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Narcissism predicts heightened cortisol reactivity to a psychosocial stressor in men

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ABSTRACT

Narcissists' sensitivity to social evaluation should increase their physiological reactivity to evaluative stressors. However, very few studies have assessed the physiological correlates of narcissism. In this study, participants completed an evaluative laboratory stressor or a non-evaluative control task. Cortisol reactivity—a marker of the hypothalamic–pituitary–adrenal (HPA) axis stress response—and negative affect (NA) were higher in the stress versus control condition. However, men showed larger cortisol responses and, among men, higher narcissism scores predicted greater cortisol reactivity and larger increases in NA. Narcissism was unrelated to cortisol reactivity and NA among women and in the control condition. These findings highlight the influence of defensive personality traits on HPA reactivity and suggest a pathway through which narcissistic traits might influence long-term health outcomes.

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1. Introduction

Narcissism is characterized by arrogance, feelings of grandiosity, a sense of entitlement, lack of empathy, and interpersonally exploitive behavior (Emmons, 1987; Raskin & Hall, 1979). Narcissistic individuals view themselves more favorably than they are viewed by others (e.g., John & Robins, 1994), especially in agentic domains (Paulhus & John, 1998). They overestimate their intelligence, attractiveness, and competence (Gabriel, Critelli, & Ee, 1994; Paulhus & John, 1998), and they are motivated by opportunities to reinforce their overly positive self-images (Morf, Weir, & Davidov, 2000; Wallace & Baumeister, 2002). Indeed, many aspects of narcissistic behavior can be characterized as defensive attempts to maintain an unrealistically positive self-view (Morf & Rhodewalt, 2001): Narcissists seek admiration rather than intimacy in close relationships (Campbell, 1999), they respond aggressively to negative feedback (e.g., Bushman & Baumeister, 1998), and they show positively biased recall of past events following interpersonal rejection (Rhodewalt & Eddings, 2002).

Although these strategies may serve some self-protective functions, they can nevertheless prove costly in other domains. For instance, the positive initial impressions that narcissists make on others tend to diminish over time (Paulhus, 1998), and narcissists' romantic relationships are generally characterized by lower levels of commitment and satisfaction (Foster, 2008). Chronic reliance on defensive strategies has also been associated with adverse physiological and health consequences (e.g., Rutledge, 2006); however, very little is currently known about the physiological implications of narcissism. In the present study, we examined a physiological system that should be particularly relevant to narcissism—the hypothalamic–pituitary–adrenal (HPA) axis. The HPA axis is one of the body's most important stress-response systems, and HPA reactivity is strongly influenced by threat of social evaluation (Dickerson & Kemeny, 2004), a psychological state that should be especially salient for narcissists. Moreover, because chronic dysregulation of the HPA axis has been associated with poor mental and physical health (e.g., Chrousos & Gold, 1992; McEwen, 2003), HPA reactivity may provide a link between narcissism and long-term health outcomes.[1]

The goal of the present study was to examine the influence of narcissism on physiological and psychological stress responses. Participants completed a modified version of the Trier Social Stress Test (TSST; Kirschbaum, Pirke, & Hellhammer, 1993; Yim, Quas, Cahill, & Hayakawa, 2010), an evaluative laboratory stressor that has been shown to elicit HPA reactivity, or a non-evaluative control task. Changes in salivary cortisol, a marker of HPA reactivity, and self-reported mood were assessed following the laboratory stressor or control task. We expected the TSST to be especially stressful for narcissistic individuals because it elicits a strong threat of social evaluation (Dickerson & Kemeny, 2004) and should be threatening

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[1] Narcissism can be observed both at clinical levels, reflecting personality disorder (American Psychiatric Association, 1994), and at sub-clinical levels, reflecting a normally distributed personality characteristic (Raskin & Hall, 1979). In our research and in the studies reviewed here, narcissism is assessed as a sub-clinical personality construct.

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specifically to characteristics that narcissists value, namely their sense of competence and agency (Paulhus & John, 1998).

1.1. The role of narcissism in physiological responses to social evaluation

In numerous studies, the TSST has been shown to elicit increases in both cortisol and reports of negative emotion (e.g., Dickerson & Kemeny, 2004; Kudielka, Schommer, Hellhammer, & Kirschbaum, 2004). Moreover, participants who report experiencing more negative emotions, particularly self-conscious negative emotions (e.g., shame, embarrassment), tend to show larger cortisol responses (e.g., Gruenewald, Kemeny, Aziz, & Fahey, 2004). Cortisol responses appear to be closely tied to the evaluative component of the TSST, as such responses are not observed when the task is performed without observers or when observers do not play an explicitly evaluative role (Dickerson, Mycek, & Zaldivar, 2008).

These findings suggest that participants who are particularly sensitive to social evaluation and prone to experience self-conscious emotions would show the largest cortisol responses to the TSST. In the current study, we investigated this idea by examining the influence of narcissism, a personality construct associated with extreme self-focus and need for admiration (Campbell, 1999; Emmons, 1984), on cortisol reactivity. Narcissists are especially sensitive to evaluation by others (Twenge & Campbell, 2003), particularly likely to experience shame (Tracy & Robins, 2004; P. J. Watson, Hickman, & Morris, 1996), and highly reactive to shame-inducing experiences (Thomaes, Bushman, Stegge, & Olthof, 2008), all of which should predict greater cortisol reactivity to evaluative stressors such as the TSST (Gruenewald et al., 2004).

To our knowledge, prior work on narcissism has not assessed HPA responses to psychosocial stressors, although there is some evidence linking narcissism with heightened cardiovascular reactivity, a measure of the autonomic nervous system (ANS) stress response. For instance, one study of men found that higher scores on the Narcissistic Personality Inventory (NPI), the most widely used measure of sub-clinical narcissism, predicted greater cardiovascular reactivity during anticipation of aversive stimuli (Kelsey, Ornduff, McCann, & Reiff, 2001). A more recent study examined changes in heart rate and blood pressure while participants imagined rejection or acceptance scenarios (Sommer, Kirkland, Newman, Estrella, & Andreassi, 2009). In this study, NPI scores predicted *lower* cardiovascular responses across tasks, whereas another measure of narcissism predicted greater cardiovascular reactivity only during the rejection scenarios. Although these findings provide some evidence that narcissists experience greater physiological arousal during stressful tasks, there is some inconsistency across tasks and measures, which may be due, in part, to the focus on the ANS stress response. ANS responses, such as cardiovascular reactivity, are elicited by psychosocial stressors, but such responses are less sensitive to the evaluative component of these stressors per se (Gruenewald et al., 2004; Schwabe, Haddad, & Schachinger, 2008). ANS responses may also be responsive to other, potentially confounding variables such as task engagement and effort (Peters et al., 1998). As Sommer et al. argue, work in this area may benefit from focusing specifically on the HPA stress response, which is more sensitive to evaluative threat.

To summarize, extant research on narcissism has not examined HPA reactivity to psychosocial stressors, which should be particularly relevant to narcissistic concerns and goals. In the present study, we expected that individuals with higher narcissism scores would show a larger cortisol response following a socially evaluative laboratory stressor, and that the relation between narcissism and cortisol reactivity would not be observed following the non-evaluative control task.

1.2. Additional considerations

Because laboratory stressors such as the TSST have been shown to increase the experience of negative emotion (e.g., Federenko, Nagamine, Hellhammer, Wadhwa, & Wust, 2004), we also assessed participants' subjective emotional responses to the experimental tasks. Insofar as narcissists experience greater distress during such stressors, we expected to see increases in both self-reported negative emotion and cortisol reactivity. However, there is also evidence for dissociations between self-reported negative emotion and cortisol responses to stressful experiences (Abelson, Liberzon, Young, & Khan, 2005; Dickerson & Kemeny, 2004), suggesting that the two kinds of responses are not necessarily isomorphic. That is, participants who report high levels of negative emotion may not necessarily show the largest cortisol responses. Self-enhancement biases, which are particularly likely among narcissists (e.g., John & Robins, 1994), may also distort self-reports of negative emotion. Therefore, in the present study, we were particularly interested in the extent to which narcissism might differentially influence psychological and physiological stress responses.

Finally, it is important to consider the role of gender in responses to psychosocial stressors such as the TSST. Men typically show larger increases in cortisol compared to women (see Kudielka & Kirschbaum, 2005) and, although gender differences in narcissism are typically small, men often score higher than women on measures such as the NPI (e.g., Foster, Campbell, & Twenge, 2003). Thus, to the extent that both narcissism scores and cortisol responses are higher among men, failing to account for gender could inflate the overall relation between narcissism and cortisol reactivity.

2. Method

2.1. Participants

Participants were 90 undergraduate students (51% female; *M* age = 20.57, *SD* = 2.91) who received either course extra-credit or monetary compensation for their participation. Thirty-four percent of participants identified as Caucasian, 33% as Asian–American, 12% as Hispanic, 10% as multiethnic, and 11% as of other ethnicities. Individuals with chronic health conditions and smokers were excluded, as these factors are known to influence cortisol reactivity. In addition, because cortisol reactivity varies according to menstrual cycle phase (Kirschbaum, Kudielka, Gaab, Schommer, & Hellhammer, 1999), and a portion of this study involved collecting saliva samples at a later date (see Quas, Yim, Edelstein, Cahill, & Rush, submitted for publication), only women on oral contraceptives were included. All procedures were approved by the University of California, Irvine, Institutional Review Board.

2.2. Procedure

All participants were tested individually in sessions beginning between 1 pm and 4 pm to control for diurnal variation in cortisol levels. After informed consent was obtained, participants completed a series of background questionnaires, including measures of their current mood. The first baseline saliva sample was obtained after a 20-min adaptation period. Next, participants completed one of two laboratory tasks: a slightly modified version of the Trier Social Stress Test (TSST-M; see below and Yim et al. (2010) for additional details) or a non-evaluative control task.

Participants who completed the TSST-M were videotaped while giving a speech and performing a mental arithmetic task in front of two observers (one male, one female). As is standard in the TSST, the observers were instructed to behave in an emotionally neutral

manner and to refrain from providing positive feedback to participants. Participants were given 3 min to prepare a 6-min speech, in which they described themselves to potential classmates, and they were informed that the videotapes would later be shown to experts who would analyze their behavior. When participants stopped speaking, they were asked scripted questions by the observers. The speech was followed by a 4-min mental arithmetic task involving serial subtraction of the number 13 from 1027 aloud.[2] At 1, 10, 20, 30, 45, 60, and 75 min relative to the end of the TSST-M, additional saliva samples were collected to capture the trajectory of cortisol changes across the session. Cortisol reactivity generally peaks approximately 20 min post-stressor (Dickerson & Kemeny, 2004), so we sampled at closer intervals around this time point. To prevent carryover effects from the TSST-M, participants in the stress condition completed the narcissism measure as part of a larger battery of questionnaires during a second session approximately two weeks later (see Quas et al., submitted for publication).

Participants in the control condition completed a series of questionnaires for the approximate duration of the TSST-M. The questionnaires, which included the narcissism measure, were completed in the absence of observers. Saliva samples were collected at times that paralleled those for participants in the TSST-M condition.

2.3. Measures

Narcissism was assessed using the Narcissistic Personality Inventory (NPI-40; Raskin & Terry, 1988), which consists of 40 forced-choice items. For each item, participants are asked to choose one of two options (e.g., "I am more capable than other people" vs. "There is a lot that I can learn from other people"). The number of narcissistic options that each participant endorses is summed to produce a total narcissism score, which can therefore range from 0 to 40. Internal consistency of the NPI in the present study was .81.

Positive and negative mood were assessed using the state version of the Positive and Negative Affect Schedule (PANAS; D. Watson, Clark, & Tellegen, 1988), which includes two 10-item subscales corresponding to positive and negative affect. Participants rated the extent to which they currently felt each of 20 emotions (e.g., distressed, scared, proud), using a 5-point Likert scale ranging from 1 "not at all" to 5 "extremely." Items are averaged within each subscale to yield mean scores for positive and negative affect. The PANAS was administered prior to and immediately after the stressor or control task and internal consistencies ranged from .70 to .91 for the individual subscales.[3]

2.4. Salivary cortisol

Salivary cortisol was assessed at eight points throughout the experimental session using the Salivette sampling device (Sarstedt, Nümbrecht, Germany). Samples were stored at room temperature until completion of the session, and then kept at −70 °C until assayed. After thawing for biochemical analysis, samples were centrifuged for 10 min at 2000*g* and 4 °C. The fraction of free cortisol in saliva (salivary cortisol) was determined by a commercially available enzyme immunoassay (ELISA, IBL-America, Minneapolis, Minnesota). The sensitivity of the assay is reported at 0.033 nmol/L, and the assay dynamic range is between 0 and 82.77 nmol/L. Inter- and intra-assay coefficients of variance are reported by IBL at 4.9% and 4.1%, respectively. All samples were assayed in duplicate. One participant in the control condition had missing data for the +45 and +60 cortisol assessments and one participant in the stress condition had missing data for the +60 assessment. Cortisol values were log-transformed to reduce skewness, and the transformed variables were used in subsequent analyses. However, for ease of interpretation, values in the tables and figure are reported in untransformed (nmol/L) values.

3. Results

3.1. Preliminary analyses

Descriptive statistics and correlations among the primary pre-task variables are presented in Table 1. As shown in Table 1, the control ($n = 42$; 50% female) and stress ($n = 48$; 52% female) groups were comparable in terms of gender, pre-task cortisol levels, narcissism scores, and pre-task positive affect, all $ps > .79$, although participants in the stress condition had somewhat higher pre-task levels of negative affect, $p = .07$. In addition, gender was unrelated to pre-task cortisol levels, narcissism scores, and negative and positive affect, all $ps > .12$.

To obtain a summary marker of cortisol increases during the experimental session, we computed an index of area under the curve with respect to increases over baseline (AUC_i) using the trapezoid formula (Pruessner, Kirschbaum, Meinlschmid, & Hellhammer, 2003). AUC_i was computed through the +30 cortisol assessment, the time point for which we had complete data for all participants. Descriptive statistics and correlations among AUC_i, changes in mood, and narcissism scores are presented by condition and gender in Table 2. As shown in Table 2, for men, the stress manipulation resulted in significantly higher AUC_i compared to the control condition, $t(42) = 4.19$, $p < .001$, $d = 1.3$, but this effect was not significant for women, $t(44) = .61$, $p = .54$, $d = .19$. In addition, time of day was unrelated to pre-task cortisol levels, $r = -.06$, $p = .59$, but was positively correlated with AUC_i, $r = .30$, $p < .01$, indicating larger cortisol responses in the later afternoon sessions. However, time of day was not a significant of predictor of cortisol trajectories (discussed below), and including this variable in subsequent analyses did not change the interpretation or significance of our main findings, so analyses are reported without time of day as a covariate.

3.2. Cortisol reactivity

Cortisol analyses were conducted using the SAS 9.2 PROC MIXED multilevel modeling procedure (see Singer & Willett,

Table 1
Descriptive statistics and correlations among primary pre-task variables.

	1	2	3	4	5
1. NPI					
2. Pre-task NA	.05				
3. Pre-task PA	.12	.12			
4. Pre-task cortisol	−.05	.13	.18		
5. Gender	−.08	−.16	.13	.17	
6. Condition	−.02	.20	.02	.03	−.02
Mean	15.54	1.33	2.55	4.18	–
SD	1.39	.30	.63	4.76	–

Note. $N = 90$, except for pre-task mood variables ($n = 80$); NPI = Narcissistic Personality Inventory, scores range from 3 to 31; NA = negative affect, PA = positive affect; cortisol levels are reported in nmol/L; gender: 0 = female, 1 = male; condition: 0 = control, 1 = stress.

[2] Participants in the current study were part of a larger study of age differences in stress responses, and the standard TSST was therefore modified slightly to make it more suitable for use with child participants. These modifications included increasing the length of the speech from 5 to 6 min, and decreasing the length of the subtraction task from 5 to 3 min. In addition, the evaluators were emotionally neutral but maintained some eye contact with participants.

[3] Ten participants in the control group did not complete the pre-task PANAS. These participants are therefore not included in analyses of changes in mood over time. The 10 participants missing pre-task PANAS data did not significantly differ from the rest of the control participants in post-task negative affect, $t(40) = .73$, $p = .47$, $d = .27$, or positive affect, $t(40) = -1.67$, $p = .10$, $d = .62$.

Table 2
Descriptive statistics and correlations among cortisol responses, mood changes, and narcissism scores by condition and gender.

	Stress condition						Control condition					
	Men (n = 23)			Women (n = 25)			Men (n = 21)			Women (n = 21)		
	Cortisol increase (AUC_i)	NA change	PA change	Cortisol increase (AUC_i)	NA change	PA change	Cortisol increase (AUC_i)	NA change[a]	PA change[a]	Cortisol increase (AUC_i)	NA change[b]	PA change[b]
NPI	.31	.53**	−.40*	−.19	−.32	−.11	.13	.38	.28	.08	−.32	.29
Cortisol increase (AUC_i)		−.10	−.11		−.19	.31		.24	.03		.31	.05
Mean	167.92	.30	.10	37.92	.37	−.07	−60.68	−.51	.03	17.48	−.50	−.07
SD	305.57	.79	.41	120.29	.75	.60	147.90	.18	.42	84.79	.16	.46

Note. Cortisol increase corresponds to the area under the curve increase (AUC_i) with respect to baseline; Cortisol levels are reported in nmol/L; NPI = Narcissistic Personality Inventory, NA = negative affect, PA = positive affect; changes in NA and PA are reported as residualized change scores.
[a] n = 17.
[b] n = 15.
* p < .06.
** p < .01.

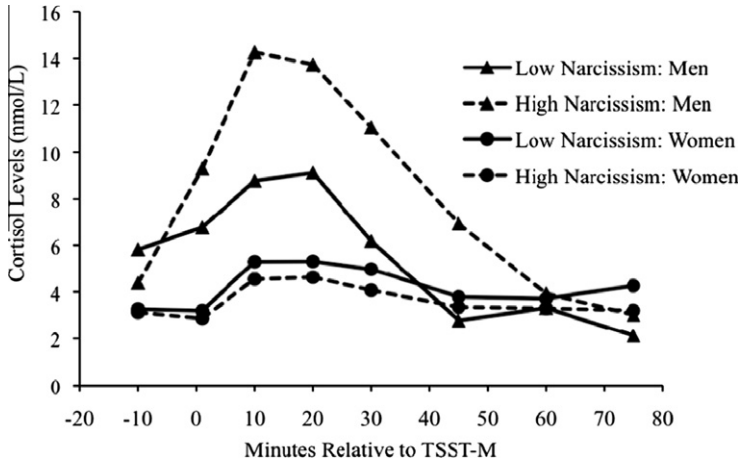

Fig. 1. The relation between Narcissistic Personality Inventory (NPI) scores, gender, and cortisol responses in the stress condition. At each time point, simple slopes are plotted separately by gender for individuals at one standard deviation above and below the mean of NPI scores (see Aiken & West, 1991).

2003), which allows for estimation of both within-person trajectories in cortisol responses and between-person differences in these trajectories. Multilevel modeling of cortisol responses over time has several advantages over analyses that use aggregated measures of cortisol, such as AUC (Hruschka, Kohrt, & Worthman, 2005; Nicolson, 2007). For instance, multilevel models can accommodate missing observations in the repeated assessments and they explicitly account for the dependence among repeated cortisol assessments from the same person, resulting in greater statistical power compared to analyses of aggregated measures (Hruschka et al., 2005).

We first examined whether the TSST-M produced larger increases in cortisol compared to the control task. Initial analyses indicated that, in the stress condition, cortisol responses were best characterized by a significant curvilinear pattern, with cortisol levels increasing after the TSST-M, peaking 10–20 min afterwards, and returning to baseline levels across later assessments. Both the linear (time) and quadratic (time^2) effects of time were therefore included in subsequent cortisol analyses, and we specifically examined whether the experimental manipulation and gender affected the quadratic cortisol response (i.e., the extent of increase over time). Results revealed a significant effect of time^2, b = −.08, SE = .009, $t(523)$ = −8.87, p < .001, and significant interactions between time^2 and condition, b = .06, SE = .01, $t(523)$ = 5.15, p < .001; and time^2 and gender, b = .04, SE = .01, $t(523)$ = 2.99, p < .01; all of which were qualified by a three-way interaction among time^2, condition, and gender, b = −.04, SE = .02, $t(523)$ = −2.50, p < .05.

Decomposing these interactions revealed that, in the stress condition, men showed a larger cortisol increase compared to women, b = −.08, SE = .01, $t(158)$ = −8.04, p < .001, and b = −.04, SE = .01, $t(173)$ = −4.43, p < .001, respectively (see Yim et al. (2010) for additional details). In the control condition, however, cortisol responses were best characterized by a linear effect of time, b = −.18, SE = .02, $t(290)$ = −9.43, p < .001, with cortisol levels gradually decreasing across the experimental session (as is typical of diurnal cortisol levels). The effects of time^2 and time^2 × gender were not significant among control participants, b = −.01, SE = .01, $t(288)$ = −1.25, p = .21, and b = −.01, SE = .01, $t(288)$ = −.60, p = .55, respectively.

Next, we examined whether cortisol responses varied as a function of participants' narcissism scores. For this analysis, the linear and quadratic effects of time were again included, along with NPI scores, gender, experimental condition, and all two-way and three-way interactions among these variables. In addition to the effects of time^2, gender, and condition reported above, results from this analysis revealed a significant interaction among time^2 and NPI scores, b = −.11, SE = .05, $t(516)$ = −2.13, p < .05; time^2, NPI

scores, and condition, $b = .23$, $SE = .08$, $t(516) = 2.83$, $p < .01$; and time^2, NPI scores, and gender, $b = .20$, $SE = .07$, $t(516) = 2.78$, $p < .01$, all of which were qualified by a four-way interaction among time^2, NPI scores, condition, and gender, $b = -.34$, $SE = .11$, $t(516) = -2.99$, $p < .01$.

Decomposing this interaction revealed that, in the stress condition, higher NPI scores predicted a significant cortisol increase among men, $b = -.11$, $SE = .06$, $t(156) = -1.93$, $p = .05$, but NPI scores were not significantly related to cortisol increases among women, $b = .09$, $SE = .05$, $t(171) = 1.60$, $p = .11$. (Note that negative regression coefficients for time^2 reflect cortisol *increases*.) In the control condition, NPI scores were unrelated to cortisol increases in both men, $b = .11$, $SE = .07$, $t(143) = 1.63$, $p = .11$, and women, $b = -.03$, $SE = .07$, $t(141) = -.47$, $p = .64$. Fig. 1 is a graphical depiction of predicted cortisol responses by gender and NPI scores in the stress condition. Following procedures recommended for plotting interactions between continuous predictors in multiple regression and multilevel modeling (Aiken & West, 1991; Curran, Bauer, & Willoughby, 2006), we plotted the simple slopes for participants one standard deviation above and below the mean of narcissism scores at each of the eight time points.

Thus, as expected, higher NPI scores were associated with greater cortisol reactivity following the socially evaluative stressor, although this effect was observed only among male participants. NPI scores were unrelated to cortisol trajectories for both men and women in the non-evaluative control condition.[4]

3.3. Self-reported mood

To examine changes in mood across the experimental session, we computed residualized change scores by regressing post-task mood scores on pre-task scores and saving the residuals. Positive residualized change scores indicate increases over time and negative scores indicate decreases over time. Pre- to post-task increases in negative affect were greater for participants in the stress condition, $M = .34$, $SD = .76$, compared to those in the control condition, $M = -.51$, $SD = .17$, $t(78) = 6.14$, $p < .001$, $d = 1.39$. Pre- to post-task changes in positive affect did not differ significantly across conditions, $t(78) = .22$, $p = .83$, $d = .05$. The TSST-M therefore reliably increased negative affect compared to the control task but had little effect on positive affect. In addition, as shown in Table 2, changes in negative affect were not significantly correlated with AUC_i in either condition, although correlations in the control condition were in the positive direction.

We next examined individual differences in changes in mood across the experimental session. Regression analyses were conducted, predicting the residualized difference scores from NPI scores, experimental condition, and gender. The latter two variables were dummy-coded and the NPI variable was centered prior to analysis. All two- and three-way interactions were included. For changes in negative affect, $R^2 = .44$, $F(7, 72) = 8.04$, $p < .001$, we found a main effect of experimental condition, $\beta = .59$, $SE = .13$, $t(72) = 6.52$, $p < .001$. Replicating earlier analyses, participants in the experimental condition reported larger increases in negative affect compared to those in the control condition. In addition, there was a significant interaction between gender and NPI scores, $\beta = .23$, $SE = .84$, $t(72) = 2.51$, $p < .05$, and the interaction among experimental condition, gender, and NPI scores approached significance, $\beta = .18$, $SE = 1.70$, $t(72) = 1.87$, $p < .06$. As shown in Table 2, decomposing this interaction revealed that, for men in the stress condition, NPI scores predicted significant increases in negative affect. However, NPI scores were not significantly correlated with changes in negative affect for women in the stress condition or for men and women in the control condition. Thus, the pattern of findings for self-reported negative affect were similar to those for cortisol reactivity: Men's NPI scores predicted increases in negative affect in the stress but not control condition, and women's NPI scores were unrelated to changes in negative affect across conditions. When the same regression analysis was conducted predicting changes in positive affect, the overall equation was not significant, $R^2 = .07$, $F(7, 72) = .82$, $p = .57$.[5,6]

4. Discussion

The goal of the present study was to examine the influence of narcissism on responses to a psychosocial stressor. Although narcissism has been associated with heightened sensitivity to social evaluation, which should increase physiological and psychological stress responses, relatively little work has examined these hypotheses. We exposed participants to a socially evaluative stressor—a version of the widely used TSST—or a non-evaluative control task, and assessed changes in salivary cortisol and self-reported affect across the experimental session. Consistent with prior research (e.g., Federenko et al., 2004; Kirschbaum et al., 1993), cortisol levels and negative affect were higher among participants in the stress versus control condition. However, the effects of the stressor were moderated by gender and by participants' narcissism scores. Specifically, among male participants, higher narcissism scores predicted greater cortisol reactivity and larger increases in negative affect following the stressor. Narcissism was unrelated to cortisol trajectories and negative affect among women and in the non-evaluative control condition.

These findings extend prior work on narcissism by demonstrating that this personality construct predicts physiological stress re-

[4] To control for any baseline differences in cortisol, we re-conducted our analyses with the pre-task cortisol sample as a covariate and the remaining seven samples as indicators of the cortisol response. Baseline cortisol levels were a significant predictor of later cortisol responses in this analysis, $b = .63$, $SE = .17$, $t(193) = 3.65$, $p < .001$, reflecting significant rank-order stability of cortisol levels over time. However, baseline cortisol levels were not significantly associated with either the linear or quadratic effects of time, $b = -.11$, $SE = .08$, $t(392) = -1.49$, $p = .14$, and $b = .01$, $SE = .009$, $t(445) = 1.25$, $p = .21$, respectively, indicating that cortisol trajectories were largely independent of initial status. In addition, although some of the effects involving time and time^2 decreased in magnitude with baseline cortisol levels covaried, the majority of effects remained statistically significant, most importantly the interaction among NPI scores, time^2, condition, and gender, $b = -.86$, $SE = .23$, $t(445) = -3.75$, $p < .001$. Thus, our main findings do not appear to be driven by baseline differences in cortisol.

[5] We also examined whether our findings were specific to any of the four NPI subscales identified by Emmons (1984): exploitativeness/entitlement (EE), superiority/arrogance (SA), leadership/authority (LA), and self-absorption/self-admiration (SS). For cortisol, when the total NPI score was replaced with each of the four NPI subscales (in separate multilevel models), significant four-way interactions emerged among EE scores, time^2, condition, and gender, $b = -.27$, $SE = .08$, $t(514) = -3.22$, $p < .01$, and among SA scores, time^2, condition, and gender, $b = -.17$, $SE = .09$, $t(518) = -1.93$, $p = .05$. The four-way interactions involving LA scores and SS scores were not statistically significant, $b = -.06$, $SE = .07$, $t(517) = -.87$, $p = .39$ and $b = -.06$, $SE = .07$, $t(517) = -.81$, $p = .42$, respectively. For negative affect, when the total NPI score was replaced with each of the four NPI subscales (in separate regression equations), a significant three-way interaction emerged among SA scores, condition, and gender, $\beta = .19$, $SE = 1.27$, $t(72) = 2.05$, $p < .05$, and the three-way interactions involving LA scores and SS scores approached significance, $\beta = .16$, $SE = 1.03$, $t(72) = 1.76$, $p = .08$, and $\beta = .17$, $SE = 1.13$, $t(72) = 1.77$, $p = .08$, respectively. The three-way interaction involving EE scores was in the same direction but was not statistically significant, $\beta = .11$, $SE = 1.30$, $t(72) = 1.04$, $p = .30$. Thus, our cortisol findings appear to be strongest for the EE and SA subscales, and our negative affect findings are generally consistent across subscales. However, because of the relatively low reliabilities of these subscales (ranging from .51 to .67 in the current study), conclusions about their independent effects should be interpreted cautiously.

[6] Because narcissism tends to be positively correlated with self-esteem (e.g., Emmons, 1984), and self-esteem has been shown to attenuate physiological and psychological responses to laboratory stressors (e.g., Chida & Hamer, 2008), we also examined whether including self-esteem in our analyses changed any of the effects reported here. For both the cortisol and mood analyses, all significant effects remained so when self-esteem and the interactions among self-esteem and our main study variables were included.

sponses, at least for men, and that such effects may be specific to evaluative contexts. In a recent review of the literature, Campbell and Campbell (2009) argue that the benefits of narcissism tend to be short-term, whereas the costs are more likely to play out over time. Moreover, they argue that the costs of narcissism are higher for those interacting with the narcissist than for the narcissist him- or herself. For instance, although narcissists report many desirable characteristics (e.g., Emmons, 1984) and make positive initial impressions on others (Paulhus, 1998), they are also likely to be manipulative, controlling, and unfaithful in close relationships (Campbell, Foster, & Finkel, 2002). Over time, narcissists tend to become disliked, unpopular, and poorly adjusted (Cramer & Jones, 2008; Paulhus, 1998). The present findings suggest a potential short-term cost experienced by narcissists themselves, namely heightened physiological and psychological reactivity to interpersonal stressors. Such responses may be less readily apparent to observers but, to the extent that they are experienced chronically, they could nevertheless contribute to adverse long-term outcomes for narcissistic individuals.

Our findings also contribute to work on the psychological precursors of HPA reactivity. Chronic HPA dysregulation has been related to poor mental and physical health outcomes (e.g., Chrousos & Gold, 1992), making the investigation of factors predisposing individuals to such dysregulation especially important. Despite decades of research on this topic, however, relatively few personality constructs have emerged as consistent predictors of HPA responses (Kudielka, Hellhammer, & Wüst, 2009). In fact, results from a recent meta-analysis indicated that negative characteristics, such as anxiety, did not reliably predict HPA responses (Chida & Hamer, 2008). The present findings suggest that negative traits more closely linked to social evaluation, such as narcissism, may be a more fruitful avenue of exploration in this area of research.

Moreover, insofar as narcissistic individuals are particularly prone to chronic HPA stress responses outside the laboratory, they could suffer poor health outcomes over time. An important direction for future research would be to examine whether the influence of narcissism on HPA activity extends to other evaluative contexts, including those likely to be experienced in the real world (e.g., Rohleder, Beulen, Chen, Wolf, & Kirschbaum, 2007), and whether such responses might contribute to long-term health outcomes. Assessing a broader range of physiological stress responses, such as measures of autonomic nervous system activity (e.g., salivary alpha-amylase, skin conductance), would be another important step toward a more complete understanding of narcissistic responses to social stressors.

It is important to note, however, that in the current study the effects of narcissism were observed only among male participants. With respect to cortisol, this is likely because, as in prior work (e.g., Kudielka & Kirschbaum, 2005), female participants showed a weaker cortisol response to the TSST-M compared to male participants. These differences may have been due in part to females' oral contraceptive use (e.g., Kirschbaum, Pirke, & Hellhammer, 1995), although there is evidence for greater reactivity among men even when birth control use is considered (e.g., Kirschbaum et al., 1999). There is also evidence that achievement-related stressors, like the TSST, elicit larger cortisol responses among men than women, whereas stressors involving social rejection elicit larger cortisol responses among women compared to men (Stroud, Salovey, & Epel, 2002). Thus, in future research, it will be important to include normally cycling women and to assess a broader range of interpersonal stressors to better understand the influences of gender and narcissism on HPA reactivity.

With respect to mood, it is noteworthy that men and women reported similar overall increases in negative affect following the TSST-M, yet the effects of narcissism on negative affect were nevertheless limited to men. The reasons for these gender differences are not immediately clear. Although there is some evidence that men score higher on measures of narcissism such as the NPI (e.g., Foster et al., 2003), gender differences in the *effects* of narcissism are much less common (see Campbell & Foster, 2007). In one relevant exception, Morf and colleagues found that narcissistic men were more motivated by tasks that allowed them to demonstrate their superiority over others than by tasks that provided opportunities for learning (Morf et al., 2000). Narcissism was unrelated to women's task engagement, however, suggesting that narcissistic men may be more responsive to opportunities for self-enhancement compared to narcissistic women. These findings again point to the need in future research for tasks that elicit self-presentation concerns for both men and women.

It will also be important to include more nuanced control conditions in future studies of narcissism and stress reactivity. The stressor used in the present study likely differed from the control task in the extent to which it elicited participants' sense of self-focus, motivation for achievement, and concerns about negative evaluation. Although all of these components of the TSST-M should be relevant to narcissistic concerns and goals, the design of the current study makes it impossible to evaluate the relative contributions of these different components. Valuable knowledge could be gained by manipulating these different components independently, for instance by comparing stressors that involve performance demands but differ in the extent of evaluation by others (see Dickerson et al., 2008).

The current study also cannot address the physiological implications of narcissism in other age groups. There is evidence that narcissism decreases with age into later adulthood (Foster et al., 2003); perhaps the physiological manifestations of narcissism change as well. Unfortunately, the vast majority of research on narcissism has focused on young adulthood, and the few studies linking narcissism with physiological processes have assessed only college-student participants (e.g., Sommer et al., 2009). Studying the physiological implications of narcissism beyond young adulthood is important because the adverse effects of narcissism may accumulate over time (Campbell & Campbell, 2009; Cramer & Jones, 2008). Narcissism may also become more maladaptive with age (Wink, 1992), potentially increasing the risk of adverse physiological and health outcomes.

Finally, prior research has convincingly shown that the TSST increases self-conscious negative emotions more than other kinds of negative emotions, and that increases in self-conscious emotions are associated with larger cortisol responses (e.g., Gruenewald et al., 2004). Narcissistic individuals are thought to be particularly concerned with the regulation of shame (e.g., Robins, Tracy, & Shaver, 2001), suggesting that increases in shame may have mediated the findings we observed here. Unfortunately, our measure of negative affect did not adequately assess self-conscious emotions, so we were unable to evaluate this possibility. Future research should include a more comprehensive assessment of self-conscious emotions when examining narcissism and cortisol responses, perhaps even including behavioral observations of these affective states. It would also be useful to assess participants' appraisals of the stressor, to determine how such appraisals influence both self-conscious emotions and cortisol responses. Bushman and Baumeister (1998, study 2), for instance, found that threat perceptions mediated the relation between narcissism and aggression: Highly narcissistic individuals perceived negative feedback as more threatening than less narcissistic individuals, and these threat perceptions increased aggression toward the source of the feedback.

In conclusion, our findings highlight the influence of defensive personality traits on physiological and psychological stress responses. We found that narcissism predicted increased cortisol reactivity and self-reported negative affect among male participants exposed to an interpersonal stressor. Given the links be-

tween chronic HPA axis dysregulation and disease, findings from the current study suggest a possible pathway through which narcissistic traits might influence long-term health outcomes.

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