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Is Vicarious Stress Functionally Adaptive? Perspective-Taking Modulates the Effects of Vicarious Stress on Future Firsthand Stress

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Mere observation of others experiencing stress is often sufficient to evoke stress vicariously, especially when people try to understand the situation from the viewpoint of others. Here, we tested whether and how the experience of vicarious stress, facilitated by perspective-taking, would influence individuals' affective and motivational reactions to an upcoming experience of firsthand stress—when they themselves encounter the same stressor in the future. Participants viewed a video clip of another participant undergoing a stressful task (a speech task), after being randomly assigned to take either a first-person perspective of the person (perspective-taking condition; n = 45) or maintain a detached, third-person, observer perspective (objective condition; n = 46). Subsequently, participants were given a surprise speech task and asked to prepare for their own speech for 2 minutes, during which their cardiovascular responses were assessed to differentiate motivational states of challenge or threat. Compared to participants in the objective condition, those in the perspective-taking condition perceived higher levels of stress in anticipation of giving a speech. The heightened stress appraisals, in turn, were associated with a more adaptive pattern of cardiovascular reactivity to the firsthand (relative to vicarious) stressor, characterized as challenge responses (an increase in cardiac output and a decrease in total peripheral resistance). These results suggest that perspective-taking enhances sensitivity to vicarious stress, which in turn, may facilitate preparedness for future stressors. Discussion centers on the functional adaptiveness of vicarious stress.

Keywords: perspective-taking, vicarious stress, firsthand stress, challenge vs. threat

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According to traditional views, stress is typically conceptualized as a destructive intrapersonal emotional experience that has an impact only on the self (e.g., Lazarus & Folkman, 1987). However, growing evidence suggests that stress also involves a dynamic interpersonal process that has a potential to influence surrounding others (Hatfield et al., 1994; Joiner & Katz, 2006; Shu et al., 2017; Waters et al., 2014). For example, mere observation of others undergoing a stressful experience is often sufficient to evoke stress and anxiety among observers, a phenomenon called "vicarious stress" (Buchanan et al., 2012; Engert et al., 2014; Shu et al., 2017).

Vicarious stress is a widespread phenomenon observed across different species, including humans and nonhuman primates (Preston & de Waal, 2002), implying its potential evolutionary significance. For example, it has been proposed that interpersonal transmission of stress may have an adaptive evolutionary basis by allowing people to gain information about potential threats in the environment, thereby promoting chances for survival (de Waal, 2008; Eibl-Eibesfeldt, 1971/1974). However, no study that we are aware of has tested functional adaptiveness of vicarious stress. In the present work, we aimed to fill this gap in knowledge by testing whether and how experiencing stress vicariously in response to observing others undergoing a stressful experience will affect the observers' own reactions when they themselves encounter the same stressful situation in the future—that is, an experience of firsthand stress. In addressing this issue, we investigated the role of perspective-taking as a potential moderator that can enhance one's sensitivity to vicarious stress and its subsequent impact. We hypothesized that those who are instructed to adopt the viewpoint of others (vs. remain an objective, detached perspective) while observing their suffering will be more prone to experiencing

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vicarious stress, and therefore, will be more impacted by it when they themselves encounter the same firsthand stressor in the future.

Perspective-Taking Enhances Sensitivity to Vicarious Stress

Humans are highly sensitized to suffering of conspecifics. Even though not directly involved, simply observing others' distress or pain is often sufficient to elicit aversive reactions among observers (Decety & Jackson, 2006; Hatfield et al., 1994; Joiner & Katz, 2006; Morrison et al., 2004; Preston & de Waal, 2002; Waters et al., 2014). For example, when witnessing another person being socially excluded, observers report increased levels of negative affect and lowered self-esteem (Giesen & Echterhoff, 2018; Wesselmann et al., 2009). Observing others' suffering such as physical pain, ostracism, and social evaluative threat also increases physiologic stress reactivity, such as greater sympathetic nervous system activity (e.g., heart rate and skin conductance; Coyne et al., 2011; Hein et al., 2011) and cortisol reactivity (Buchanan et al., 2012; Engert et al., 2014). Moreover, several social neuroscience studies demonstrated that the same brain networks (the so-called pain matrix, including the anterior midcingulate cortex and the anterior insula) are recruited when experiencing one's own pain and when empathizing with the pain of others (Decety & Jackson, 2006; Singer, 2006), thereby suggesting that firsthand and vicarious stress experiences may share overlapping neural representations.

However, not all individuals are equally sensitive to experiences of vicarious stress. In particular, those who try to understand the situation by imagining themselves in the place of a target victim may be more prone to experiencing stress vicariously while observing the target's suffering. One pertinent cognitive skill that allows people to transcend the egocentric perspective and understand situations from another person's viewpoint is perspective-taking, a core cognitive component of empathy (Batson, 1991; Davis, 1983; Hoffman, 1982). People who deliberately adopt a perspective of others may be more vigilant to affective signals of others, which in turn may lead them to experience greater vicarious stress by enhancing empathic concern (e.g., Batson, 2011). In support of this view, evidence suggests that those who spontaneously engage in this process (i.e., those who are high in trait levels of perspective-taking) exhibit a greater increase in cortisol reactivity while observing a stranger undergoing a stressful task (Trier Social Stress Test; Buchanan et al., 2012). More germane to the present research, when perspective-taking was manipulated by instructing participants to adopt the perspective of a target victim while observing ostracism, these individuals showed a greater decrease in self-esteem and a sense of control, compared to those who were not given any instructions (Giesen & Echterhoff, 2018). Not surprisingly given the link from perspective-taking to enhanced empathetic concern (e.g., Batson, 2011), both state and trait levels of empathic concern are also positively associated with the experience of vicarious emotions (Engert et al., 2014; Shu et al., 2017), suggesting that the sensitivity to vicarious stress is likely enhanced both through the cognitive and emotional mechanisms underlying empathy.

The Effects of Vicarious Stress on Firsthand Stress

One remaining question is whether increased sensitivity to vicarious stress, augmented by perspective-taking, offers any functional advantages (or disadvantages) when people face the same stressor in the future. To address this question, we examined whether and how experiencing stress vicariously in response to observing a stranger performing a stressful task will affect individuals' own reactions when they face the same stressor in the future and whether experimentally induced perspective-taking modulates this process. Our work was guided by two competing predictions.

On the one hand, vicarious stress might have an evolutionary purpose as previous theorists have proposed (de Waal, 2008; Eibl-Eibesfeldt, 1971/1974). By observing others dealing with stressful situations, one might be better able to prepare themselves for future threats of a similar kind by engaging in mentalization or simulation of possible future actions (Gallese & Goldman, 1998). This prediction is motivated by several findings suggesting that the process of mentalization helps people cope with stressful situations by reducing uncertainty or ambiguity surrounding the situations and facilitating adaptive responses such as enhanced emotion regulation skills (Ensink & Mayes, 2010; Tessier et al., 2016). Critically, if perspective-taking facilitates the experience of vicarious stress, this process may then allow people to address the future stressor more effectively by facilitating preparation and coordination of adequate future actions. Such an adaptive reaction is likely to occur when one perceives to have sufficient personal resources to deal with the situational demands of an upcoming stressor. This type of appraisals has been associated with an approach-oriented motivational tendency, characterized as challenge responses (Blascovich & Mendes, 2000; Blascovich & Tomaka, 1996). Thus, the first possibility is that perspective-taking during a vicarious experience of stress would lead to more adaptive, challenge responses when people anticipate facing the same stressor in the future.

On the other hand, it could be argued that perspective-taking during a vicarious experience of stress may lead to defensive, threat reactions in response to the future firsthand stress experience of the same kind. This prediction is guided by recent evidence suggesting that after experiencing vicarious stress, people show greater defensive reactions, such as increased vigilance to threat and behavioral avoidance (Shu et al., 2017), and also report greater loss of psychological resources to deal with the situation at hand, such as high levels of perceived threat and negative affect (Zeidner et al., 2011). Specifically, Shu et al. (2017) showed that after viewing a series of video clips in which target victims expressed fear and anxiety, participants who adopted an empathic perspective (as opposed to an objective perspective) became more risk-averse, reflecting their increased vigilance to potential threat cues. Increased threat reactions may in turn hijack cognitive resources that are needed to address future stressors (Richards & Gross, 2006; Schmader & Johns, 2003). If vicarious stress exploits cognitive resources deemed necessary to address future stressors, it stands to reason that perspective-taking, which will facilitate the experience of vicarious stress, may lead people to address the future stressor ineffectively by activating greater defensive, threat responses. Such a defensive reaction is likely to occur when appraisals of situational demands exceed personal resources, which have been accompanied by more inhibitional (rather than activational) motivational states of threat (Blascovich & Mendes, 2000; Blascovich & Tomaka, 1996). Thus, the second possibility is that those who adopt a perspective of a target person in a stressful situation would show more defensive, threat responses when they themselves anticipate encountering the same stressful situation in the future.

The Present Study

We tested these two opposing predictions by examining how perspective-taking, manipulated in the context of an experiment, would influence participants' reactions in response to (a) an experience of vicarious stress and (b) a subsequent, unexpected experience of firsthand stress. Specifically, participants were first asked to view a video clip of their interaction partner (i.e., another participant whom they were later told to interact with) performing a speech task, a standardized laboratory task that has been shown to reliably activate the sympathetic nervous system (e.g., Mendes et al., 2008). Perspective-taking was manipulated by instructing participants either to adopt the perspective of their partner or to maintain a detached, objective perspective while observing their partner's speech. Subsequently, participants were instructed that they would be delivering an impromptu speech of their own and were then asked to prepare for the speech for two minutes—a critical window during which we assessed their cardiovascular responses to differentiate motivational states of challenge or threat in anticipation of the firsthand stressor.

Based on the biopsychosocial model of challenge and threat, we differentiated challenge and threat states based on three cardiovascular parameters—prerejection period (PEP), cardiac output (CO), and total peripheral resistance (TPR)—to capture the motivational states driven by appraisal mechanisms that may operate outside of conscious awareness (Blascovich & Mendes, 2000; Lovallo, 2005). Both challenge and threat states occur in motivated performance situations that involve active engagement during a self- or goal-relevant task, which elicits increases in sympathetic nervous system activation (indexed by decreases in PEP). However, challenge is characterized as improved cardiac efficiency (increased CO) and vasodilation (decreased TPR), whereas threat is characterized as decreased cardiac efficiency (little or no change in CO) and vasoconstriction (no change or an increase in TPR; e.g., Blascovich et al., 2004; Mendes et al., 2008). Using these cardiovascular parameters, we tested whether participants would react to an unexpected experience of firsthand stress differently depending on the type of perspective they adopted during the vicarious experience of stress. Specifically, we examined how perspective-taking influences individuals' *anticipatory* responses to the firsthand stressor. Lazarus and Folkman (1984) noted, "threat concerns harms or losses that have not yet taken place but are anticipated" (p. 32), while defining challenge as a "focus on the potential for gain or growth inherent in an encounter" (p. 33). According to these definitions, examining anticipatory stress responses can provide an ideal context to explore the effect of perspective-taking on how people plan to cope with the firsthand stressor, based on either challenge or threat patterns of cardiovascular responses.

Method

Participants

Ninety-five adults between the ages of 18 and 35 (59 women; $M_{age} = 25.73$, $SD_{age} = 4.56$) were recruited from the San Francisco Bay Area using advertisements and listservs. The sample included 42.1% of European Americans, 24.2% of Asians, 14.7% of Hispanics, 7.4% of Blacks, and 9.5% of mixed races. Race information was missing for 2.1% of the participants. Before scheduling a lab visit, participants were screened for medical conditions that could affect cardiovascular responses, including (a) significant medical illnesses (e.g., hypertension or heart arrhythmia), (b) a current or past diagnosis of psychiatric disorder (e.g., clinical anxiety or depression), and (c) obesity (body mass index > 35). Participants were compensated $40 for their participation.

Although the sample size was not estimated based on an a priori power analysis, in our previous studies that involved similar physiological assessments we typically aimed for 30 participants per condition, and then in light of recent valid concerns regarding replication, we aimed to increase the sample size by at least 50% (resulting in a minimum of 45 per condition). A sensitivity power analysis using G*Power (Faul et al., 2009) showed that we had .80 power to detect the two-way interaction effect between condition (perspective-taking vs. objective) and task involvement (vicarious vs. firsthand) on our outcome variables based on the final sample ($N = 91$ after data attrition; see the Results section below for the exclusion criteria) with a small to medium effect (i.e., Cohen's $d = .30$) ($\alpha = .05$, two-tailed).

Procedure

Eligible participants were scheduled for a two-hour lab experiment. The study consisted of four phases. See Figure 1 for the timeline of the study. All study procedure and materials were approved by the Institutional Review Board at the University of California, San Francisco. F1

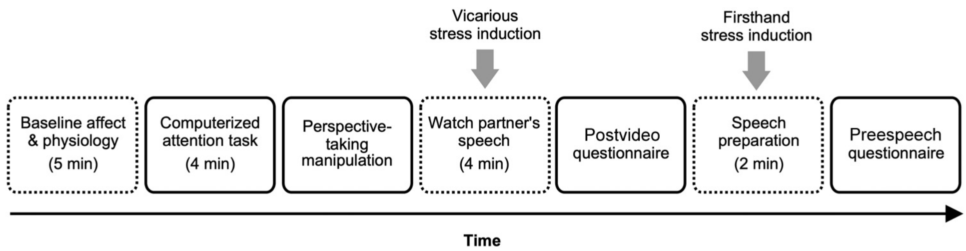
Phase 1: Consenting and Baseline Physiological Recording

Upon arrival, participants provided informed consent and completed a *baseline questionnaire*, which included a measure of baseline affect and arousal (see Measures). The experimenter then applied sensors for physiological recording and participants were instructed to sit quietly and relax for five minutes, during which we obtained baseline physiological responses. The sensors remained attached to the participants throughout the entire study.

Phase 2: Computerized Attention Task

Next, participants performed a computerized attention task for four minutes, in which they were asked to visually track a number of moving dots for 15 trials. This task was chosen as a comparison task to a speech task, which participants were later told had been assigned to another participant while they had been performing this task (see Phase 3 below). Both tasks were similar in length, but the attention task was not designed to elicit any stress responses.

Figure 1
Timeline of the Study



Note. Dotted outlines indicate the times when cardiovascular responses were obtained. Two indices of stress reactivity, one for vicarious stress and one for firsthand stress, were computed for each of three cardiovascular responses—preejection period (PEP), cardiac output (CO), and total peripheral resistance (TPR). Participants' baseline responses obtained during the last 30 seconds of the baseline period were subtracted from the responses extracted from the most reactive portion during the video task (150 seconds after the video onset for 30 seconds) and during the speech preparation (the first 30 seconds) to assess vicarious and firsthand stress reactivity, respectively.

Phase 3: Vicarious Stress Induction and Perspective-Taking Manipulation

After completing the attention task, participants were falsely led to believe that there was another participant in a different lab room and that we wanted them to interact with this person during the rest of the experiment. All participants verbally consented to continue with this portion of the experiment. Participants were then told that based on a predetermined assignment chart, they and their partner had been randomly assigned to perform two different tasks in the preceding part (Phase 2); whereas participants themselves had been assigned to perform the computerized attention task they just completed, their partner had been assigned to perform a speech task, during which they gave a speech on the topic of why they would be perfect for their dream job for five minutes. Participants were further told that their partner's speech had been video-recorded and we wanted them to view the video clip to learn some basic information about their partner before the upcoming meeting with this person.

Following an established procedure from prior work (Batson et al., 1997), perspective-taking was manipulated by instructing participants to adopt a different perspective while viewing the video clip depending on their experimental condition. Those randomly assigned to the perspective-taking condition were instructed, "*While you are watching this video, try to imagine how you yourself would feel and think if you were in your partner's position, giving the same speech. Try not to concern yourself with attending to all the information presented. Just concentrate on trying to imagine how you yourself would feel and think.*" Those randomly assigned to the objective condition were instructed, "*While you are watching this video, try to be as objective as possible about what your partner says. To remain objective, do not let yourself get caught up in imagining what this person has been through and how he or she feels as a result. Just try to remain objective and detached.*"

Participants then watched a 4-mintue video in which a target delivered a speech in front of two evaluators. The gender of the target in the video was matched to the participant's gender. Both male and female versions were clips of real participants from our previous study that employed a similar stress-induction procedure. We selected clips from these past participants who were visibly nervous (i.e., who at times spoke with a trembling voice and avoided eye-contact with the interviewers) to ensure that simply observing their performance would be sufficient to evoke vicarious stress responses. After watching the video, participants completed a *postvideo questionnaire* that included manipulation check items and measures of their perceptions of their partner's affective reactions during the speech and their own affective and stress responses while observing their partner's speech.

Phase 4: Firsthand Stress Induction

Next, participants were given a surprise speech task. Participants were told that they would need to perform the same speech task that their partner had just completed before the upcoming meeting with this person. They were informed that due to an experimenter error, we had mistakenly asked their partner to perform the speech task, but because of the predetermined assignment chart we needed the participant to now give the speech. Participants were then asked if they would be willing to give the same speech on the topic of why they would be perfect for their dream job for five minutes. Only those who provided a verbal consent were given further instructions about the task (see Appendix for verbatim task instructions) and were then introduced to two interviewers (one male and one female) who they were told would be watching and evaluating their speech. Next, participants were given two minutes to prepare for their speech privately after the interviewers left the room.

After the speech preparation, participants completed a *prespeech questionnaire*, which included questions about their affective reactions and stress appraisals about the upcoming speech task. Although participants were led to believe that they would perform the speech task, we stopped the experiment immediately after participants completed the questionnaire as we were interested in examining participants' motivational tendencies *in anticipation of* a stressful experience, rather than during their actual task performance. Finally, participants were probed for suspicion and debriefed.

Measures

Cardiovascular Responses

We first assessed preejection period (PEP) as a measure of sympathetic nervous system activation. PEP represents the time interval between the electrical stimulation of the heart (as indicated by the Q-point in the electrocardiography) and the opening of the aortic valve (as indicated by the B-point in impedance cardiography) and is considered a relatively pure measure of sympathetic nervous system activity (e.g., Burgess et al., 2004). In addition, participants' motivational tendencies of challenge versus threat were differentiated based on two cardiovascular responses—(a) cardiac output (CO); an estimate of the amount of blood processed by the heart each minute and (b) total peripheral resistance (TPR); an estimate of the overall resistance/dilation in the arterioles. These responses were obtained using electrocardiography, impedance cardiography, and blood pressure. Two disposable Ag/AgCl electrodes were placed in a modified Lead II configuration (right upper chest, left lower rib) to record electrocardiography using an ECG 100 C amplifier, interfaced with a Biopac MP150 data acquisition system (Goleta, CA). Impedance cardiography was recorded with a NICO−100 C module, also interfaced with the Biopac MP150 system. A tetrapolar aluminum/mylar tape electrode system was used to generate signals for basal transthoracic impedance (Z0) and the first derivative basal impedance (dZ/dt). Both electrocardiography and impedance cardiography signals were sampled at 1000Hz. We used IMP (3.0) module from Mindware Technologies (Gahanna, OH) to edit and score the data offline in 30 second-bins, and then extracted PEP and CO. We also obtained noncontinuous blood pressure recordings using Colin Prodigy II (San Antonio, TX) to estimate TPR, based on the following formula: (mean arterial pressure [MAP]/CO) × 80 (Sherwood et al., 1990). Noncontinuous blood pressure is inferior to continuous blood pressure, but available instrumentation did not allow us to measure continuous blood pressure.

We computed two reactivity indices on each of the three cardiovascular parameters (PEP, CO, and TPR), first to assess participants' *vicarious stress reactivity* (while they observed their partner's speech), and second to assess their *firsthand stress reactivity* (while they prepared for their own speech). Participants' baseline responses obtained during the last 30 seconds of the initial resting period were subtracted from the responses extracted from the most reactive portion during the video task (150 seconds after the video onset for 30 seconds) and during the speech preparation (the first 30 seconds), in which participants exhibited the most elevated sympathetic nervous system activation (i.e., when the decrease in PEP was largest), to assess vicarious and firsthand stress reactivity, respectively.

Self-Report Measures

Participants completed three packets of questionnaires throughout the study: (a) baseline questionnaire, (b) postvideo questionnaire, and (c) prespeech questionnaire.

Baseline Questionnaire. The baseline questionnaire included the Self-Assessment Manikin (SAM; Bradley & Lang, 1994); which assessed the degree to which participants felt happy (1 = *unhappy*, 9 = *happy*; $M = 6.98$, $SD = 1.13$) and aroused (1 = *calm*, 9 = *excited*; $M = 3.89$, $SD = 1.50$) at baseline. For exploratory purposes, we also administered the Beck Depression Inventory (BDI; Beck et al., 1961) and Ten-Item Personality Inventory (TIPI; Gosling et al., 2003) to assess depressive symptoms and personality traits, respectively. We do not discuss the results from these measures as they were included to explore issues that were not directly relevant to the questions of the present work. See online supplementary materials for other measures we administered in both postvideo and prespeech questionnaires.

Postvideo Questionnaire. Immediately after observing their partner's speech, participants first completed the manipulation check items, adopted from Scultz (2002). Participants rated the extent to which they adopted their partner's perspective [2 items; e.g., To what extent did you try to imagine how the person in the film clip was feeling and thinking during the speech?; $r(90) = .611$, $p < .001$] versus maintained a detached, objective perspective [2 items: e.g., To what extent did you objectively observe the person in the film clip?; $r(90) = .278$, $p = .008$], while watching the video clip, using a 7-point scale (1 = *not at all*, 7 = *a great deal*). After reverse-scoring responses of the two items assessing the degree to which participants maintained an objective perspective, scores were averaged to create a single index, with higher numbers indicating greater perspective-taking ($\alpha = .71$, $M = 3.78$, $SD = 1.21$).

Next, participants used a 5-point scale (1 = *not at all*, 5 = *a great deal*) to rate the extent to which they thought their partner had felt positive affect (10 items; e.g., excited, active; $\alpha = .82$, $M = 2.77$, $SD = .59$) and negative affect (10 items; e.g., distressed, nervous; $\alpha = .81$, $M = 2.15$, $SD = .54$) during the speech, using the Positive and Negative Affect Schedule (PANAS; Watson et al., 1988). Using the same scale, participants also rated how positive ($\alpha = .89$, $M = 2.94$, $SD = .77$) and negative ($\alpha = .82$, $M = 1.44$, $SD = .45$) they felt immediately after watching their partner's speech.[1] Fn1

Finally, participants rated their agreement (1 = *disagree strongly*, 7 = *agree strongly*) with the following statement, "Watching my partner's speech was stressful," which was used as an index of vicarious stress appraisals ($M = 3.82$, $SD = 1.96$).

Preespeech Questionnaire. Immediately following the speech preparation, participants rated their current feelings using the PANAS (positive affect; $\alpha = .91$, $M = 3.21$, $SD = .80$, negative affect; $\alpha = .83$, $M = 1.81$, $SD = .57$). Participants also rated the degree to which they perceived the upcoming speech task as stressful by rating their agreement (1 = *disagree strongly*, 7 = *agree strongly*) with the following statement, "The upcoming task is very stressful" ($M = 4.33$, $SD = 1.95$), which served as an index of firsthand stress appraisals.[2] Fn2

Results

Data Attrition and Preliminary Analyses

Three participants did not complete the study; two participants refused to continue when they were asked to give a speech and one participant revealed that she had a clinical diagnosis of depression, and thus, her session was discontinued. One participant was additionally excluded because he admittedly was under the influence of a drug (i.e., marijuana). After these exclusions, the final analysis included 91 participants (57 women; M_{age} =

[1] We administered the PANAS following a standard protocol in our lab. Given that cognitive and affective components of stress sometimes do not correlate with each other (e.g., Hauser et al., 2018), we did not have a strong *a priori* hypothesis regarding the modulating effect of perspective-taking on affective responses.

[2] The materials and data for the current paper are available at Open Science Framework (OSF): https://osf.io/5mu6y/.

25.80, $SD_{\text{age}} = 4.58$; 45 in the perspective-taking condition and 46 in the objective condition).

Before data analyses, we inspected data for extreme data points (values more than three times the interquartile range) and found two outliers on CO reactivity indices, one for vicarious stress reactivity and the other for firsthand stress reactivity. These data points were excluded from the pertinent analyses. Next, we ran a series of preliminary analyses, first to examine whether baseline affect/arousal or gender influenced any of the outcome variables. Participants in the perspective-taking condition did not differ from those in the objective condition in their baseline affect or arousal, $F(1, 88) = .14$, $p = .712$, and $F(1, 88) = .32$, $p = .576$, respectively, and controlling for these variables did not alter any of the results we report below. Gender did not significantly interact with condition to predict any outcome variables, $F\text{s} < 2.14$, $p\text{s} > .148$. We also tested whether the degree to which participants were suspicious about the study procedure influenced our results. Ten participants expressed suspicion about the study procedure, either about the presence of another participant ($n = 5$), or about the fact that they would need to give a speech ($n = 2$), or both ($n = 3$). The number of suspicious participants did not differ by condition, $\chi^2(1, N = 91) = .001$, $p = .971$, and moreover, excluding them did not alter any of the results. We thus used the total sample for the final analysis.

Manipulation Check

An analysis of variance (ANOVA) revealed a significant condition effect on the composite index of manipulation check, $F(1, 88) = 50.72$, $p < .001$, $\eta^2_p = .37$, 90% confidence interval [CI: .23, .47]. Participants in the perspective-taking condition indicated that they had adopted their partner's perspective while observing the speech ($M = 4.51$, $SE = .15$) significantly more than those in the objective condition ($M = 3.04$, $SE = .15$), indicating the success of our perspective-taking manipulation.

Analysis 1: The Effects of Perspective-Taking on Vicarious Stress and Firsthand Stress

Our goal was to examine whether and how the manipulation of perspective-taking influenced participants' reactions in response to the experience of vicarious stress and the subsequent, unexpected experience of firsthand stress. To address this issue, we conducted a series of mixed ANOVAs with condition (perspective-taking vs. objective) as a between-participants factor and task involvement (vicarious vs. firsthand) as a within-participants factor on three categories of outcome variables we assessed—(a) affective reactions, (b) stress appraisals, and (c) cardiovascular responses.

Affective Reactions

First, we tested whether perspective-taking influenced participants' affective reactions in response to the vicarious stressor and/or in anticipation of the firsthand stressor by analyzing positive affect and negative affect separately. When we analyzed positive affect, there was no main effect of condition, $F(1, 85) = .01$, $p = .925$. However, the main effect of task involvement was significant, $F(1, 85) = 22.59$, $p < .001$, $\eta^2_p = .21$, 90% CI [.09, .33], indicating that participants reported higher levels of positive affect in anticipation of giving a speech ($M = 3.20$, $SE = .09$) relative to observing their partner giving a speech ($M = 2.94$, $SE = .08$). The effect of task involvement tended to be larger among those in the perspective-taking condition, $F(1, 43) = 19.88$, $p < .001$, $\eta^2_p = .32$, 90% CI [.13, .47], than those in the objective condition, $F(1, 42) = 4.51$, $p = .040$, $\eta^2_p = .10$, 90% CI [.00, .25], as indexed by a Condition × Task involvement interaction effect, $F(1, 85) = 3.91$, $p = .051$, $\eta^2_p = .04$, 90% CI [.00, .13].

When we performed the same mixed ANOVA on negative affect, we found a significant main effect of condition, $F(1, 88) = 12.75$, $p = .001$, $\eta^2_p = .13$, 90% CI [.04, .24]; participants in the perspective-taking condition experienced higher levels of negative affect ($M = 1.79$, $SE = .07$) than those in the objective condition ($M = 1.45$, $SE = .07$). In addition, we also found a significant main effect of task involvement, $F(1, 88) = 82.91$, $p < .001$, $\eta^2_p = .49$, 90% CI [.36, .58], such that participants showed an increase in negative affect in anticipation of the firsthand stressor ($M = 1.81$, $SE = .06$) compared to during the vicarious experience of stress ($M = 1.44$, $SE = .05$). Notably, the interaction effect between condition and task involvement was not significant, $F(1, 88) = 1.50$, $p = .225$, indicating that perspective-taking increased negative affect both during the vicarious experience of stress and in anticipation of the firsthand stressor.[3] Fn3

Stress Appraisals

Next, we examined whether perspective-taking influenced stress appraisals during the vicarious experience of stress and also in anticipation of the firsthand stressor using the same analytic strategy. The mixed ANOVA analysis revealed a significant main effect of condition, $F(1, 86) = 10.14$, $p = .002$, $\eta^2_p = .11$, 90% CI [.02, .21]; participants in the perspective-taking condition reported higher levels of stress overall ($M = 4.62$, $SE = .23$) compared to those in the objective condition ($M = 3.56$, $SE = .24$). In addition, the main effect of task involvement was also significant, $F(1, 86) = 6.52$, $p = .012$, $\eta^2_p = .07$, 90% CI [.01, .17], indicating that participants perceived greater stress in anticipation of giving a speech ($M = 4.38$, $SE = .20$) relative to observing their partner giving a speech ($M = 3.81$, $SE = .20$). However, the Condition × Task involvement interaction was not statistically significant, $F(1, 86) = .32$, $p = .573$, suggesting that perspective-taking increased perceived stress in response to both vicarious and firsthand stressors.

The result that perspective-taking enhanced stress appraisals in response to both stressors suggests that perspective-taking during the vicarious experience of stress had a sustained effect of enhancing sensitivity to the future experience of firsthand stress. To demonstrate this point further, we conducted a mediation analysis to examine whether vicarious stress appraisals mediated the condition effect on firsthand stress appraisals (i.e., Condition → Vicarious stress appraisals → Firsthand stress appraisals). The analysis first showed a significant effect of condition (0 = *objective*, 1 =

[3] In a subsidiary analysis, we also tested whether participants perceived their partner's affective reactions during the speech differently as a function of their experimental condition. The effect of condition was not significant on both positive affect and negative affect, $F(1, 88) = 3.48$, $p = .066$ and $F(1, 88) = 1.11$, $p = .295$, respectively, indicating that participants in the perspective-taking condition did not differ from those in the objective condition in perceived levels of their partner's affective responses during the speech task.

perspective-taking) on vicarious stress appraisals, $b = 1.19$, 95% CI [.40, 1.99], $t(86) = 2.98$, $p = .004$. When both condition and vicarious stress appraisals were tested as joined predictors of firsthand stress appraisals, the path from condition to firsthand stress appraisals was no longer significant, $b = .48$, 95% CI [−.31, 1.26], $t(85) = 1.21$, $p = .230$, whereas the relationship between vicarious stress appraisals and firsthand stress appraisals remained statistically significant, $b = .39$, 95% CI [.18, .59], $t(85) = 3.81$, $p < .001$. When we conducted a bootstrapping test using the Hayes' PROCESS Model 4 with 5,000 resamples, this analysis confirmed that the mediated path from condition to firsthand stress appraisals through vicarious stress appraisals was statistically significant, Hayes Index = .46, 95% bias-corrected bootstrapping CI = [.14, 1.01].

Cardiovascular Responses

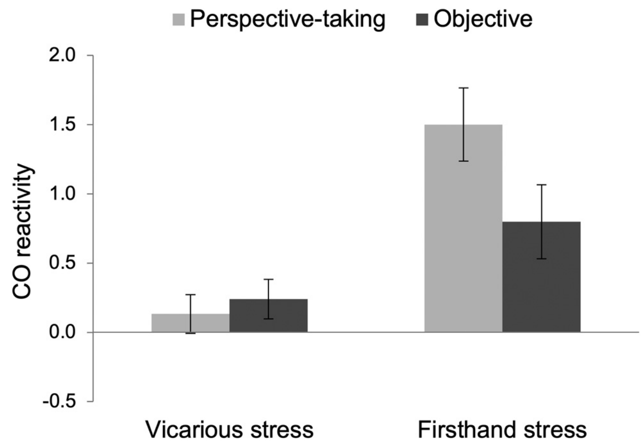
Next, we examined whether perspective-taking modulated cardiovascular stress responses differently in response to the vicarious versus firsthand stressor by performing the same mixed ANOVA on each of the three indices of stress reactivity: PEP, CO, and TPR.

First, the analysis on PEP reactivity yielded a main effect of task involvement, $F(1, 82) = 125.78$, $p < .001$, $\eta_p^2 = .61$, 90% CI [.47, .69]. Not surprisingly, participants showed significantly greater sympathetic nervous system activation in anticipation of giving a speech ($M = -12.62$, $SE = .97$) than in response to observing their partner's speech ($M = -2.64$, $SE = .56$). Neither the main effect of condition nor its interaction with task involvement was significant, $F(1, 82) = 2.09$, $p = .152$ and $F(1, 82) = 2.62$, $p = .109$, respectively. Importantly though, participants in both conditions showed a significant increase in sympathetic nervous system activation from baseline levels in response to both vicarious and firsthand stress experiences, $ts > |-2.88|$, $ps < .006$, Cohen's $ds > .44$, justifying the further exploration into challenge versus threat reactivity.

We then examined CO reactivity to differentiate states of challenge versus threat. A main effect of task involvement was significant, $F(1, 82) = 39.28$, $p < .001$, $\eta_p^2 = .32$, 90% CI [.19, .44]. Participants showed a greater increase in CO, a cardiovascular pattern consistent with challenge, in anticipation of giving a speech ($M = 1.21$, $SE = .18$) than in response to observing their partner's speech ($M = .18$, $SE = .10$). There was no main effect of condition, $F(1, 82) = .98$, $p = .326$, but there was a significant Condition × Task involvement interaction effect, $F(1, 82) = 4.14$, $p = .045$,
F2 $\eta_p^2 = .05$, 90% CI [.00, .14]. As Figure 2 displays, both groups showed an increase in their CO reactivity in response to the firsthand relative to vicarious stressor, but this effect was significantly larger among those in the perspective-taking condition, $F(1, 42) = 39.85$, $p < .001$, $\eta_p^2 = .49$, 90% CI [.29, .61], than those in the objective condition, $F(1, 40) = 7.81$, $p = .008$, $\eta_p^2 = .16$, 90% CI [.03, .33]. When we decomposed the Condition × Task involvement interaction by examining the effect of condition separately for each type of stressor, participants in the perspective-taking condition tended to show greater CO reactivity in anticipation of giving a speech ($M = 1.50$, $SE = .26$) than those in the objective condition ($M = .80$, $SE = .27$), although this effect was not statistically significant, $F(1, 83) = 3.49$, $p = .065$, $\eta_p^2 = .04$, 90% CI [.00, .13]. In contrast, participants did not show different levels of CO reactivity in response to observing their partner's speech as a function of their condition, $F(1, 84) = .29$, $p = .592$.

Figure 2

Cardiac Output (CO) Reactivity as a Function of Condition in Response to Vicarious (Left) and Firsthand (Right) Stress



Note. The error bars indicate standard error.

Using a noncontinuous blood pressure monitor is less than ideal when examining challenge and threat patterns because the spot readings of blood pressure happen infrequently; occluding the brachial repeatedly is both uncomfortable for participants, disruptive of the flow of the study, and can artificially elevate blood pressure. Given the minimum measurement of blood pressure responses, we did not observe significant main effects of condition, task involvement, or their interaction on TPR reactivity, $Fs < .09$, $ps > .768$, indicating that condition did not exert any direct effect on TPR reactivity in response to the vicarious or firsthand stressor.

Analysis 2: Relationships Between Stress Appraisals and Cardiovascular Responses

The foregoing analyses suggest that perspective-taking during the vicarious experience of stress led participants to perceive greater stress in anticipation of delivering a speech and also show a greater increase in their cardiovascular reactivity (CO) in anticipation of the firsthand relative to vicarious stressor. Next, we ran a series of correlational analyses to examine how participants' stress appraisals about the upcoming firsthand stressor were associated with *changes* in cardiovascular reactivity in response to the firsthand relative to vicarious stressor, to begin to address whether increased perceptions of firsthand stress, caused by perspective-taking, were associated with motivational states of challenge or threat. We computed the change score for each of the three cardiovascular parameters separately (PEP, CO, and TPR) by subtracting the vicarious stress reactivity scores from the firsthand stress reactivity scores, such that higher scores indicate a greater increase in cardiovascular reactivity in response to the firsthand (vs. vicarious) stressor. We examined the change scores to partial out the variances caused by the experience of vicarious stress and/or generic individual differences in physiological reactivity to a novel and stressful environment in general, so that we could analyze the unique variance attributed to the anticipation of the Fn4 firsthand stressor.[4]

As shown in Figure 3, firsthand stress appraisals were significantly F3 correlated with all three change indices of cardiovascular reactivity. First, higher perceptions of stress in response to the upcoming speech task were associated with an increase in sympathetic nervous system activation, indexed by a greater decrease in PEP responses over time, $r(84) = -.273$, $p = .012$ (see Figure 3A). Notably, these appraisals were also associated with an increase in CO, $r(84) = .340$, $p = .002$, and a decrease in TPR, $r(83) = -.218$, $p = .047$, both consistent with challenge (vs. threat) patterns of cardiovascular reactivity (see Figures 3B and 3C, respectively). None of these relationships were moderated by condition, $ts < |-.90|$, $ps > .371$, suggesting that regardless of condition, those who perceived greater stress in response to the anticipation of firsthand stress showed greater cardiovascular responses characteristic of challenge (vs. threat). In contrast, when we tested vicarious stress appraisals, none of the cardiovascular change scores were significantly predicted by this variable, $rs < |-.045|$, $ps > .690$.

Remember that the condition effect was significant on firsthand stress appraisals. In conjunction with this condition effect, the aforementioned correlations with cardiovascular change scores suggest a possibility that perspective-taking during the vicarious experience of stress led to motivational states of challenge (vs. threat) in response to the firsthand (vs. vicarious) stressor, indirectly by enhancing firsthand stress appraisals. This implies a mediation model in which the effects of condition on CO and TPR change scores are mediated by firsthand stress appraisals (i.e., Condition → Firsthand stress appraisals → Cardiovascular patterns of challenge vs. threat). We tested this mediation model separately for CO and TPR change scores, using the Hayes' Fn5 PROCESS Model 4, with 5000 bias-corrected bootstrapping samples.[5]

The Indirect Effect of Perspective-Taking on Cardiac Output

First, as reported above, the effect of condition (0 = *objective*, 1 = *perspective-taking*) was significant on firsthand stress appraisals, $b = 1.13$, 95% CI [.31, 1.94], $t(82) = 2.74$, $p = .008$. When both condition and firsthand stress appraisals were entered simultaneously as predictors of CO change scores, the condition effect became nonsignificant, $b = .41$, 95% CI [−.26, 1.07], $t(81) = 1.22$, $p = .226$, while the effect of firsthand stress appraisals remained significant, $b = .24$, 95% CI [.07, .41], $t(81) = 2.79$, $p = .007$. A bootstrapping test confirmed that the mediation model was statistically significant, Hayes Index = .27, 95% F4 bias-corrected bootstrapping CI = [.06, .66] (see Figure 4A), indicating that perspective-taking during the vicarious experience of stress increased perceived stress about the upcoming firsthand stress experience, which in turn, was associated with increased CO reactivity over time.

The Indirect Effect of Perspective-Taking on Total Peripheral Resistance

Although the total effect of condition on TPR change scores was not statistically significant (see above), a mediation can still occur without having a significant total effect (Kenny & Judd, 1984; Shrout & Bolger, 2002). We thus performed the same mediation analysis as it is possible that condition exerted its effect on TPR responses over time, indirectly through its influence on stress appraisals. As shown above, condition significantly predicted firsthand stress appraisals, $b = 1.03$, 95% CI [.21, 1.85], $t(81) = 2.49$, $p = .015$. When both condition and firsthand stress appraisals were included as joint predictors of TPR change scores, the condition effect on TPR change scores was not significant, $b = 14.84$, 95% CI [−64.01, 93.69], $t(80) = .37$, $p = .709$. Importantly, the relationship between firsthand stress appraisals and TPR change scores remained significant, $b = -20.93$, 95% CI [−41.46, −.41], $t(80) = -2.03$, $p = .046$. Despite the absence of the total effect of condition on TPR change scores, this result suggests that condition still influenced TPR change scores, indirectly by increasing firsthand stress appraisals, Hayes Index = −21.48, 95% bias-corrected bootstrapping CI [−59.87, −2.79] (see Figure 4B).[6] Fn6

Discussion

Stress signals are not simply a representation of one's internal states that only have an impact on the self, but these signals can also influence surrounding others by providing critical information about potential threats or dangers in the environment (Adolphs,

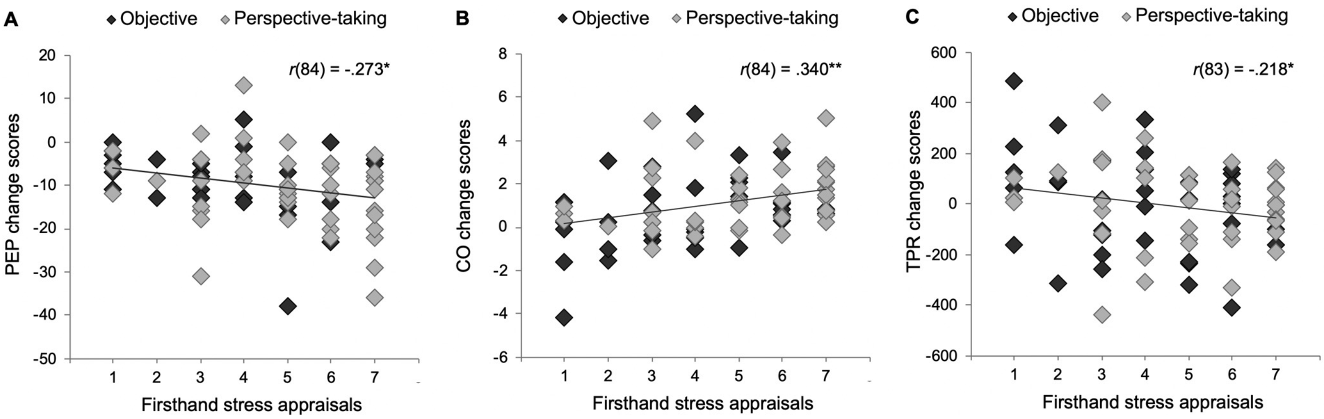
[4] When we analyzed the absolute physiological responses in response to the anticipation of the firsthand stressor, the mediation analyses on both CO and TRP were not statistically significant, 95% bias-corrected bootstrapping CIs [−0.03, 0.52] and [−35.41, 10.32], respectively, presumably because these variables likely included variances attributed to the exposure to the vicarious stressor and/or to a novel environment, and thus, they were not correlated with firsthand stress appraisals.

[5] In an additional set of analyses, we tested self-reported threat/challenge appraisals (Mendes et al., 2007) in anticipation of the firsthand stressor as an alternative mediator, rather than using the single-item measure of global stress appraisals. A threat (vs. challenge) ratio index was computed by dividing demand appraisals (4 items; e.g., "The upcoming task will take a lot of effort to complete"; $\alpha = .81$, $M = 4.11$, $SD = 1.38$) by resource appraisals (4 items; e.g., "I have the abilities to perform the upcoming task successfully"; $\alpha = .74$, $M = 4.81$, $SD = 1.03$), such that a higher score indicates greater perceived demands relative to resources ($M = 0.93$, $SD = 0.47$). The indirect effect of this ratio index was statistically negligible on both CO and TRP change scores, 95% bias-corrected bootstrapping CIs = [−0.08, 0.21] and [−10.38, 6.89], respectively. Although these null results might seem puzzling, this pattern is consistent with several studies that documented the lack of convergence between self-reported demand and/or resource appraisals and cardiovascular patterns of challenge/threat (Blascovich et al., 2002; Turner et al., 2012; Turner et al., 2014). It is possible that participants were not able to report the appraisal processes they engaged in to assess the amount of personal resources vis-à-vis situational demands in anticipation of the future stressor. Such an assessment process may have occurred unconsciously, and therefore, participants may have arrived at challenge or threat states, not necessarily with conscious awareness of the underlying appraisal mechanisms (Blascovich & Mendes, 2000; Lovallo, 2005).

[6] Although vicarious stress appraisals did not predict cardiovascular change scores directly, our earlier mediation analysis (i.e., Condition → Vicarious stress appraisals → Firsthand stress appraisals) suggests a possibility that perspective-taking caused challenge (vs. threat) patterns of cardiovascular responses, indirectly by elevating stress appraisals about two stressors (vicarious and firsthand) working in tandem. We formally tested this possibility by performing a sequential mediation analysis, in which vicarious stress appraisals were included as the first mediator that was hypothesized to modulate firsthand stress appraisals as the second mediator in accounting for the condition effect on cardiovascular responses—i.e., Condition → Vicarious stress appraisals → Firsthand stress appraisals → Challenge (vs. threat) responses. This sequential mediation model proved to be significant on both CO and TPR change scores, 95% bias-corrected bootstrapping CIs = [0.04, 0.35] and [−31.29, −2.28], respectively (see Figure S1 for statistics), thereby highlighting the role that vicarious stress appraisals played in mediating the condition effect on firsthand stress appraisals and its subsequent effect on challenge (vs. threat) responses.

Figure 3

The Relationships Between Firsthand Stress Appraisals and Cardiovascular Change Scores (A: PEP, B: CO, C: TPR)



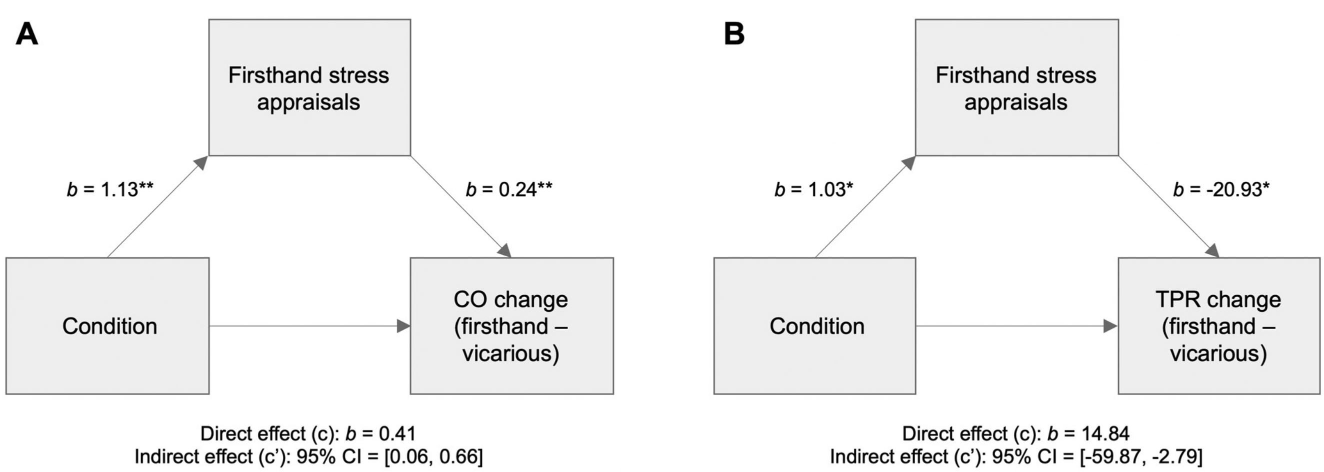
Note. Cardiovascular change scores were calculated by subtracting the scores from vicarious stress from the corresponding scores from firsthand stress, such that higher scores indicate an increase in cardiovascular reactivity in response to the firsthand (vs. vicarious) stressor. Statistical significance is indicated by asterisk (* $p < .05$. ** $p < .01$). PEP = preejection period; CO = cardiac output; TPR = total peripheral resistance.

2013). Therefore, even if a situation does not have immediate personal relevance, observing others in the stressful situation and empathizing with their suffering could be functionally adaptive as it may facilitate preparedness for possible future threats of a similar kind. The functional significance of vicarious stress, however, has been largely assumed rather than empirically tested (de Waal, 2008; Eibl-Eibesfeldt, 1971/1974). Moreover, it has been unclear under what conditions the functional significance of vicarious stress could be enhanced. The goal of the current work was to address these issues by examining the role that perspective-taking plays in modulating the sensitivity to vicarious stress and its subsequent impact on reactions to firsthand stress.

Three key findings emerged. First, participants who had been instructed to adopt a first-person perspective of their interaction partner reported higher levels of stress and negative affect in response to observing this person's speech, compared to those who had been instructed to maintain a third-person, objective perspective. This result is consistent with previous findings suggesting that perspective-taking enhances sensitivity to vicarious stress (Buchanan et al., 2012; Giesen & Echterhoff, 2018). Second, our analysis extends this literature by showing that perspective-taking during the vicarious experience of stress has sustained effects on increasing sensitivity to a future experience of firsthand stress. When participants were given a surprise speech task afterward,

Figure 4

The Indirect Effects of Condition on (A) CO Change Scores and (B) TPR Change Scores via Firsthand Stress Appraisals



Note. Unstandardized coefficients are shown. The values in square brackets are 95% bias-corrected confidence intervals (CIs) from a bootstrap test with 5,000 replications. Cardiovascular change scores were calculated by subtracting the scores from vicarious stress from the corresponding scores from firsthand stress, such that higher scores indicate an increase in cardiovascular reactivity in response to the firsthand (vs. vicarious) stressor. Statistical significance is indicated by asterisk (* $p < .05$. ** $p < .01$). Condition (0 = *objective*, 1 = *perspective-taking*); CI = confidence interval; CO = cardiac output; TPR = total peripheral resistance.

those who had adopted a first-person perspective of their partner (as opposed to those who had maintained an objective perspective) perceived higher levels of stress in anticipation of giving their own speech. Third, the heightened stress appraisals about the upcoming firsthand stress experience, in turn, were associated with a more activational, challenge pattern of cardiovascular reactivity over time, indexed by an increase in CO and a decrease in TPR in response to the firsthand (vs. vicarious) stressor. Taken together, these results suggest that resonating with the distress of others may have adaptive values by facilitating readiness for future stressors, and importantly, perspective-taking can augment such effects.

We theorized that vicarious stress could lead to adaptive reactions by facilitating mentalization or simulation of possible future actions. This view is consistent with the simulation theory of empathy (Gallese & Goldman, 1998), which posits that understanding others' action and its underlying intention requires a mental simulation of the observed actions. Increasing evidence on motor resonance supports this view by showing that the neural substrates that are recruited when people perform an action are also active when they observe someone else performing the same action (see Ferrari & Rizzolatti, 2014 for review). Importantly, another line of research suggests that observing others' distress activates this "mirror neuron system" (Lamm et al., 2011), thereby suggesting that motor resonance might be a core process leading to an experience of vicarious stress. Insofar as internal simulation of a goal-directed action facilitates its execution in the future, it stands to reason that perspective-taking, which enhances stress responses during a vicarious experience of stress, might also facilitate preparedness for such an action. Future research is necessary to directly test this speculation by examining whether increased action tendency, indexed by motor resonance, is a mechanism underlying the functional adaptiveness of vicarious stress and whether this tendency is more strongly pronounced under the context of perspective-taking.

Our findings also have implications for observational learning. Learning about potential threats in the environment based on others' emotional reactions is likely less risky than learning based on individual experiences (Askew & Field, 2008; Olsson & Phelps, 2007). Thus, vicarious stress might have evolved as a core mechanism facilitating observational learning (Olsson & Phelps, 2004). Indeed, observational learning based on distress of conspecifics is a widespread phenomenon, evident in both human and other nonhuman primates (Öhman & Mineka, 2001). Notably, emerging evidence suggests that this form of social learning is more facilitated among those who are high in trait empathy (Olsson et al., 2016). Similarly, those who showed a greater activity in empathy-related regions of the brain in response to observing a target person's distress showed enhanced learning of fearful stimuli afterward (Olsson et al., 2007). These results highlight the critical role of empathy in vicarious learning, and yet, this evidence is exclusively based on learning from vicarious experiences of fear or anxiety—the emotions that typically engender defensive, inhibitional reactions of threat (see also Shu et al., 2017). Will empathy also facilitate observational learning of more approach-oriented, activational reactions of challenge? We expect that if those response are deemed more adaptive in a certain context, empathy (or perspective-taking as a core cognitive component of this construct) might facilitate learning and preparation of such challenge responses, possible by elevating stress appraisals about a given situation. Of course, this idea is based on posthoc speculation and must be verified in future work.

Several caveats should be noted before concluding. First, although perspective-taking led to a greater increase in CO reactivity in response to the firsthand (relative to vicarious) stressor, there was no corresponding effect on TPR reactivity. It is possible that the use of a noncontinuous blood pressure monitor did not provide enough precision in the measurement of blood pressure responses, which prevented us from observing a reliable condition effect on TPR reactivity. Nonetheless, our mediation analyses suggest that perspective-taking still exerted an effect on TPR reactivity (as well as CO reactivity), indirectly via enhancing firsthand stress appraisals. These analyses shed light on one possible mechanism through which perspective-taking during the vicarious stress experience facilitates challenge (vs. threat) responses, and yet, caution is due in interpreting these results given that mediation does not imply causation, and moreover, we cannot exclude the possibility that the indirect effects we observed were accounted for by other, unmeasured third variables.

Second, perspective-taking increased vicarious stress responses when we tested self-reported levels of stress appraisals and negative affect, but we failed to find a corresponding effect on physiologic stress reactivity. Although unexpected, this asymmetry is consistent with many studies that found a similar dissociation between self-report measures of affective processes and physiological responses (e.g., Dickerson & Kemeny, 2004; Lang et al., 1998; Lang et al., 1993). At first glance, the finding that there was no condition effect on general arousal (indexed by PEP reactivity) might seem puzzling, but we believe that this null result does not contradict our overall theoretical perspective. We argue that vicarious stress can be adaptive as it enables simulation of adequate future actions through active observation during stressor exposure (Gallese & Goldman, 1998). This cognitive process of simulation may not necessarily require an activation of the general arousal system directly. Consistent with this view, Engert et al., (2014) similarly argued that vicarious stress is likely a manifestation of complex assessments of the situation at hand, rather than involving automatic activation of sympathetic nervous system. Future research is necessary to examine different aspects of vicarious stress that may or may not involve physiological arousal.

Third, as typically done in prior work (e.g., Batson et al., 1997), we drew our conclusion based on the comparison between the perspective-taking condition and the objective condition, but this contrast makes it difficult to discern which condition was more responsible for our results. Interestingly, a recent meta-analysis (McAuliffe et al., 2018; see also McAuliffe et al., 2020) showed that it was the instructions to "remain objective" that down-regulated individuals' spontaneous emotional reactions, rather than perspective-taking enhancing them. However, given that this meta-analysis focused exclusively on empathic concern as an outcome variable, defined as "an emotion that is congruent with and elicited by perceived suffering" (McAuliffe et al., 2020; p. 141), it has yet to be tested whether it was also the remain-objective instructions that decreased the functional significance of vicarious stress in the current study, rather than perspective-taking enabling it. Relatedly, one might argue that participants in the objective condition may have used reappraisal to remain detached from the stressor. Then, our results that these participants felt less negative affect and stress, but at the same time, exhibited less adaptive patterns of cardiovascular reactivity in response to their own stressor, might be consistent with growing evidence suggesting that the benefits of reappraisal are often accompanied by functional costs (e.g., Ford et al., 2019; Ford & Troy, 2019). To understand our results within the context of broader literature on emotion regulation, it is necessary to examine the independent effects of perspective-taking versus remain-objective instructions on functional adaptiveness of vicarious stress by adding a "no-instruction" control condition in future work.

Fourth, although participants believed that they would be performing a speech task, we did not ask them to actually perform the task because we were interested in examining their motivational states *in anticipation of* a future firsthand stress experience, building on the definitions of challenge and threat appraisals by Lazarus and Folkman (1984). Although evidence suggests that anticipatory stress responses are similar to those resulting from actual stress (Balodis et al., 2010; Hobfoll, 2001), we cannot directly address whether perspective-taking will enable individuals to cope with the stressor better precisely at the moment of stress exposure. Prior evidence suggests that this is a likely possibility by showing that reappraising stress-induced arousal as a challenge (rather than threat) resulted in better task performance (Jamieson et al., 2010). Building on this evidence, we anticipate that perspective-taking will enable more effective coping at the moment of a stressful experience by activating a challenge state. Future research is needed to test this prediction. Another important future extension would be to examine potential transfer effects of perspective-taking by testing whether perspective-taking facilitates preparedness for other types of stressors (that are different from a type of vicarious stress).

In conclusion, the current work highlights the role that perspective-taking plays in modulating the effects of vicarious stress on future firsthand stress. Perspective-taking may enhance the functional value of vicarious stress by increasing activational patterns of cardiovascular reactivity in response to firsthand (relative to vicarious) stress, via elevating stress appraisals. Unlike the traditional view conceptualizing stress primarily as a destructive experience, our work therefore suggests that stress can at times promote positive motivational outcomes such as challenge responses.

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Appendix

Speech Task Instructions

We would like for you to imagine that this is a preliminary interview for a desirable job in your specific area of interest. You will describe qualities that make you well suited for this dream job during a five-Minute speech to a panel of interviewers. You can talk about your work experience, your work style, and your strengths and weaknesses. During the speech we would like for you to describe in detail one particular example from your past that demonstrates your work ethic and/or individual philosophy that would be relevant for the job. The interviewers will let you know when the 5 minutes are over. During your speech, please try to demonstrate that you have insight into yourself regarding your strengths and weaknesses as a person, and how you are trying to change aspects of yourself that need changing and augmenting aspects of yourself that are positive.

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AUTHOR QUERIES

AUTHOR PLEASE ANSWER ALL QUERIES 1

AQau— Please confirm the given-names and surnames are identified properly by the colours.
■=Given-Name, ■= Surname
The colours are for proofing purposes only. The colours will not appear online or in print.

AQ1—Author: AUTHOR: Please shorten the running head for your article to a maximum of 50 including spaces. Please provide complete details for (Bradley & Lang, 1995) in the reference list or delete the citation from the text. There is no mention of (Bradley & Lang 1994 and Preston & de Waal 2002) in the text. Please insert a citation in the text or delete the reference as appropriate.

AQ2—Author: Please indicate the source(s) of any facial subjects used in your manuscript. If your photos have been taken from a noncommercial database, please provide the name of that database. If your photos have been taken from a commercially copyrighted database, please provide the name of the database AND indicate that you have received permission to reprint and provide the name of the copyright holder(s). If you are using original photos, please confirm that the subjects granted permission to have their likenesses reprinted.

AQ3—Author: Your article contains supplemental material. If you have queries for references that are not cited in the text, these can be ignored if the references are found in the supplemental material..