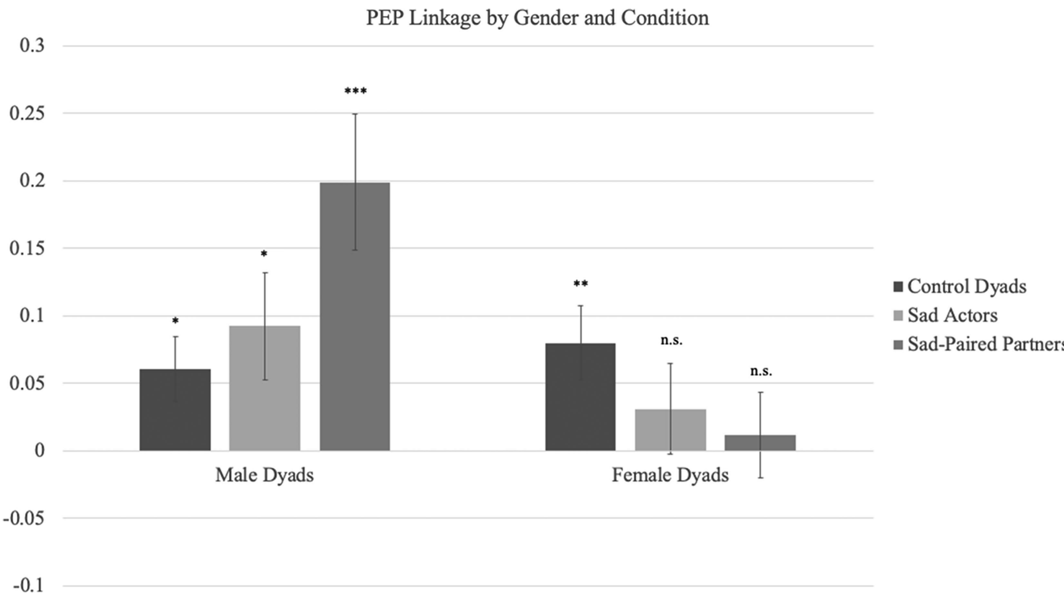
Male Dyads

For male dyads, the two-way lagged partner PEP × Condition interaction was significant, suggesting that male dyads showed different levels of linkage by condition, $F(2, 152) = 3.08$, $p = .049$, $R^2_\beta = .04$. Linkage was positive and significantly different from zero for all three groups, including sad actors, $b = .09$, 95% CI [0.01, 0.17], $SE = .04$, $t(88.4) = 2.31$, $p = .023$, $R^2_\beta = .24$, sad-paired partners, $b = .20$, 95% CI [.10, .30], $SE = .05$, $t(384) = 3.96$, $p < .001$, $R^2_\beta = .20$, and dyad members in the control condition, $b = .06$, 95% CI [.01, .11], $SE = .02$, $t(102) = 2.49$, $p = .014$, $R^2_\beta = .24$. Linkage was not significantly stronger for sad-paired partners compared to sad actors, $b = .11$, 95% CI [−0.24, 0.02], $SE = .06$, $t(195) = -1.67$, $p = .097$, $R^2_\beta = .12$, but was significantly stronger for sad-paired partners compared to dyad members in the control condition, $b = -.14$, 95% CI [0.03, 0.25], $SE = .06$, $t(278) = -2.48$, $p = .014$, $R^2_\beta = .15$. Sad actors were not significantly different from control dyads, $b = -.03$, 95% CI [−0.12, 0.06], $SE = .05$, $t(91.7) = -0.67$, $p = .502$, $R^2_\beta = .07$. The effect of linkage in male sad dyads was primarily driven by sad-paired partners, who exhibited strong positive linkage to sad actors. In other words, sad actors' physiologic responses influenced their partners' physiologic responses in the next time period (Figure 5).

Female Dyads

For female dyads, the two-way lagged partner PEP × Condition interaction was not significant, indicating that linkage within female dyads did not differ by condition, $F(2, 144) = 1.55$, $p = .216$, $R^2_\beta = .02$. Control dyads were the only group that demonstrated positive, significant linkage, $b = .08$, 95% CI [.03, .13], $SE = .03$, $t(179) = 2.91$, $p = .004$, $R^2_\beta = .21$. For sad actors, linkage was not significant, $b = .03$, 95% CI [−.03, .10], $SE = .03$, $t(136) = .920$, $p = .360$, $R^2_\beta = .08$. For sad-paired partners, linkage was also not different from 0, $b = .01$, 95% CI [.07, −.05], $SE = .03$, $t(128) = .370$, $p = .712$, $R^2_\beta = .03$. Therefore, only control dyads showed positive linkage (see Figure 5).

Figure 5
Means of Physiologic Linkage for Male and Female Dyads by Condition



Note. Greater scores indicate greater physiologic linkage toward their interaction partner. PEP = preejection period; n.s. = not significant.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Post Hoc Analyses

We found that within sad male dyads, male sad actors appeared engaged during the interaction (e.g., smiling and gesturing), and sad-paired partners were physiologically linked to them. In contrast, female sad dyads did not show these signs of engagement, nor were they linked to their partners. To better understand these behavioral and physiologic patterns, we conducted two exploratory analyses. First, we tested whether gesturing and smiling predicted PEP linkage. We posit that certain social behaviors signal engagement and might play a key role in helping dyad members attune to their partners. Second, we explored parasympathetic responses by testing whether dyads exhibited RSA linkage. RSA can be useful for assessing social cue sensitivity. Increases in RSA are associated with social responsiveness, or a heightened awareness of social cues, such as changes in facial expressions (Fabes et al., 1993; Human & Mendes, 2018; Muhtadie et al., 2015; Park et al., 2013). Using RSA as a measure of social responsiveness and attunement, we assessed whether RSA linkage varied as a function of condition and gender.

Behavior and Idiographic Linkage

To test whether these behaviors are indeed associated with physiologic linkage, we examined whether one dyad member's behaviors (smiling and gesturing) predicted their partner's linkage to them during the interaction. Given that behavior was measured at two time points (getting acquainted interaction and Taboo) and physiologic linkage was measured continuously throughout each interaction, we computed idiographic linkage scores for each dyad member that represented the average linkage in each interaction. This process leaves each person with one linkage score per task representing how strongly one person's PEP reactivity at Time 1 predicted their partner's reactivity at Time 2. We then used the MIXED command (SPSS ×29) to examine whether one person's degree of gesturing and smiling predicted how much their partner was linked to them. We found that gesturing was not significantly associated with partner linkage, $b = .02$, 95% CI [−0.08, 0.12], $SE = 0.05$, $t(329.09) = 0.324$, $p = .746$, $R^2_\beta = .02$, while there was a marginal association between smiling and partner linkage, $b = .11$, 95% CI [−0.002, 0.22], $SE = 0.06$, $t(173.08) = 1.95$, $p = .053$, $R^2_\beta = .15$.

Nonetheless, because we converted linkage into an averaged idiographic score for these analyses, we were only able to test whether linkage and behavior were correlated. In order to make meaningful comparisons, we had to convert both measures into person-level scores resulting in four scores: behavior (1) and linkage (2) during the getting acquainted interaction and behavior (3) and linkage (4) during Taboo. Therefore, it is important to exercise caution when interpreting these results.

RSA Linkage

In a secondary analysis, we tested whether dyad members' RSA responses were synchronized. We found a main effect of respondent prior RSA on respondent current RSA, indicating that participants were stable from one moment to the next, $F(1, 174) = 7.88$, $p = .006$, $R^2_\beta = .04$. We did not observe a main effect of lagged partner RSA, indicating that overall, participants were not physiologically linked to their partners, $F(1, 160) = 0.03$, $p = .868$, $R^2_\beta = .0001$. There was also not a significant main effect of gender, $F(1, 104) = .01$, $p = .914$, $R^2_\beta < .001$. We did not observe a three-way interaction between partner's prior RSA, condition, and gender $F(2, 161) = 1.51$, $p = .225$, $R^2_\beta = .02$. However, we did find an effect of condition and partner's prior RSA on RSA responses, indicating that RSA linkage varied by condition, $F(2, 160) = 4.96$, $p = .008$, $R^2_\beta = .06$.

For sad actors, we observed negative (or antiphase) linkage, where decreases in their partner's RSA predicted increases in their own RSA (or increases in their partner's RSA predicted decreases in their own RSA), $b = -0.068$, $t(124) = -2.44$, $p = .016$, $R^2_\beta = .21$. Conversely, sad-paired partners exhibited positive (or in-phase) linkage, where their partner's RSA in one moment predicted their own RSA in the next, $b = 0.060$, $t(183) = 2.02$, $p = .045$, $R^2_\beta = .15$. These findings suggest that, regardless of gender, sad-paired partners were more attuned to their partners whereas sad actors were less attuned. We did not observe RSA linkage in control dyads, $b = 0.004$, $t(207) = .19$, $p = .847$, $R^2_\beta = .01$.

Altogether, these RSA findings suggest that sad-paired partners—regardless of gender—may be responsive to social cues, picking up on their partner's affective states, while sad actors are not as attuned. Integrating these findings with our PEP analyses, we speculate that RSA linkage indicates that sad-paired partners are attuned to their partners, but the way sad actors engage in a motivated cooperative task differs by gender. Male sad actors are motivated to coordinate with their partner (as indicated by PEP), which in turn draws their partner to want to coordinate back. Sad female actors, on the other hand, might not share this motivation to coordinate and instead withdraw, prompting sad-paired partners to also withdraw.

It is important to note, however, that because our primary interest was in PEP, all physiologic data, including RSA, were scored in 30-s epochs. While 30-s epochs are optimal for PEP (Ahonen et al., 2018; I. Ekman et al., 2012; Palumbo et al., 2017; Thorson et al., 2018), shorter epochs may compromise the reliability of RSA and 1-min epochs are more reliable and preferred (Berntson et al., 1997; Weissman & Mendes, 2021). Moreover, given that these analyses were exploratory, we caution against overinterpreting these findings.

Discussion

The aim of this study was to investigate whether sadness carries over into a subsequent social interaction with a new acquaintance and explore whether gender plays a role. Our results suggest that the sadness induction did impact behavior and physiology, with this effect varying by gender—sadness-induced men exhibited increased gesturing and smiling during the interaction, signaling higher engagement than their partners. In contrast, sadness-induced women smiled less relative to their partners, signaling disengagement from the interaction, but smiled as often as control dyads. These gender-specific behavioral responses highlight contrasting effects of sadness on social interactions. Meanwhile, there was no difference in gesturing or smiling when comparing sad-paired partners and control dyads for either women or men. Within male dyads, sad-paired partners demonstrated stronger physiologic linkage to sad actors than dyads in the control condition. In female dyads, however, neither sad-paired partners nor sad actors exhibited physiologic linkage, whereas female control dyads did show such linkage. These findings suggest that men may have compensated for their sadness by employing overt behavioral cues of engagement, whereas women seemed to withdraw from the interaction.

Although we observed gender differences in behavior and physiology, trained coders and sentiment analysis revealed that men and women expressed similar levels of sadness and emotional intensity during the emotion induction. Women did not recall more emotional experiences than men, yet their behavior and physiologic responses were different during the interaction. This pattern of findings suggests that these gender differences are not a result of differences in the manipulation, but rather, differences in how men and women behaved during the dyadic encounter. Furthermore, we did not find an effect of condition or gender on physiologic reactivity, indicating that men and women showed similar physiologic arousal regardless of condition. Given that sadness is a low-arousal emotion, it is not surprising that it did not elicit overall differences in sympathetic reactivity.

In post hoc analyses, we tested the link between behavior and physiologic linkage, finding that smiling was weakly associated with the extent to which the partner exhibited linkage. We did not find an association between gesturing and linkage. These findings provide some evidence of a relationship between observable behavior (i.e., smiling) and physiologic linkage. It is possible that one dyad member's smiling signaled engagement during the interaction, prompting their partner to become attuned to them. However, it is important to note that this effect was marginal, and the analysis treated linkage as a single score rather than a temporal measure and we exercise caution to avoid overinterpretation. Additionally, we explored RSA linkage, finding that linkage varied by condition but not by gender. Sad actors exhibited negative RSA linkage (a decrease in their partner's RSA predicted an increase in their own RSA), whereas sad-paired partners showed positive linkage (a decrease in their partner's RSA predicted a decrease in their own RSA). These findings provide early evidence that sad-paired partners, regardless of gender, were more responsive to social cues and more attuned to their partner's affective states relative to sad actors.

Linkage is a complex process, and isolating a single mechanism can be challenging. It is theorized that people become linked in response to both low-level (i.e., odor, touch) and high-level processes (e.g., interpreting a partner's emotions; for review see West & Mendes, 2023). However, behaviors are dynamic and both types of processes might be at play. For example, a person might signal conflicting cues, such as gesturing to signal engagement whereas their tone suggests disengagement. In this study, we assume that linkage primarily stems from high-level processes (e.g., picking up on engagement), but we cannot rule out the influence of other factors like sensory input or other social cues.

Sadness and Gender

The emotion induction influenced behavior and physiologic linkage for both sad actors and their partners, with gender playing a notable role. In female dyads, female sad actors displayed less engagement, characterized by reduced smiling and absence of physiologic linkage toward their partners. Sadness is often associated with passive coping and withdrawal, and it is plausible that this emotional state manifested as disengagement during the interaction. In turn, the disengagement displayed by the sad actors could demotivate their partners from engaging with them, which may explain the absence of linkage between female sad-paired partners and sad actors.

Surprisingly, the induction of sadness prompted men to display behaviors that are atypical of sadness, showing even greater engagement in the interaction. Although men in the sadness condition did not report greater negative affect compared to men in the control condition, we observed significant differences in their behavior during the interaction. Specifically, sad men exhibited increased gesturing and smiling, whereas their partners demonstrated strong physiologic linkage. Given the nonsignificant differences in self-reported affect following the induction, men may have been regulating their emotions during the induction, recalling personal experiences that were rated as similarly sad to that of women while not feeling sad. The behavioral differences we observed suggest that the induction still influenced them, even did not make them more consciously sad. This heightened engagement could be interpreted as an effort to counteract the sadness induction in the moment, resulting in an overcorrection effect. The expression of sadness is often viewed as nonnormative for men, which might drive men to regulate their emotions early on. In fact, men are more likely to try to regulate their sadness by distracting themselves or expressing other emotions, like anger, to conceal sadness compared to women who are more likely to ruminate (Rivers et al., 2007; Timmers et al., 1998). Men may not be suppressing their emotions—suppression is typically characterized by increased psychological distress and heightened physiologic arousal (Gross, 1998; Waters et al., 2020), which we did not observe in our study. Still, prior research indicates that people overcompensate for discomfort in uncomfortable interactions (Mendes & Koslov, 2013). Therefore, it is plausible that sadness prompted men to actively engage with their partner as a form of emotion regulation, and in turn, their partners shifted their attention toward the actors and became more attuned to them. In both cases, sadness appears to subtly impact interpersonal interactions by influencing the actor's social cues, consequently shaping their partner's response to them. While the emotion literature primarily focuses on female participants, especially in interpersonal contexts, this research emphasizes the importance of recognizing potential gender differences in emotion. This is especially relevant considering that norms surrounding emotion expression differ for men and women. Overall, our research contributes to bridging this gap by exploring how sadness affects one's behavior and its consequential impact on interactions with others.

Constraints on Generality and Future Directions

We speculate that the gender differences in our study reflect differences in socialization and do not speak to any fundamental differences between gender categories. Men are often wary of emotional disclosure with other men, especially those they are not close to, which may be due to conventional masculinity norms (Gough et al., 2021; McKenzie et al., 2018). Western households might reinforce gender norms in emotional expression from an early age, with parents preferentially attending more to girls' sadness and boys' anger (Chaplin et al., 2005; Cherry & Gerstein, 2021). These divergent responses may trigger an association of internalizing emotions like sadness with femininity and externalizing emotions like anger with masculinity from an early age; down the line, this might discourage men from expressing sadness (Fischer et al., 2003; Rivers et al., 2007; Tiedens, 2001). However, further research is necessary to fully understand what is driving this difference in behavior.

It is important to note that there are constraints on the generality of our findings. Our study exclusively included cis-male and cis-female participants to examine gender effects. Future research should explore whether similar patterns emerge for other genders, such as people who were socialized as one gender, but identify as another gender (e.g., transgender and nonbinary individuals). If the gender differences in engagement observed in this study are indeed a reflection of socialization, it may be that people who were raised male, but do not currently identify as male, behave similarly to the cis-men in our sample due to learned emotional norms. However, the reverse might also be true—if sadness is associated with femininity, individuals who were not raised female but identify as female might embrace these gendered emotion norms, and their behavior may more closely align with the cis-women in our sample. Exploring responses to highly gendered emotions, like sadness, introduces an interesting question of whether people adhere to the norms they were raised with or the norms associated with their current identity. It is crucial for future research to incorporate diverse gender identities to gain a more comprehensive understanding of how sadness and related behaviors may differ across gender identities. Additionally, our findings do not provide insight into sadness within cross-gender interactions. It is plausible that the compensatory behaviors among men in our study were influenced by the presence of same-gender partners, and they may have behaved differently if paired with a partner of a different gender. By pairing participants with gender-matched partners, the social norms surrounding sadness may have been made more salient, prompting men to engage in overcompensation to avoid violating these norms in the presence of a male partner. Future research should investigate whether these responses vary depending on whether individuals interact with someone of the same or different gender. Additionally, the sad condition had a higher number of female dyads than male dyads. Although our initial intention was to recruit an equal number of men and women, we did not consider gender when assigning participants to different conditions, resulting in an uneven distribution of male and female dyads in the sad condition.

While participants did express sadness during the emotion induction, as evidenced by subjective and sentiment analyses, they did not appear sad during the interaction. The primary goal of this study was to assess whether experiences of sadness carry over into a subsequent interaction without the actor disclosing it or informing the partner about the emotion induction. We designed the study to mirror real-life experiences; one might want to set aside feelings of sadness before meeting a stranger, where the norms are typically to be friendly and engaged (Behrens & Kret, 2019; Hardy & Van Vugt, 2006). This approach allowed us to examine the subtle cues that leak out without explicit awareness. However, given the gender differences we observed, future work should explore how men and women would engage with their partners when partners are explicitly aware of the sad experience. If these behavioral differences stem from gendered emotion norms, would male sad-paired partners disengage and withdraw from their partners, and would female sad-paired partners engage more in an attempt to regulate their partner's emotions? Would disclosing the sad experience encourage sad actors to express sadness differently with their same-gender partners? Exploring responses to explicit sadness could provide deeper insights into the role of gendered emotion norms in interactions.

In our everyday interactions, we often aim to make a good impression, concealing negative emotions in the process. While prior work suggests that high-arousal emotions, like anxiety, tend to leak out through attention-grabbing behaviors, less is known about whether sadness, characterized by social withdrawal, can be similarly detected in social interactions. Furthermore, prior work has predominantly focused on female samples. Our work contributes to the literature by investigating gender differences in emotion in social interactions. We chose to focus on sadness—an emotion often stigmatized in men—to explore how men and women deal with sadness amid conflicting societal expectations.

Conclusion

Taken together, our study employed a multimethod approach to examine the influence of sadness on emotions, behaviors, and physiology within social interactions. Our findings revealed distinct gender differences in behavior after recalling a sad experience, underscoring the significance of recognizing and considering gender variations in emotional responses. This research contributes to the understanding of how sadness subtly manifests in attention and engagement cues, providing valuable insights into the role of emotions in guiding social interactions.

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