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Abstract This experiment tested the hypothesis that self-focused attention might increase cortisol release. Social self-preservation theory suggests that social evaluation and associated feelings of shame are associated with cortisol reactivity, whereas one implication of objective self-awareness theory is that self-critical awareness and associated feelings of anxiety might be associated with increases in cortisol. 120 participants completed a public speech task either in front of an evaluative panel (social threat), in a non-evaluative setting while watching themselves in real-time on a television (self-focus), or in the mere presence of a non-evaluative person (control). Cortisol increased comparably among men in the social threat and self-focus conditions, but not among men in the control condition. There were no effects for women. Shame was correlated with increased cortisol in the social threat condition, whereas anxiety was correlated with increased cortisol in the self-focus condition. One broad implication of this work is that negative evaluation may increase cortisol regardless of whether this source comes from oneself or others.

Keywords Cortisol · Objective self-awareness · Social threat · Blood pressure · Stress

T. F. Denson (✉) · I. Granville-Smith
School of Psychology, University of New South Wales, Sydney, NSW 2052, Australia
e-mail: t.denson@unsw.edu.au

J. D. Creswell
Department of Psychology, Carnegie Mellon University, Pittsburgh, PA, USA

Introduction

It is increasingly appreciated that specific characteristics of stressors and the specific way one appraises stressors induces qualitatively distinct biological stress response profiles (Denson et al., 2009b; Kemeny, 2003; Weiner, 1992). Hypothalamic–pituitary–adrenal (HPA)-axis activation and corresponding cortisol release may be triggered by specific psychosocial factors. For example, early research indicated that cortisol (and corticosterone) was elicited in situations characterized as unpredictable, novel, and uncontrollable (Mason, 1968). More recently, experimental studies and an influential meta-analytic review (Dickerson & Kemeny, 2004) have described how socially evaluative settings, and the self-conscious emotions they evoke (e.g., shame) may contribute to cortisol responding (Dickerson & Kemeny, 2004; Dickerson et al., 2004; Gruenewald et al., 2004). This work by Dickerson, Kemeny, and colleagues has formed the basis of Social Self-Preservation Theory, which posits that social evaluative threat and accompanying feelings of shame may signal a loss of social esteem or social status, and that cortisol release may serve as a mechanism for reintegrating or overcoming this social threat (Dickerson et al., 2004). This work has raised important questions about the nature of social evaluative threat and cortisol release—what features of a socially evaluative setting are necessary? Is the mere presence of evaluation sufficient to induce HPA axis activation? Identifying psychosocial factors that activate the HPA axis is important, as greater cortisol reactivity is linked to health outcomes. For example, greater cortisol responses to laboratory stressors are linked to higher central adiposity (Epel et al., 2000) and predicted a greater likelihood of upper respiratory tract infections during a 12-week high stress follow-up period (Cohen et al., 2002).

The present study explored the role of self-focus in cortisol responding to acute stress. It may be that self-awareness is sufficient to induce social evaluative threat, as self-awareness is associated with feelings of anxious psychological arousal when one compares a current self with personal or normative standards (Carver & Scheier, 1981, 1998; Duval & Wicklund, 1972; Silvia & Duval, 2001). As described in Objective Self-Awareness theory, if the current self falls short of one's personal or normative standards, an aversive state of anxiety ensues (e.g., feelings of fear and apprehension). Such anxiety is believed to motivate normative behavior. Indeed, self-focus induced by the simple presence of a mirror or video camera can increase anxiety and adherence to normative standards (Diener & Wallbom, 1976; Mor & Winquist, 2002). Self-aware individuals are less likely to cheat when presented with the opportunity to do so and more likely to act in accordance with their moral convictions (Batson et al., 1999; Diener & Wallbom, 1976). Thus, social self-preservation theory and objective self-awareness theory are similar in that both emphasize the role of social threat. The key difference between the two is that social self-preservation theory suggests that the source of threat is external to an individual; whereas objective self-awareness theory suggests that internally focused self-comparison to normative standards or an ideal self may produce a state of social threat. Another key difference is that social self-preservation theory highlights a special role for feelings of shame whereas objective self-awareness theory posits a special role for anxious psychological arousal.

What is particularly interesting from this account is that self-awareness may be sufficient for inducing social evaluative threat in certain situations. Specifically, social evaluative threat may be present when one is made aware of oneself in an evaluative (performance) context, and this self-awareness may elicit comparable cortisol responding to being evaluated by others. Thus self-focus in and of itself should not cause increased HPA activation, but when it results in a comparison between oneself and standards in a motivated performance context (like the Trier Social Stress Test [TSST]), self-focus will elicit HPA activation. In fact, the TSST (Kirschbaum et al., 1993), a common laboratory stress challenge task, consists of a participant delivering a speech and performing difficult mental arithmetic in front of an evaluative group of expert panelists. Notably, studies have shown that negative social evaluation by the panelists, as opposed to simply performing these tasks alone in a room or with a passive experimenter, significantly increases cortisol production (Dickerson et al., 2008; Gruenewald et al., 2004). Building on objective self-awareness theory, intrapersonal experiences of anxiety (e.g., fear, apprehension) and cortisol responding when one is made to focus on the self could energize normative behavior and thereby enhance social acceptance, in much the same way as one would respond to the presence of social evaluative threat.

In addition to cortisol output, the present research also examined cardiovascular responses to assess the specificity of our theorizing. We expected cortisol to increase in the self-focus and social-evaluative threat conditions, but blood pressure to increase in all three conditions. That is, we had no theoretical reason to expect that cardiovascular responses would differ as a function of these manipulations, but good reason to expect that cortisol should be responsive to the self-focus and social-evaluative threat manipulations. That is, we expected to observe an increase in cardiovascular reactivity during the TSST in all three conditions, but increased cortisol reactivity only in the self-focus and social-evaluative threat conditions. Social self-preservation and objective self-awareness theories also suggest specific and dissociable emotional pathways by which social evaluative threat and self-focus elicit cortisol responding, such that feelings of shame would be associated with increased cortisol during social evaluative threat, and anxiety would be associated with increased cortisol during self-focus. We also controlled for the potentially arousing effects of the mere presence of other individuals by comparing the effects of social-evaluative threat and self-focus to a condition in which an unobserving experimenter sat quietly in the room with the participant (Dickerson et al., 2008; Zajonc, 1965).

Method

Participants and design

A total of 122 healthy undergraduates at the University of New South Wales participated in the experiment. We asked participants not to eat, exercise, or consume caffeine 1 h prior to the experiment. Exclusion criteria including smoking, amphetamine use, chronic infections, cancer, tumours, any immune, autoimmune, or metabolic disease, endocrine disorders, use of contraceptive medication, pregnancy, and breast-feeding. Two participants were excluded due to extreme cortisol levels at study entry (± 3 *SD*s from the mean), leaving a total sample of 120 ($M_{age} = 21.42$ years, $SD_{age} = 4.93$ years; ranging from 18 to 45; 64 women). We randomly assigned participants to one of three conditions: social threat, self-focus, or a mere presence control condition. Men and women were equally distributed across conditions, $\chi^2(2) = 0.82, p = 0.67$. All data were collected from March to August 2009.

Materials and procedure

In order to control for diurnal variation, all research was conducted between the hours of 1:00 pm and 7:00 pm.

Participants were seated at a desk. A 30-min relaxation period followed, during which participants completed questionnaires and read affectively-neutral nature magazines in the remaining time. Following the 30-min relaxation period, the experimenter took the first of four baseline blood pressure measurements with an Omron automatic cuff. The experimenter took the first of three saliva samples for cortisol with a Salivette (Sarstedt, Rommelsdorf, Germany).

Experimental manipulation

Participants were then informed that they would have 5 min to prepare a 7-min presentation that described their suitability for their ideal job. They were told that a counting task would follow, but were not given further details until the time of the task. The counting task consisted of counting backward from 1,000 in sevens.

In the *social threat* condition participants completed the speech and counting tasks in front of a non-accepting evaluative panelist and the experimenter, using procedures adapted from the TSST (Kirschbaum et al., 1993). The panelist (a study confederate) was introduced as an expert on linguistic abilities and communication. In the standard TSST, the panelist is typically neutral. The non-accepting panelist was included to increase feelings of social threat. Performance was ostensibly recorded by a visible digital video camera on a tripod aimed at the participant.

In the *self-focus* condition, participants completed the same speech and counting tasks except they did so while watching their performance (in real time) on a 32″ LCD television, which was transmitted via a digital video camera placed just above the television. Participants were told that observing one's facial features while presenting can improve communication ability, and that the video camera was not recording their performance. Although we did not explicitly ask whether participants believed their performance was being recorded, no participants expressed suspicion during a debriefing in which they were given the opportunity to do so. This manipulation is similar to objective self-awareness manipulations such as the presence of a mirror (Silvia & Duval, 2001). This condition also differed from the social threat condition in that there was no evaluative panelist and the experimenter worked quietly in the corner on a computer with headphones and did not look at the participant.

In the *mere presence* control condition, participants performed the speech and counting tasks in a room with the experimenter present (who worked quietly with headphones as in the self-focus condition; Dickerson et al., 2008). In order to control for self and social evaluation, the panelist and the video camera were not present in the mere presence condition. In order to ensure equal effort across the tasks, participants were informed that it was of the utmost importance to speak until stopped by the experimenter. Unbeknownst to participants, an experimenter listened outside the room and in rare cases when a participant stopped speaking, the experimenter instructed participants to continue the task.

Following the speech and counting tasks, participants were given 30 min to complete the final questionnaires and read affectively-neutral nature magazines. They were then debriefed, thanked and compensated for their participation.

Physiological assessments

In addition to the baseline assessments, BP was measured immediately following the speech task, the counting task, and following the 30-min recovery period. Cortisol assessments were taken following the counting task and after the 30-min recovery period. Cortisol samples were stored at −20°C and analyzed by a professional reference laboratory in Dresden, Germany. After thawing, Salivettes were centrifuged at 3,000 rpm for 5 min, which resulted in a clear supernatant of low viscosity. Salivary cortisol concentrations were measured using commercially available chemiluminescence-immuno-assays with high sensitivity (IBL International, Hamburg, Germany). Intra- and inter-assay coefficients of variations were below 10%. Cortisol concentrations were natural log transformed prior to analysis.

Manipulation checks and emotional reactions

In order to assess the extent to which participants experienced social threat or self-focus, participants were asked to rate "how strongly" they thought about *themselves* and *other people's opinions* throughout the tasks (1 = not at all, 7 = very much). Participants also completed emotional adjectives describing their mood as a result of the task. Feelings of *shame, disgrace*, and *embarrassment* formed a reliable composite of self-conscious emotions evoked during social threat ($\alpha = 0.88$). Feelings of *fear* and *apprehension* ($\alpha = 0.74$) assessed anxiety (1 = not at all, 7 = very much).

Statistical analyses

Analyses were completed in SPSS 17. A power analysis with the GPower program revealed statistical power to be approximately 0.63 for men within conditions to detect a medium-sized ($d = 0.50$) increase in stress responding with $\alpha = 0.05$. For women, power was approximately 0.67. We utilized between-participant ANOVAs to examine the efficacy of the experimental manipulations. These were followed by mixed ANOVAs to evaluate the effects of the experimental manipulations and gender on physiological responses during the course of the experiment. When the sphericity assumption was violated, mixed model *F* statistics relied on Huynh–Feldt corrected degrees of freedom (Tabachnick & Fidell, 2001). In the presence of an interaction, we conducted post hoc tests within each group to further describe the nature of the interaction. We also conducted planned contrasts to test our a priori hypothesis that peak cortisol reactivity would be greater among participants in the social threat (+1) and self-awareness (+1) conditions compared to the mere presence control condition (−2). Finally, we investigated correlations between self-reported emotional reactions and physiological reactivity.

Results

One-way ANOVAs revealed significant differences on the extent to which participants focused on others' opinions, $F(2,117) = 3.08$, $p = 0.05$, $\eta^2 = 0.05$, and themselves, $F(2,117) = 4.80$, $p = 0.01$, $\eta^2 = 0.08$, during the stressor (Table 1). Post hoc tests revealed that, participants in the social threat condition reported thinking about others' opinions more strongly than those in the self-focus, $t(79) = 2.03$, $p = 0.05$, $d = 0.44$, or mere presence conditions, $t(78) = 2.38$, $p = 0.02$, $d = 0.52$. The latter two conditions did not differ from each other, $t < 1$, $p = 0.68$, $d = 0.09$. Conversely, participants in the self-focus condition reported thinking about themselves more strongly than participants in the social threat, $t(79) = 2.90$, $p = 0.005$, $d = 0.66$, or mere presence conditions, $t(79) = 2.37$, $p = 0.02$, $d = 0.53$. The latter two groups did not differ, $t < 1$, $p = 0.58$, $d = 0.14$. These data suggest effective social threat and self-focus inductions. There were no interactions with sex, *F*s < 1. There was a trend for men to have higher cortisol levels than women at baseline ($M_{\text{men}} = 2.10$, $SD_{\text{men}} = 0.46$; $M_{\text{women}} = 1.94$, $SD_{\text{women}} = 0.51$), $t(114) = 1.82$, $p = 0.07$, $d = 0.33$, and significantly higher mean arterial pressure, ($M_{\text{men}} = 86.47$ $SD_{\text{men}} = 5.89$; $M_{\text{women}} = 81.54$, $SD_{\text{women}} = 8.15$), $t(115) = 3.68$, $p < 0.001$, $d = 0.68$. Gender was included as a moderator in subsequent analyses.

Cortisol

A 2 (sex) × 3 (condition) × 3 (time) mixed ANOVA revealed a significant 3-way interaction, $F(4,153) = 2.74$, $p = 0.05$, $\eta_p^2 = 0.05$. Separate 3 (condition) × 3 (time) ANOVAs for men and women revealed a marginally significant interaction for men, $F(4,78) = 2.28$, $p = 0.08$, $\eta_p^2 = 0.08$, but not for women, $F(4,75) = 1.76$, $p = 0.17$, $\eta_p^2 = 0.06$. Inspection of the means for women revealed significantly lower cortisol at baseline in the mere presence condition than in the social threat or self-focus conditions, $F(2,59) = 4.04$, $p = 0.02$, $\eta_p^2 = 0.12$ (see Fig. 1), whereas men showed no such differences, $F(2,51) = 0.34$, $p = 0.71$, $\eta_p^2 = 0.01$. Time of day did not differ as a function of experimental condition for the women and thus diurnal variation could not be responsible for the low cortisol concentrations for women in the mere presence condition, $\chi^2(24) = 22.18$, $p = 0.63$. Furthermore, the women did not show cortisol increases from baseline as a result of the stressor, $F(1,61) = 0.02$, $p = 0.90$, $d = -0.02$. In contrast, men had significant increases in cortisol from baseline to peak cortisol reactivity, $t(53) = 3.32$, $p = 0.002$, $d = 0.46$. Thus we describe the cortisol effects for men in more detail and discuss the null effects for women in the discussion section.

The left panel of Fig. 1 presents the time course for the men's cortisol responses across the three assessment points in the three study conditions. Consistent with our hypothesis that social threat and self-focus would increase cortisol reactivity, those in the social threat condition showed an increase in cortisol from baseline to peak reactivity as a result of the stressor, $t(19) = 3.64$, $p = 0.002$, $d = 0.80$, as did those in the self-focus condition, $t(17) = 2.50$, $p = 0.02$, $d = 0.59$. Also as expected, cortisol for men in the mere presence condition did not change from baseline as a result of the task, $t(15) = 0.17$, $p = 0.87$, $d = 0.05$.

Furthermore, a directional planned contrast comparing peak reactivity in both the social threat (+1) and self-focus (+1) against the mere presence control condition (−2) revealed greater cortisol levels in the former conditions as a result of the stressor, $t(52) = 1.75$, $p < 0.05$, $d = 0.52$. A second planned contrast comparing peak reactivity in the

Table 1 Means (and *SD*s) of how strongly participants focused on others' opinions and themselves during the stressor as a function of experimental condition and sex

	Social threat ($n = 39$)			Self-focus ($n = 41$)			Mere presence ($n = 40$)		
	Whole condition *M (SD)*	Men *M (SD)*	Women *M (SD)*	Whole condition *M (SD)*	Men *M (SD)*	Women *M (SD)*	Whole condition *M (SD)*	Men *M (SD)*	Women *M (SD)*
Others' opinions	5.18 (1.71)	4.70 (1.81)	5.63 (1.54)	4.39 (1.77)	4.16 (1.80)	4.59 (1.76)	4.23 (1.86)	4.06 (2.05)	4.35 (1.75)
Self-focus	3.48 (1.65)	3.65 (1.76)	3.26 (1.59)	4.46 (1.42)	4.89 (1.29)	4.09 (1.44)	3.68 (1.58)	3.82 (1.71)	3.57 (1.31)

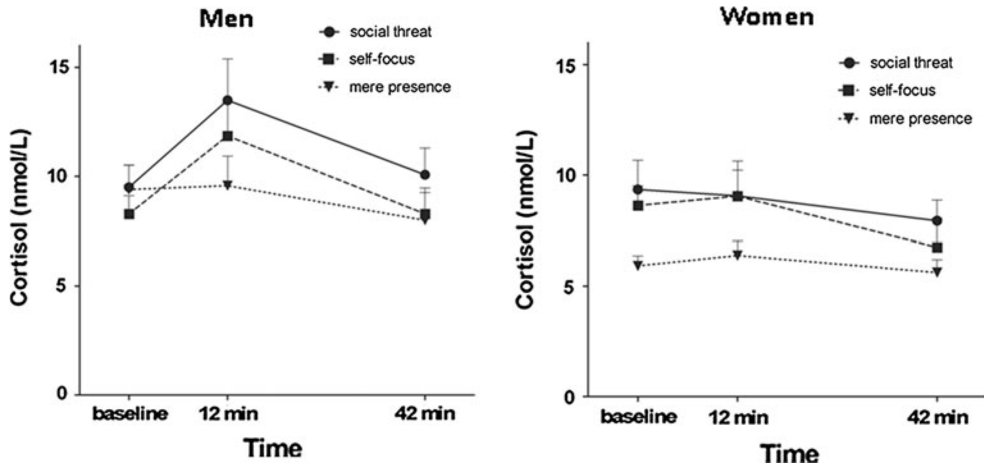

Fig. 1 Cortisol responses for men and women as a function of experimental condition at 12 and 42 min following stressor onset. In males, both social threat and self-focus increased cortisol responses whereas the mere presence of a non-evaluative person did not

social threat to the self-focus condition revealed no differences in peak reactivity, $t(52) = 0.67$, $p = 0.50$, $d = 0.22$. Thus, both social threat and self-focus elicited similarly increased cortisol responses to the tasks in men, whereas the mere presence of a non-evaluative other person did not increase cortisol in men.

Cardiovascular responses

We calculated mean arterial pressure for each of the four time points. A 2 (gender) × 3 (condition) × 4 (time) mixed ANOVA revealed a significant main effect of gender such than men had significantly higher mean arterial pressure at all 4 time points, $F(1,107) = 13.66$, $p < 0.001$, $\eta^2 = 0.11$. Moreover, this main effect was qualified by a condition × time interaction, $F(5,292) = 2.75$, $p = 0.02$, $\eta^2 = 0.05$. Because the 3-way interaction was not significant we collapsed across gender. As can been seen in Table 2, participants in the self-focus condition, $t(39) = 4.81$, $p < 0.001$, $d = 0.78$, mere presence condition, $t(37) = 4.79$, $p < 0.001$, $d = 0.79$, and social threat condition showed increased MAP as a result of the speech task, $t(38) = 5.84$, $p < 0.001$, $d = 1.09$. There were no differences between groups at any of the 4 time points, all Fs < 1, suggesting a similar pattern of cardiovascular responses for all three groups.

Table 2 Means (and *SD*s) of mean arterial pressure for men and women across the experiment as a function of experimental condition

	Social threat ($n = 39$) *M* (*SD*)	Self-focus ($n = 41$) *M* (*SD*)	Mere presence ($n = 40$) *M* (*SD*)
Baseline	83.32 (7.53)	83.08 (7.41)	85.19 (7.61)
Post-speech	92.39 (13.44)	89.87 (8.89)	89.01 (10.56)
Post-counting	88.17 (10.14)	86.39 (8.52)	87.35 (8.87)
Recovery	83.63 (9.11)	84.55 (8.78)	85.98 (8.69)

Shame and anxiety: distinct emotional correlates of cortisol stress responding

Table 3 reports the means and standard deviations for the self-reported emotional responses. A 3 (condition) × 2 (gender) between-participants ANOVA revealed only main effects of gender for self-reported anxiety, $F(1,114) = 10.70$, $p = 0.001$, $\eta_p^2 = 0.09$, and a marginally significant main effect of gender for self-reported shame, $F(1,114) = 3.78$, $p = 0.054$, $\eta_p^2 = 0.03$. In both cases, women reported higher levels of anxiety ($M_{\text{women}} = 4.13$, $SD_{\text{women}} = 1.45$; $M_{\text{men}} = 3.24$, $SD_{\text{men}} = 1.65$), and shame than men ($M_{\text{women}} = 3.59$, $SD_{\text{women}} = 1.87$; $M_{\text{men}} = 2.96$, $SD_{\text{men}} = 1.69$). Anxiety and shame were significantly correlated in the entire sample, $r(120) = 0.67$, $p < 0.001$ and in each condition: social threat, $r(39) = 0.64$, $p < 0.001$; self-focus, $r(40) = 0.80$, $p < 0.001$; and control, $r(39) = 0.56$, $p < 0.001$.

We conducted hierarchical regression analyses for the men to test for interactions between the experimental manipulations and self-reported emotional responses on cortisol output following the task and at recovery. The condition variables were dummy-coded using the mere presence control condition as the reference group. The dependent measures were the log-transformed cortisol concentrations following the task and at recovery, uncorrected for baseline.[1] These analyses revealed significant

[1] Because we did not have baseline measures of shame and anxiety, we felt it most appropriate to analyze the data uncorrected for baseline. Moreover, the significant correlations between shame/anxiety and cortisol at each Times 2 and 3, but not baseline or at any time point in the control condition, suggests that the relationship between self-reported emotions and cortisol concentrations is specific to the period of stress responding in the two active experimental conditions. Nonetheless, we conducted an area under the curve analysis with respect to zero as a sensitivity test (Pruessner et al., 2003). The emotion × condition interaction remained significant, $\beta = 0.63$, $t(45) = 2.72$, $p = 0.009$, $R^2_{\text{adjusted}} = 0.20$. The pattern of simple slopes was nearly identical. The only difference was that the correlation between the area under the curve and anxiety was slightly reduced in the self-focus condition, $r(18) = 0.39$, $p = 0.11$.

Table 3 Means (and *SDs*) of shame and anxiety reported as a result of the stressor as a function of experimental condition and gender

	Social threat ($n = 39$)		Self-focus ($n = 41$)		Mere presence ($n = 40$)	
	Men *M* (*SD*)	Women *M* (*SD*)	Men *M* (*SD*)	Women *M* (*SD*)	Men *M* (*SD*)	Women *M* (*SD*)
Shame	2.73 (1.62)	3.95 (2.07)	3.14 (1.80)	3.76 (1.86)	3.04 (1.72)	3.13 (1.69)
Anxiety	3.28 (1.66)	4.63 (1.54)	3.34 (1.66)	4.16 (1.43)	3.09 (1.71)	3.70 (1.32)

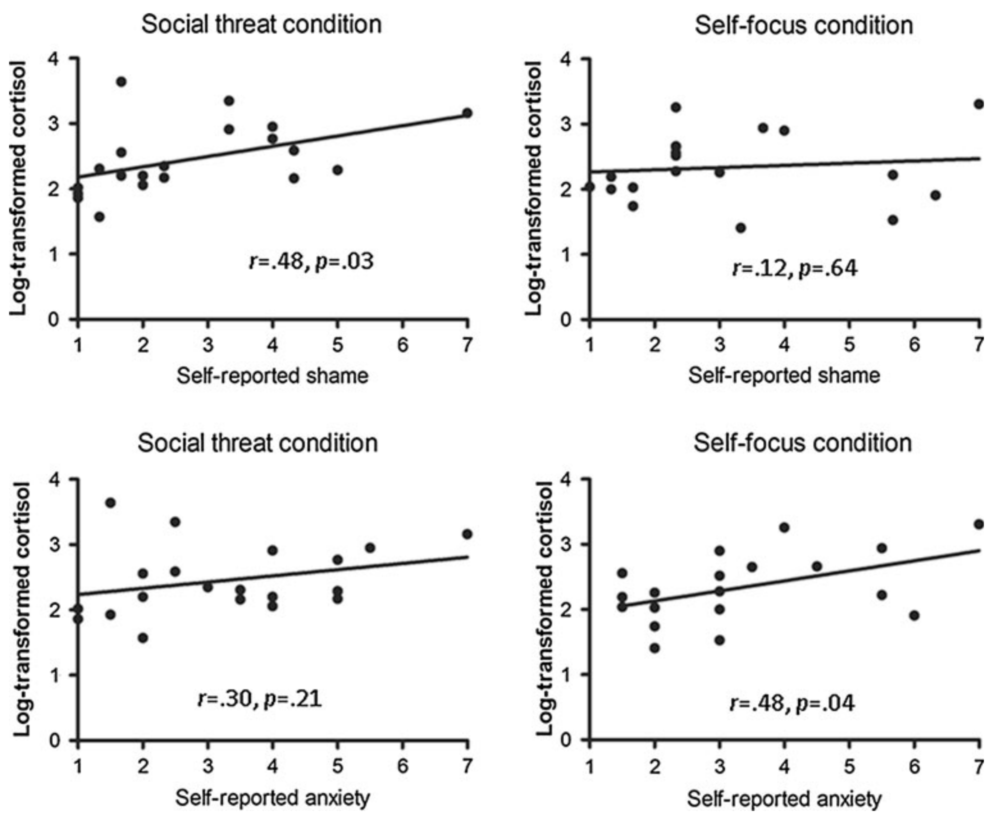

Fig. 2 Correlations between self-reported shame and anxiety with cortisol concentration at 12 min following stressor onset as a function of social threat or self-focus condition in men. Shame was significantly correlated with cortisol in the social threat condition and anxiety was significantly correlated with cortisol in the self-focus condition, but not vice versa

emotion × condition interactions for cortisol output following the task, $\beta = 0.71$, $t(45) = 2.76$, $p = 0.008$, $R^2_{\text{adjusted}} = 0.20$, and at recovery, $\beta = 0.73$, $t(45) = 2.61$, $p = 0.012$, $R^2_{\text{adjusted}} = 0.12$. Follow-up tests of the simple slopes revealed that for those in the social threat condition, shame was correlated with increased cortisol both following the task, $r(20) = 0.48$, $p = 0.03$, and at recovery, $r(20) = 0.43$, $p = 0.06$. By contrast, in the self-focus condition, there were no significant correlations between shame and cortisol following the task, $r(19) = 0.12$, $p = 0.64$, or at recovery, $r(19) = 0.15$, $p = 0.55$. However, in the self-focus condition anxiety was correlated with increased cortisol following the tasks, $r(19) = 0.48$, $p = 0.04$, and following recovery, $r(19) = 0.50$, $p = 0.03$. By contrast, in the social threat condition, there were no significant correlations between anxiety and cortisol following the task, $r(20) = 0.30$, $p = 0.21$, or at recovery, $r(20) = 0.34$, $p = 0.14$. See Fig. 2. There were no significant correlations in the control condition or between shame or anxiety and baseline cortisol concentrations in any of the conditions. We conducted analogous analyses for the mean arterial pressure responses. However, there were no significant interactions.[2]

Discussion

Within the context of a motivated performance stress-challenge task, the present study found that self-focus

[2] On an exploratory basis, we also examined the extent to which the manipulation checks (i.e., the extent to which participants endorsed focusing on themselves and others' opinions) interacted with the experimental conditions to predict cortisol and mean arterial pressure responses. These analyses revealed just one significant manipulation check × condition interaction on post-speech mean arterial pressure, $b = -0.37$, $t(109) = 2.76$, $p = 0.01$. Follow up tests revealed that self-reported increased focus on others' opinions was inversely related to mean arterial pressure in the social threat condition, $r(39) = -0.52$, but not in the other conditions.

increased cortisol responses in men to the same extent as being negatively evaluated by others. By contrast, the mere presence of a non-evaluative individual did not increase cortisol. Thus, self-focus within a motivated performance setting is sufficient to elicit a cortisol response comparable to that of social evaluative threat. These findings are consistent with specificity approaches to emotions: the notion that cognitive and emotional reactions can shape our physiological responses to acute stressors (Denson et al., 2009b; Dickerson & Kemeny, 2004; Lazarus & Folkman, 1984). Moreover, although self-focus and social threat broadly increased negative affectivity in comparable ways, the emotional correlates of cortisol reactivity were distinct. Shame was associated with increased cortisol in the social threat condition (which replicated Gruenewald et al., 2004) and anxiety was associated with increased cortisol in the self-focus condition. There were no significant correlations in the control condition. These data suggest the possibility that variation in emotional responding might be responsible for the intensity of cortisol reactivity when exposed to negative social evaluation and aversive self-focus.

Although originally intended as a model of behavior, objective self-awareness theory provides an explanation for how self-focus might have increased cortisol responses. Objective self-awareness theory recognizes the importance of the self in instigating self-regulatory behavior via self-criticism and anxiety. A period of self-focused attention is a prerequisite for becoming a "self-critical observer". Indeed, meta-analysis suggests that self-focused attention following a negative event increases negative affect (Mor & Winquist, 2002). The present findings extend this work, demonstrating that self-awareness induces HPA axis activation in response to stress, possibly via anxiety.

In the present research, increased cortisol in response to social threat and self-focus occurred only in men. Although previous studies have shown blunted cortisol responding to the TSST in women (for a review, see Kudielka & Kirschbaum, 2005), there were two limitations that precluded our ability to test for condition differences in cortisol reactivity in our female subsample. The first is that there was a failure of randomization—female participants in the mere presence condition had lower levels of cortisol at baseline compared to all other study conditions. Second, female participants in all three experimental conditions did not show significant increases in cortisol to the laboratory stress-challenge task. There are several possible physiological and psychological reasons for these effects in women. Although most published studies using the TSST report that freely cycling women show similar cortisol reactivity to men, a number of previous laboratory stress studies have found gender differences in cortisol stress responding, which is likely explained by differences in sex hormones (i.e., estrogens), post-menopausal status, or oral contraceptive use (Goldstein et al., 2010; Kajantie, 2008; Kudielka et al., 1998; Kudielka & Kirschbaum, 2005; Lovallo et al., 2010; Zoccola et al., 2010). A second possible explanation is that variation in the menstrual cycle can influence cortisol responses to stress (Kirschbaum et al., 1999; Symonds et al., 2004). Our research was limited in that we did not assess phase of menstruation in the present research, which could account for underlying differences in basal cortisol between groups and/or the lack of cortisol reactivity among women, as blunted cortisol responses to stress often occur during the follicular phase. Another possibility is that the women in the present research may have been experiencing higher levels of chronic stress than men. Chronic stress can cause hypocortisolemia (Fries et al., 2005) and blunted HPA axis activation in response to stress (Bellingrath & Kudielka, 2008). Moreover, a recent study reported that women experiencing high levels of chronic stress showed a blunted cortisol awakening response relative to women experiencing lower levels of stress (O'Connor et al., 2009). Moreover, although men and women did not differ in terms of age, we did not collect data on socioeconomic status or other background variables which may have accounted for the blunted effect in women.

Female non-reactivity could also be explained by underlying differences in the type of stressors females find stressful as other work suggests that men and women are physiologically responsive to different types of stressors. In this case, Stroud et al. (2002) observed that only males showed cortisol reactivity to a verbal and math stressor, which is like the TSST used in the present study. Men and women also differ in physiological reactivity to marital conflict depending on the behavior of their spouse, power dynamics, and perceived spousal support (Heffner et al., 2004; Kiecolt-Glaser et al., 1996; Loving et al., 2004). Consistent with the specificity approach, these findings are presumably influenced by cognitive appraisals and emotional responses as research suggests that men and women sometimes differ in their emotional reactions to stressors. Relevant to the present research, a meta-analysis found that the effect of self-focus on negative affect was greater in predominantly female samples compared to male-dominated samples (Mor & Winquist, 2002). Future research on gender and stress may clarify conditions under which self-focus may elicit cortisol responses in women.

Although the experimental manipulations impacted cortisol directly, they did not differentially impact self-reported shame and anxiety (i.e., there was no main effect of the experimental manipulations on shame or anxiety). As such only partial support was obtained for the notion that social threat and self-focus would increase cortisol responses via dissociable emotional pathways. Future research testing for condition differences could benefit by including baseline as well as post-stressor measures of emotional responding. Nonetheless, the largest increases in cortisol were observed in participants who reported experiencing relatively high levels of shame in the social threat condition and high levels of anxiety in the self-focus condition, but not vice versa. Thus, the specificity of emotional responses to the experimental manipulations was associated with subsequent levels of cortisol output. We interpret this as an indication that subtle within-condition differences in shame and anxiety may be driving cortisol responding in the social threat and self-focus conditions, respectively. However, we also note that we did not use standardized measures to assess emotion. Rather, we relied on a few select emotion items. Future research may benefit from including additional, well-validated self-report emotion measures as well as measures of implicit affect to further explore these emotion-cortisol relationships.

In the present research, all groups showed an increase in mean arterial pressure from baseline. This is largely consistent with research comparing a social-evaluative TSST to a condition in which participants performed the tasks alone (Dickerson et al., 2009; Gruenewald et al., 2004). In both experiments, both groups showed an increase from baseline in cardiovascular responses. One experiment reported no differences between groups in mean arterial pressure during the task (Dickerson et al., 2009); however another found a non-significant trend toward higher systolic blood pressure and heart rate in the social-evaluative condition (Gruenewald et al., 2004). The authors interpreted these findings as suggesting that participants were equally aroused and engaged in the tasks. Nonetheless, some caution is warranted as our blood pressure assessments were taken after the completion of the stressors, rather than during the stressor. Measurements taken during the stressor might have resulted in a maximal response such that increases in mean arterial pressure would have been greatest in one or both of our stress conditions relative to control. The present research was also limited in that we did not aggregate multiple measures of blood pressure over short periods of time. Thus, future research could incorporate multiple measures of cardiovascular activity taken throughout the duration of the stressor.

Our findings highlight the role of context in determining physiological responses to stress. Shame was correlated with higher concentrations of cortisol in the social threat condition, and only anxiety was associated with increased cortisol in the self-focus condition. Future research could investigate additional contexts by which anxiety might lead to increased cortisol responding. Indeed, a recent meta-analysis of social stressors and emotion inductions failed to find a significant relationship between fear and cortisol reactivity (Denson et al., 2009b). Nonetheless, the variability in effect sizes suggests that there are certain conditions in which anxious feelings might increase cortisol reactivity and individual studies report associations between anxiety and cortisol release (Walker et al., 2011). The present research derived from objective self-awareness theory contributes to our knowledge in this regard by identifying self-evaluation in motivated performance settings as one such context.

The present study also compliments and extends recent work on the relationship between rumination and cortisol. Rumination is sometimes defined as perseverative self-focused attention toward one's negative emotions (Nolen-Hoeksema et al., 2008). One study found that rumination was associated with prolonged cortisol recovery following a speech task (Zoccola et al., 2008). In another study, participants were provoked by the experimenter and induced to ruminate by writing about the insult (e.g., "the feelings and emotions you have towards the other people in the study you have encountered"), themselves (e.g., "what kind of person you are"), or a neutral topic (Denson et al., 2009a). Self-focused rumination maintained high levels of cortisol. These findings are consistent with a recent meta-analysis which found that acute stressors judged to elicit perseverative, brooding, self-focused rumination were associated with increased cortisol reactivity (Denson et al., 2009b). Future research could investigate the extent to which a critical self-consciousness is responsible for the impact of self-focused rumination on delayed cortisol recovery to stress.

Another promising avenue for future research could entail training attention toward positive aspects of the self. Self-awareness within stressful situations presumably focuses attention on negative aspects of the self; however, individuals who tend to focus on positive aspects of the self have lower cortisol responses to threatening situations (Creswell et al., 2005). Attentional training toward accepting stimuli reduces cortisol responses to stress (Dandeneau et al., 2007). Presumably training individuals to attend to positive aspects of the self should reduce the aversive effects of OSA during stress. Doing so would clarify why self-focus is physiologically and psychologically beneficial for some individuals and detrimental for others.

In summary, our data suggest that potential for negative evaluation increases cortisol regardless of whether this source comes from oneself or others. Although short-term and time-limited stress responses are adaptive in mobilizing energy for fight or flight (McEwen, 1998), a number of studies suggest that excessive or prolonged stress reactivity can result in increased susceptibility to a variety of negative physical health outcomes (e.g., upper respiratory tract infections, cardiovascular disease) (Cohen et al., 2002; Jennings et al., 2004; Matthews et al., 2006). The present findings provide one intriguing implication for these health findings, suggesting that the mere activation of self-consciousness within a motivated performance situation can influence HPA-axis activity in ways that may place individuals at risk.

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