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Implicit need for achievement predicts attenuated cortisol responses to difficult tasks

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A B S T R A C T

The present research tested the hypothesis that the implicit need for achievement (n Achievement) predicts attenuated cortisol (C) responses to difficult tasks, because it represents a propensity to view difficulty as a cue to mastery reward. In two studies, n Achievement was assessed through content-coding of imaginative stories and salivary C was assessed both at baseline and post-task. In Study 1 ($N = 108$ US students), n Achievement predicted an attenuated C response to a one-on-one competition in the laboratory, regardless of whether participants won or lost. In Study 2 ($N = 62$ German students), n Achievement predicted an attenuated C response to the Trier Social Stress Test (Kirschbaum, Pirke, & Hellhammer, 1993), but not to a non-stressful control task. In Study 2 only, the attenuating effect of n Achievement was moderated by gender, with only men showing the effect. Across both studies, the average effect size of the association between n Achievement and C responses to difficult tasks was $r = -.28$. These findings point to a role of n Achievement in emotion regulation.

1. Introduction

A growing literature documents that implicit motives, that is, nonconsciously operating affective preferences for specific classes of incentives (McClelland, Koestner, & Weinberger, 1989; Schultheiss, 2008), are closely associated with the release of hormones from the hypothalamic–pituitary–adrenal (HPA) and the hypothalamic–pituitary–gonadal (HPG) axes (for an overview, see Schultheiss, 2013). For instance, the need for power (or n Power), a preference for having impact on others (Winter, 1992), is associated with basal levels of testosterone in men and estradiol in women and predicts changes in these hormones in response to experimental variations in dominance victory and defeat (Stanton & Schultheiss, 2009). The need for affiliation (n Affiliation), a preference for establishing, maintaining, or restoring close, friendly relationships with others (Koestner & McClelland, 1992), is reciprocally associated with the release of progesterone (Schultheiss, Wirth, & Stanton, 2004; Wirth & Schultheiss, 2006). However, so far comparatively little is known about the hormonal correlates of the need for achievement (n Achievement), a preference for doing things better and surpassing standards of excellence (McClelland & Koestner, 1992). In the present research, we explore the notion that this motive has a damping effect on HPA activation in response to challenging tasks under conditions of competition (Study 1) and public speaking (Study 2).

1.1. n Achievement: Measurement and concept

n Achievement is assessed with the picture-story exercise (PSE; McClelland et al., 1989), a descendant of Morgan and Murray's (1935) Thematic Apperception Task. PSE measurement of n Achievement is based on causal validation studies (see Borsboom, Mellenbergh, & van Heerden, 2004; McClelland, 1958) in which achievement motivation was experimentally aroused in a group of participants by having them work on personally challenging tasks. Control participants worked on the same tasks under neutral conditions. All participants then wrote stories about the same set of picture cues, which depicted a variety of achievement-related situations. Researchers found that arousal- and control-group participants' stories systematically differed in their content, with the former writing more frequently than the latter about long-term goals, unique accomplishment, or competing with a standard of excellence. These differences were distilled into coding manuals, allowing researchers in subsequent studies to assess dispositional differences in the spontaneous occurrence of achievement-related thoughts (McClelland, Atkinson, Clark, & Lowell, 1953; for replications, see Haber & Alpert, 1958; Klinger, 1967; Pang, 2010; Schroth, 1987). Thus, the PSE measure of n Achievement presents a window into the process of how individuals automatically construe challenging, achievement-related situations. It has little overlap with questionnaire measures of the self-attributed need to achieve, that

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is, of how people *think* they typically behave when faced with challenging tasks (Spangler's, 1992, meta-analysis yielded an average correlation of .09 between both types of measures) – hence the term *implicit*.

A large body of literature built on the PSE measure of n Achievement documents that individuals high in n Achievement respond to difficulty and challenge in a different manner than individuals low in n Achievement (for recent reviews, see Pang, 2010; Schultheiss & Brunstein, 2005). The former are more likely than the latter to choose challenging goals (i.e., goals with only a moderate chance of success), to persist on such goals, and to increase their efforts when receiving negative performance feedback (e.g., Brunstein & Maier, 2005; see McClelland, 1987, for a review). Their mastery-oriented approach to challenges also makes achievement-motivated individuals more likely to come up with innovative problem solutions and to succeed in business contexts (McClelland, 1961). High-achievement individuals' propensity for seeking and mastering challenges has been traced back to childhood socialization practices that emphasize and reward autonomous mastery of age-appropriate tasks (reviewed in Schultheiss & Brunstein, 2005).

Summarizing theory and research on n Achievement, Schultheiss and Brunstein (2005) have characterized the mindset of the achievement-motivated person as follows:

> "[...] deviations from expectation, or moderate uncertainty when tackling a task, is the cue which through previous learning has become associated with the positive affect of mastery and regaining certainty and control at a higher level of complexity or quality. This knowledge (which is emotional, not declarative) inoculates achievement-motivated individuals against the initial frustrations of working on a challenging task and turns the challenge into an opportunity for reward: *per aspera ad astra*, through hardship to new heights [...]" (p. 44, italics in original).

This suggests that achievement-motivated individuals view difficult tasks as challenges that hold the promise of reward rather than as threats of impending failure. Thus, a person high in n Achievement should view a difficult task as less stressful and more manageable than a person low in n Achievement would (see also Lazarus & Folkman, 1984).

There is some direct evidence that high n Achievement is associated with a positive view of difficulty and an active-coping approach. An experimental study by Reeve, Olson, and Cole (1987; Study 2), in which participants competed against another person on a challenging puzzle task and the outcome (win, lose) was varied experimentally, revealed that high n Achievement predicted higher expectancy to succeed, greater felt importance of the task, and, regardless of winning or losing, greater positive affect after the competition and better actual and perceived performance. A study by Engeser and Rheinberg (2008) shows that individuals high in n Achievement experience flow to a greater extent than individuals low in n Achievement when confronted with moderately difficult tasks (see also Baumann & Scheffer, 2010, 2011, for replications of this finding with a novel measure of n Achievement). These findings are consistent with McClelland et al's (1953) original observation that, if given the choice, individuals high in n Achievement prefer challenging tasks, whereas individuals low in n Achievement avoid them.

1.2. The current research

In the present research, we explored whether the differences between individuals high or low in n Achievement in dealing with difficult tasks also extends to HPA responses. We proceeded on the notion that difficult tasks are only stressful if the individual feels overtaxed and fails to view them as manageable – in other words, if he or she responds to them like a low-n Achievement person would. Under these circumstances, an increase in the release of cortisol (C) through the HPA axis is part of the typical physiological stress response (Sapolsky, 2002). Elevated C helps to make and keep glucose available for the muscles and other systems required to deal with the stressor, particularly if the individual's capability of effectively dealing with the stressor is uncertain and the resulting energy demand may be protracted. If, on the other hand, an individual is high in n Achievement and views a difficult task as manageable or even attractive, because it promises the experience of mastery, the task should not represent a stressor and C should therefore not be elevated.

We tested this hypothesis in two experimental studies that featured demanding tasks whose outcome was uncertain. In Study 1, we examined how US students differing in their n Achievement levels respond to experimentally manipulated victory or defeat in a face-to-face competition against another participant. Competitions, be they real or staged in the laboratory, frequently elicit anticipatory and reactive C increases (e.g., Kivlighan, Granger, & Booth, 2005; Passelergue & Lac, 1999), which, along with the uncertainty of the outcome, suggests that they represent difficult, stressful tasks for participants on average. In Study 2, we examined whether adult Germans' n Achievement moderates their responses to the Trier Social Stress Test (TSST, Kirschbaum et al., 1993; for meta-analyses, see Campbell & Ehlert, 2012; Dickerson & Kemeny, 2004), a well-established psychosocial stressor that causes a robust activation of the HPA axis, relative to a non-stressful control task. In both studies, n Achievement was assessed with the PSE at the beginning of the testing session and C was assessed in saliva before and after the critical task. This allowed us to examine the role of n Achievement in C changes in response to difficult tasks.

2. Study 1: n Achievement and cortisol responses to a competition

In the first study, we analyzed data from a study originally conducted to test effects of n Power and victory and defeat in a one-on-one competition on HPG and HPA responses (Stanton & Schultheiss, 2007; Wirth, Welsh, & Schultheiss, 2006, Study 2) for predictive effects of n Achievement on post-competition C changes. Based on the previously reviewed findings by Reeve et al. (1987, Study 2), who failed to find a moderating effect of competition outcome on n Achievement-associated affect and performance, we expected n Achievement to predict C changes among competition winners and losers in a similar way. More specifically, we hypothesized that individuals high in n Achievement would show a smaller C response to the contest situation than individuals low in n Achievement.

2.1. Method

2.1.1. Participants

Undergraduate students ($N = 116$, aged $M = 20$ years) from the University of Michigan participated in same-sex pairs. Paired participants were not previously acquainted with one another. Psychology majors were not admitted to the study. Five participants had missing hormone and/or motive data and were discarded from further analyses. Three had previously participated in a similar study with false contest feedback and were excluded, too. The remaining sample consisted of 108 participants (53 women, 14 of them on birth-control pills). Participants had refrained from eating and oral hygiene for at least 1 h prior to the start of the study. Sessions were scheduled to start between 10:30 am and 4:30 pm, with a duration of 2.5 h. Participants were paid a total of $35 for their participation. The study had received prior approval by the University of Michigan Institutional Review Board. Findings from this study, but not related to n Achievement, were previously reported in Wirth et al. (2006; Study 2) and in Stanton and Schultheiss (2007).

2.1.2. Design

Contest outcome (win versus lose) was varied experimentally, with one randomly assigned winner and one randomly assigned loser in each pair of participants. Individual differences in n Achievement represented a quantitatively assessed independent variable. C assessed after the contest and averaged across three measurements (T4, T5, T6) represented the dependent variable, and C assessed before the contest and averaged across three measurements (T1, T2, T3) served as a covariate.

2.1.3. Procedure

Sessions were run by a single male or female experimenter. As part of hypotheses unrelated to those reported here, participants were administered, in a double-blind fashion, 200 mg caffeine or placebo (vitamin C) at the beginning of the study. In the pre-contest phase, participants provided a saliva sample (T1, at 0 min), then completed a PSE (25 min duration) and other tasks. Next, the experimenter announced that participants would compete against each other in a contest. Participants then provided a second saliva sample (T2, at 52 min), and, after completing another task, provided a third saliva sample (T3, at 64 min).

During the contest, participants were sitting facing each other at two linked computers and competed against each other on 10 rounds of a visuomotor task. After each round, the computers provided preprogrammed feedback informing one participant that he or she had won and the other that he or she had lost. Participants in the winning condition "won" all rounds except for the second and the fifth, and participants in the losing condition "lost" all rounds except for the second and the fifth. An awareness probe at the end of the experiment indicated that none of the included participants realized that the contest outcome was rigged. For further details about the contest, see Wirth et al. (2006, Study 2).

After the contest, participants collected three additional saliva samples immediately (T4), 15 min (T5), and 30 min (T6) after the contest while completing other tasks unrelated to the results reported here. Participants were fully debriefed about the hypotheses underlying the study and the manipulations employed.

2.1.4. n Achievement

Participants' n Achievement was assessed with a five-picture PSE (see Wirth et al., 2006, Study 2, for picture details). Pictures were presented on the computer screen, and participants had 5 min to handwrite each story on designated writing sheets. Stories were later coded for achievement imagery following the criteria described in Winter's (1994) Manual for Scoring Motive Imagery in Running Text. These include (a) adjectives indicating excellence, (b) positive evaluation of goals or performances, (c) winning or competing with others, (d) negative affect associated with failure, and (e) unique accomplishments. A trained scorer who was a native speaker of English, who had previously attained over 85% agreement with training materials prescored by experts and contained in the Manual, and who was blind with regard to participants' experimental condition coded all stories. Because n Achievement scores, summed across all 5 picture stories ($M = 3.91$, $SD = 2.21$), were correlated at $r = .29$, $p = .002$, with total word count ($M = 527$, $SD = 113$), we corrected n Achievement scores by regression for word count and converted the residuals to z scores. We used these standardized scores in subsequent data analyses.

2.1.5. Salivary cortisol

For each sample, participants used a fresh sugar-free chewing gum to collect between 2 and 10 ml saliva in a sterile polypropylene vial and then removed the chewing gum (Dabbs, 1991). Vials were closed and frozen immediately at the end of each data collection session. Samples were purified with three freeze–thaw cycles and subsequent centrifugation. C levels were determined by solid-phase ^{125}I radioimmunoassay (Coat-A-Count, Diagnostic Products Corporation, Los Angeles, CA). C was measured using 400 μl saliva samples in combination with water-diluted standards (analytical range: 0.5–50 ng/ml) and overnight incubation at room temperature. The average intra-assay coefficient of variation (CV) was 5.5%. The lower limit of detection (B0–3 SD) was 0.023 ng/ml. Because salivary C values had a skewed distribution, all were subjected to the following transformation: log (1 + C value). The resulting values were normally distributed and used in all further analyses.

2.2. Results

Table 1 provides an overview of the descriptive statistics and correlations between the study variables (see Wirth et al., 2006, Study 2, for descriptive data on C before and after the contest).[1] To test whether n Achievement had a specific effect on C changes in response to the contest, we ran a series of hierarchically layered regression models with post-contest C as dependent variable, pre-contest C as covariate, and the predictors n Achievement, Outcome, Caffeine, and gender as well as the interaction terms between n Achievement and the other predictors (see Table 2). Model 1 documented moderately high retest stability from pre-contest C to post-contest C. As shown in Table 2 and illustrated in Fig. 1, n Achievement predicted decreases in post-contest C (Model 2).[2] This effect remained robust even when Outcome, Caffeine, and gender were also entered into the regression (Model 3), although caffeine administration and gender both had significant effects on post-contest C, too. Caffeine administration increased post-contest C relative to placebo, and women had a weaker cortisol response to the contest than men. The association between n Achievement and post-contest C was not moderated by any of the other predictors (Model 4). We also explored whether the three-way interactions between n Achievement, Outcome, and gender or between n Achievement, Outcome, and Caffeine accounted for additional variance in post-contest C, but without significant findings, *ps* > .56.

2.3. Discussion

The findings of Study 1 suggest that higher n Achievement predicts reduced C increases in response to a face-to-face competition task, regardless of whether participants eventually won or lost the contest. This effect was not moderated by caffeine, which had an independent boosting effect on C responses to the competition, or participant gender, which also had an independent effect on C responses such that women had a lesser post-contest increase than men. While these findings are consistent with our hypothesis that n Achievement attenuates stress responses to situations in which a difficult task is encountered, the design of Study 1 did not allow us to compare the role of n Achievement in response to a difficult task (i.e., the competition) to its role in a control condition with an easy

[1] We regard the slight, but statistically significant association between pre-contest C and contest outcome as a random effect (Type I error) and therefore refrain from interpreting it.

[2] Given the substantial variation in participants' time of testing, we examined whether time of day moderated the association between n Achievement and post-contest C, while holding pre-contest C constant. The effect was not significant, $B = 0.008$, $SE = 0.019$, $t(103) = 0.45$, $p = .654$.

Table 1
Descriptive statistics and correlations of variables in Study 1.

	M	*SD*	1	2	3	4	5	6
1. Outcome[a]	0.50	0.50	–					
2. Caffeine[b]	0.51	0.50	.02	–				
3. Gender[c]	0.49	0.50	−.02	−.18	–			
4. n Achievement[d]	0.00	1.00	.00	−.07	.15	–		
5. Precontest C[e]	1.20	0.35	.20[*]	.00	.09	.01	–	
6. Postcontest C[e]	1.13	0.42	.17	.31[***]	−.18	−.20[*]	.61[***]	–
7. Resid. postcontest C	0.00	0.34	.06	.38[***]	−.29[***]	−.26[**]	.00	.80[***]

[a] 0 = lose, 1 = win.
[b] 0 = placebo, 1 = caffeine.
[c] 0 = male, 1 = female.
[d] Residualized for word count and transformed to *z* scores.
[e] Log-transformed and averaged across 3 measurements.
[*] $p < .05$.
[**] $p < .01$.
[***] $p < .005$.

Table 2
Predictors of post-contest cortisol changes in Study 1.

Variable	Post-contest C[a]															
	Model 1				Model 2				Model 3				Model 4			
	B	*SE*	*t*	*p*	*B*	*SE*	*t*	*p*	*B*	*SE*	*t*	*p*	*B*	*SE*	*t*	*p*
Constant	0.259	0.116	2.24	.027	0.255	0.112	2.28	.025	0.185	0.110	1.68	.095	0.179	0.112	1.59	.115
Pre-contest C[a]	0.727	0.093	7.85	.000	0.730	0.090	8.14	.000	0.736	0.084	8.75	.000	0.745	0.087	8.53	.000
n Achievement[b]					−0.088	0.032	−2.78	.006	−0.070	0.029	−2.41	.018	−0.107	.070	−1.53	.128
Outcome[c]									0.032	0.059	0.55	.586	0.028	0.060	0.47	.640
Caffeine[d]									0.222	0.058	3.79	.000	0.217	0.060	3.65	.000
Gender[e]									−0.135	0.059	−2.27	.025	−0.140	0.061	−2.31	.023
n Ach × Outcome													−0.008	0.061	−0.14	.892
n Ach × Caffeine													0.041	0.066	0.63	.533
n Ach × Gender													0.044	0.065	0.68	.500
R^2	.368				.411				.523				.526			
F	61.64[***]				36.64[***]				22.34[***]				13.71[***]			
df	1, 106				2, 105				5, 102				8, 99			
ΔR^2					.043				.112				.003			
ΔF					7.73[**]				7.95[***]				0.21			
df					1, 105				3, 102				3, 99			

[a] Log-transformed and averaged across 3 measurements.
[b] Residualized for word count and transformed to *z* scores.
[c] 0 = lose, 1 = win.
[d] 0 = placebo, 1 = caffeine.
[e] 0 = male, 1 = female.
[*] $p < .05$.
[**] $p < .01$.
[***] $p < .005$.

task. Although we observed no significant association between n Achievement and C before the contest, when participants were working on relatively easy questionnaires and baseline tasks, examining and interpreting this correlation is not equivalent to testing the relationship between n Achievement and task-induced changes in C. It therefore remains unclear whether the C-damping effect of n Achievement is specific to demanding tasks or also occurs in response to easy tasks.

3. Study 2: n achievement and cortisol responses to the trier social stress test

In Study 2, we addressed this issue by comparing the role of n Achievement in the HPA response to a well-validated protocol for inducing stress through a difficult task, the TSST, to its role in a control condition with a non-demanding task. We predicted that n Achievement would be associated with a reduced C response to the TSST only and would be unrelated to C changes in the control condition.

3.1. Method

3.1.1. Participants

Participants initially included 63 healthy students (32 males) from Ruhr-University Bochum, Germany, between 19 and 30 years of age. A-priori exclusion criteria were: previous participation in the TSST; body mass index under 18 or over 30; medical treatment; oral contraceptive use; pregnancy; smoking. One participant from the control condition was excluded due to outlier values in cortisol concentration (more than 1.5 inter-quartile range above the upper quartile). This left 62 participants (31 males) for data analyses, 32 in the stress condition and 30 in the control condition. Mean age of the total sample was 23.87 years. Findings from other results of this study not related to implicit motives have been published elsewhere (Wiemers, Sauvage, Schoofs, Hamacher-Dang, & Wolf, 2013).

3.1.2. Design

Stress was varied experimentally by assigning participants randomly to the TSST condition ($n = 32$) or to a non-stressful control

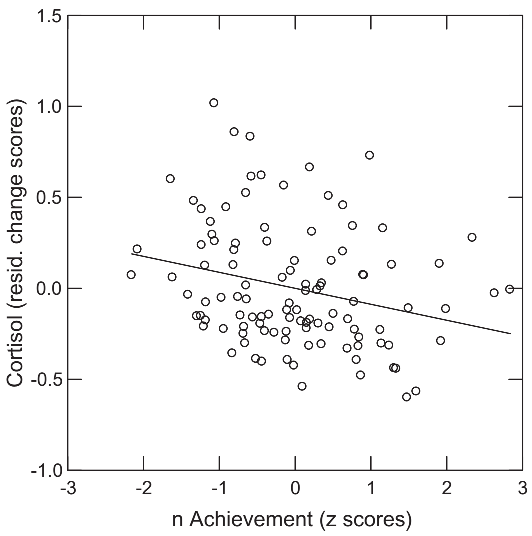

Fig. 1. Association between n Achievement and post-contest C changes (log-transformed and aggregated across three measurements), residualized for pre-contest C (log-transformed and aggregated across three measurements) in Study 1.

condition ($n = 30$). Individual differences in n Achievement represented a quantitatively assessed independent variable. C assessed after the experimental manipulation and averaged across three measurements represented the dependent variable, and C level assessed before the contest served as a covariate.

3.1.3. Procedure

Participants came to the lab between 1:45 pm and 3:30 pm, signed informed consent, and completed the PSE. Afterwards they provided the baseline saliva sample and were exposed to the TSST or the control condition. Three further saliva samples were sampled 1 min, 10 min and 25 min after the end of the stress or control condition.

Psychosocial stress was induced in experimental-group participants using a slightly modified version of the TSST (Kirschbaum et al., 1993), an established procedure that reliably elicits elevated C levels. During the TSST, the subject is first asked to try to convince a "committee" consisting of a man and a woman of her or his qualifications for a fictitious job in an 8-min free speech after 5 min of preparation time. The "job interview" is videotaped and the committee acts in a neutral and reserved manner (for more detailed information, see Wiemers, Schoofs, & Wolf, 2013). In the control condition, the "friendly TSST" (Wiemers, Sauvage, et al., 2013; Wiemers, Schoofs, et al., 2013), participants also gave an 8-min free speech in front of a committee after a 5-min preparation time. However, participants are told that they are assigned to a control condition; committee members are introduced as laboratory employees with whom participants are supposed to talk for a while; committee members act in a friendly and supportive manner; and there is no videotaping. Thus, unlike the experimental condition, the control condition is less difficult than the original TSST, because it lacks several stress-inducing components of the TSST. As a consequence, it does not lead to a significant C increase (Wiemers, Sauvage, et al., 2013; Wiemers, Schoofs, et al., 2013).

3.1.4. n Achievement

Participants' n Achievement was assessed with Pang and Schultheiss's (2005) 6-picture PSE. Pictures were presented in random order on the computer screen and participants typed their stories on the keyboard. A trained scorer who was a native speaker of German, who had previously attained over 85% agreement with training materials, and who was blind to participants' experimental condition, coded all stories for n Achievement using the same coding manual and criteria as in Study 1. Participants' n Achievement scores, summed across all 6 picture stories ($M = 5.13$, $SD = 2.82$), were correlated at $r = .52$, $p = .00001$, with total word count ($M = 590$, $SD = 173$). Like in Study 1, we corrected n Achievement scores by regression for word count, converted the residuals to z scores, and used these standardized scores in subsequent data analyses.

3.1.5. Salivary cortisol

Participants were advised to refrain from eating, drinking anything but water, and brushing their teeth or doing excessive sports 1 h before testing. Saliva samples were collected with Salivettes® (Sarstedt, Germany) four times. Cortisol was analyzed by an immunoassay (IBL, Hamburg, Germany). Inter- and intra-assay CVs were below 10%. Assay sensitivity was 0.16 ng/ml.

3.2. Results

Table 3 provides an overview of the descriptive statistics and correlations between the study variables. As expected, condition had a large effect size, with participants in the TSST condition displaying considerably higher post-task C levels than participants in the control condition. n Achievement had no direct effect on post-task C. To test whether n Achievement had a specific effect on C changes in response to the TSST versus the control condition, we ran a series of hierarchically layered regression models with post-task C as dependent variable, baseline C as covariate, and the predictors n Achievement, condition, and gender as well as their two- and three-way interaction terms (see Table 4). Model 1 documented high retest stability from pre- to post-task C. Results for Model 2 indicate that the effect of condition on post-task C was specific and strong even when n Achievement and gender were entered simultaneously. These latter predictors had no specific main effects on C changes. However, Model 3 revealed that both the n Achievement × Condition as well as the n Achievement × Gender interactions accounted for specific increments in variance in post-task C. Follow-up analyses revealed that among participants in the TSST condition, n Achievement was associated with lower post-task C, $B = -0.110$, $SE = 0.066$, $pr = -.29$, $t(29) = -1.65$, $p = .05$ (one-tailed test here only) after controlling for baseline C, whereas among participants in the control condition, n Achievement was not significantly related to post-task C, $B = 0.090$, $SE = 0.055$, $pr = .30$, $t(27) = 1.66$, $p = .11$ (see Fig. 2). Moreover, in men n Achievement was nonsignificantly associated with lower residualized post-task C, $B = -0.099$, $SE = 0.084$, $pr = -.21$, $t(29) = -1.17$, $p = .25$, and in women it was nonsignificantly associ-

Table 3
Descriptive statistics and correlations of variables in Study 2.

	M	*SD*	1	2	3	4	5
1. Condition[a]	0.52	0.50	–				
2. Gender[b]	0.48	0.50	.03	–			
3. n Achievement[c]	0.00	1.00	.14	−.21	–		
4. Baseline C[d]	2.17	0.52	.01	.10	.12	–	
5. Post-task C[e]	2.32	0.57	.50***	.05	.07	.62***	–
6. Resid. post-task C[e]	0.00	0.44	.62***	−.02	.00	.00	.78***

[a] 0 = control, 1 = TSST.
[b] 0 = male, 1 = female.
[c] Residualized for word count and transformed to *z* scores.
[d] Log-transformed.
[e] Log-transformed and averaged across 3 measurements.
* $p < .05$.
** $p < .01$.
*** $p < .005$.

ated with higher residualized post-task C, $B = 0.122$, $SE = 0.079$, $pr = .28$, $t(27) = 1.54$, $p = .14$. These two-way interactions were qualified by a n Achievement × Gender × Condition effect in Model 4. Follow-up analyses revealed that this effect was due to a significant n Achievement × Condition effect in men, $\Delta R^2 = .282$, $\Delta F(1,27) = 26.05$, $p < .00005$, that did not emerge for women, $\Delta R^2 = .017$, $\Delta F(1,25) = 2.63$, $p = .12$. In men, n Achievement was a strong negative predictor of post-task C (controlling for pre-task C) in the TSST condition, $B = -0.327$, $SE = 0.081$, $pr = -.75$, $t(13) = -4.05$, $p = .001$, and, at overall much lower levels, a strong positive predictor in the control condition, $B = 0.189$, $SE = 0.062$, $pr = .64$, $t(13) = 3.03$, $p = .01$. Inspection of scatterplots of these bivariate relationships suggested that they were not due to outlier or leverage effects. In women, n Achievement was not a significant predictor of post-task C in either condition, $ps > .10$.

3.3. Discussion

The findings of Study 2 replicate and extend those of Study 1. As expected, n Achievement predicted a reduced C response to a difficult, stressful public-speaking task (TSST), but not to an easy, non-stressful control task. It is remarkable, but consistent with our hypothesis, that although the TSST produced a large C increase effect in our study and thus replicates a robust finding from other studies employing the TSST, the C response data plotted in Fig. 2 suggests that this main effect is driven primarily by individuals low in n Achievement, who had large C increases relative to baseline. In contrast, post-TSST C levels of individuals at the high end of n Achievement were scarcely elevated relative to baseline, and their overall C response did not differ much from that of control group participants.

Because we compared predictive effects of n Achievement in the difficult-task TSST condition against a less demanding control condition, we were also able to differentiate our observations from Study 1. As expected, n Achievement predicted a reduced C response only in the context of a difficult task, but not in the context of a control task that shared many formal features with the TSST (e.g., speaking, presence of others) except for the difficulty level and social-evaluation aspect.

Unexpectedly, the damping effect of n Achievement on C responses on the TSST emerged only and very strongly for men, but not for women. Because we did not observe any moderating effect of gender on n Achievement-associated C changes in Study 1 and also because there is no a priori reason why men and women should differ in their responses to public speaking, but not to winning or losing a competition, we do not want to overinterpret this finding at this point. We note, however, that across studies men tend to show stronger HPA responses to performance stress tasks such as the TSST than women do (Kudielka, Hellhammer, & Wüst, 2009; Stroud, Salovey, & Epel, 2002), an effect that may be even more pronounced in low-n Achievement men. And there is also evidence that although overall n Achievement levels do not differ between men and women (e.g., Pang & Schultheiss, 2005), they predict responses to different types of challenge in men and women due to gender differences in socialization (Duncan & Peterson, 2010). Either effect or a combination of both may help to explain why n Achievement plays a greater role for men than for women for their HPA response to the TSST.

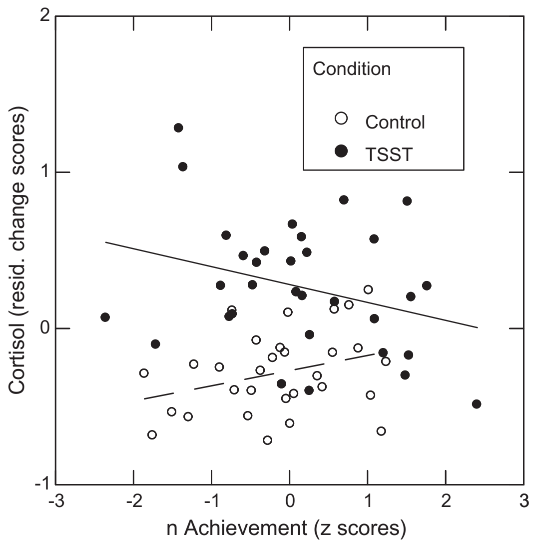

Fig. 2. Association between n Achievement and post-task C changes (log-transformed and aggregated across three measurements), residualized for log-transformed baseline C, as a function of condition in Study 2.

4. General discussion

In the present research, we tested the hypothesis that individuals high in n Achievement, who have learned to associate the challenge of a difficult task with the pleasure of mastering it, have a lower stress response to challenging tasks than individuals low in n Achievement, who have not come to associate difficult tasks with mastery. Across two studies, one with a face-to-face competition and an experimentally manipulated outcome and the other with a stressful public-speaking task, we obtained replicable evidence that higher levels of n Achievement predict a weaker stress response, as assessed through salivary C changes with baseline C levels controlled for.

The overall effect size (Pearson correlation) of the association between n Achievement and C changes was −.26 in Study 1 (competition task) and −.29 in Study 2 (TSST). We therefore estimate the population effect size of n Achievement and C responses to difficult tasks to be −.28 and thus in the medium range according to Cohen (1992). Using G∗Power 3.1 (Faul, Erdfelder, Buchner, & Lang, 2009), we calculated post-hoc power for Study 1 as 88% (single slope) and for Study 2 as 77% (difference between two slopes). Thus, we had a 68% (.88 × .77) probability of detecting the predicted negative association between n Achievement and C in response to difficult tasks in two consecutive studies.

We also found that n Achievement is not generally associated with lower C per se. n Achievement was not significantly associated with baseline C levels in either study. In Study 2, n Achievement did not predict decreasing C in response to a non-challenging control task. These observations support our hypothesis that the stress-reducing role of n Achievement is limited specifically to difficult tasks and thus to achievement-related situations, but not to situations that feature no achievement incentives.

Unexpectedly, Study 2 also provided evidence that the damping effect of n Achievement for C responses to challenges emerges for men but not for women. However, because participant gender did not moderate the association between n Achievement and C changes in Study 1, this effect needs to be replicated first before more far-reaching interpretations are advanced.

4.1. Implications

Taken at face value, the findings of the present research suggest that physiologically, individuals high in n Achievement are better able to regulate their stress response to difficult tasks than individuals low in n Achievement. This observation is not only consistent with Schultheiss and Brunstein's (2005) proposal that n Achievement represents a predisposition to associate the difficulty of a

Table 4
Predictors of post-task cortisol changes in Study 2.

Variable	Post-task C[a]															
	Model 1				Model 2				Model 3				Model 4			
	B	*SE*	*t*	*p*	*B*	*SE*	*t*	*p*	*B*	*SE*	*t*	*p*	*B*	*SE*	*t*	*p*
Constant	0.847	0.248	3.42	.001	0.562	0.205	2.75	.008	0.590	0.198	2.98	.004	0.565	0.170	3.33	.002
Baseline C[a]	0.680	0.111	6.12	.000	0.689	0.090	7.68	.000	0.691	0.084	8.28	.000	0.693	0.072	9.70	.000
n Achievement[b]					−0.045	0.048	−0.94	.351	−0.005	0.083	−0.06	.951	0.187	0.083	2.26	.028
Condition[c]					0.564	0.092	6.15	.000	0.548	0.119	4.61	.000	0.605	0.103	5.90	.000
Gender[d]					−0.053	0.094	−0.56	.576	−0.013	0.129	−0.10	.919	−0.121	0.113	−1.07	.290
n Ach × Condition									−0.225	0.093	−2.42	.019	−0.539	0.105	−5.12	.000
n Ach × Gender									0.229	0.088	2.59	.012	−0.261	0.132	−1.98	.053
Condition × Gender									−0.019	0.177	−0.11	.915	0.055	0.153	0.36	.719
n Ach × Condition × Gender													0.732	0.161	4.55	.000
R^2	.384				.630				.698				.783			
F	37.45***				24.26***				17.86***				23.91***			
df	1, 60				4, 57				7, 54				8, 53			
ΔR^2					.246				.068				.085			
ΔF					12.62***				4.08*				20.68***			
df					3, 57				3, 54				1, 53			

[a] Log-transformed and averaged across 3 measurements.
[b] Residualized for word count and transformed to *z* scores.
[c] 0 = control, 1 = TSST.
[d] 0 = male, 1 = female.
* $p < .05$.
** $p < .01$.
*** $p < .005$.

task with the pleasure of its subsequent mastery and thus with an ability to view difficulty as a positive challenge and not as a negative threat. It is also consistent with the conceptualization of n Achievement as a capacity for up-regulating positive affect in the face of difficulty (Baumann & Scheffer, 2010; Kuhl, 2001; see also McClelland et al., 1953). These accounts converge on a conceptualization of n Achievement as an automatic regulator of emotional-affective responses that kicks in whenever an individual is faced with challenging tasks. Our view of n Achievement as an emotion-regulation capacity is not only supported by the endocrine data we present here, but also, as mentioned before, by experimental studies showing robust positive-affect responses in response to demanding tasks (e.g., Engeser & Rheinberg, 2008; Reeve et al., 1987, Study 2) and better actual performance in response to signals of difficulty in high-n Achievement individuals (Brunstein & Hoyer, 2002; Brunstein & Maier, 2005). Moreover, it is supported by studies that document heightened psychosocial adjustment and emotional well-being and lower levels of impaired mood and depression in individuals high in n Achievement (McAdams & Vaillant, 1982; Musty & Kaback, 1995; Orlofsky, 1978). We contend that these outcomes accrue from the ability of high-n Achievement individuals to deal with demanding situations and tasks in a confident, hopeful manner.

The functional properties of n Achievement as an automatic emotion-regulation disposition stand in marked contrast to explicit, effortful modes of emotion regulation, such as deliberate suppression or reappraisal, which can lead to increased C responses to stressors like the TSST (e.g., Lam, Dickerson, Zoccola, & Zaldivar, 2009). We therefore suggest that the notion of n Achievement as an emotion-regulation disposition should be further explored in research using other endocrine and physiological stress measures, other types of tasks, and perhaps in juxtaposition to self-reported habitual or experimenter-instructed regulation strategies.

4.2. Limitations and future directions

Although the measure of n Achievement we have used in the present research has demonstrated causal validity (see Borsboom et al., 2004; McClelland, 1958), the association between measured n Achievement and C changes in response to challenging tasks was correlational and is thus open to alternative interpretations (e.g., another factor not reflecting achievement motivation may influence both the n Achievement measure and C changes, rendering their association spurious). Future studies should aim to manipulate implicit achievement motivation to determine whether this motive has a causal attenuating effect on C responses to challenge.

Furthermore, although we have argued in this paper that high n Achievement makes people view challenges as an opportunity for mastery rather than as a threat, we did not obtain measures of pre-task appraisals to support this claim. Although past research has found evidence of positive task appraisals among high-n Achievement individuals in response to challenge (e.g., Reeve et al., 1987, Study 2), we suggest that such explicit appraisal measures should be complemented by measures of implicit appraisal processes (see Moors, 2010) in future studies on the stress-attenuating role of n Achievement. This would provide a more comprehensive picture of what type of appraisal actually mediates the hypothesized effect of n Achievement on stress responses.

Finally, we have argued in this paper that n Achievement plays a critical role when dealing with *difficult* tasks. The tasks we examined in our studies certainly fit this definition in the sense that it was not clear to participants whether they would win or lose on the competition task in Study 1 or whether they would be able to perform well in front of an unsympathetic audience in the TSST condition of Study 2. However, because both tasks also involved performing in the presence of other people (an opponent and an experimenter in Study 1, a jury in Study 2), one could argue that n Achievement moderates stress responses to social-evaluative threat rather than to task difficulty per se (see, for instance, Dickerson & Kemeny, 2004). Note, however, that behavioral studies clearly document that n Achievement predicts increased energy investment to difficult tasks under solo conditions, that is, when there is no social-evaluative threat present (e.g., Brunstein & Hoyer, 2002; Brunstein & Maier, 2005). There is also evidence that C increases in response to demanding solo tasks (e.g., Häusser, Mojzisch, & Schulz-Hardt, 2011). These findings are consistent with the notion that the stress-attenuating effect of n Achievement is not restricted to social-evaluative threat, but can also be observed with other tasks, provided that they are difficult enough to elicit HPA activation main effects. We readily concede, however, that the jury is still out on this issue and more research is needed to test whether it is task difficulty, as we argue here, or social-evaluative threat that drives the association between n Achievement and reduced C responses.

5. Conclusion

Drawing on data from two studies in which task difficulty was manipulated experimentally, the present research provides evidence in support of the notion that n Achievement is a moderator of the HPA response to stressors. We have found that individuals high in n Achievement show less of a C response to demanding tasks than individuals low in n Achievement. This observation supports Schultheiss and Brunstein's (2005) hypothesis that n Achievement represents a propensity to view difficulty as a cue to pleasurable mastery and thus to deal with demanding tasks as manageable opportunities for mastery rather than as overwhelming threats of failure. Based on these considerations and our present findings, we encourage further explorations into the emotion-regulating functions of the implicit need for achievement.

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References

Baumann, N., & Scheffer, D. (2010). Seeing and mastering difficulty: The role of affective change in achievement flow. *Cognition and Emotion, 24*, 1304–1328.
Baumann, N., & Scheffer, D. (2011). Seeking flow in the achievement domain: The achievement flow motive behind flow experience. *Motivation and Emotion, 35*, 267–284.
Brunstein, J. C., & Hoyer, S. (2002). Implizites und explizites Leistungsstreben: Befunde zur Unabhängigkeit zweier Motivationssysteme [Implicit versus explicit achievement strivings: Empirical evidence of the independence of two motivational systems]. *Zeitschrift fur Pädagogische Psychologie, 16*, 51–62.
Brunstein, J. C., & Maier, G. W. (2005). Implicit and self-attributed motives to achieve: Two separate but interacting needs. *Journal of Personality and Social Psychology, 89*(2), 205–222.
Campbell, J., & Ehlert, U. (2012). Acute psychosocial stress: Does the emotional stress response correspond with physiological responses? *Psychoneuroendocrinology, 37*(8), 1111–1134.
Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*, 155–159.
Dabbs, J. M. (1991). Salivary testosterone measurements: Collecting, storing, and mailing saliva samples. *Physiology & Behavior, 49*, 815–817.
Dickerson, S. S., & Kemeny, M. E. (2004). Acute stressors and cortisol responses: A theoretical integration and synthesis of laboratory research. *Psychological Bulletin, 130*(3), 355–391.
Duncan, L. E., & Peterson, B. E. (2010). Gender and motivation for achievement, affiliation-intimacy, and power. In J. C. Chrisler & D. R. McCreary (Eds.). *Handbook of gender research in psychology gender research in social and applied psychology* (Vol. 2, pp. 41–62). New York: Springer.
Engeser, S., & Rheinberg, F. (2008). Flow, moderators of challenge-skill-balance and performance. *Motivation and Emotion, 32*, 158–172.
Faul, F., Erdfelder, E., Buchner, A., & Lang, A. G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. *Behavior Research Methods, 41*(4), 1149–1160.
Haber, R. N., & Alpert, R. (1958). The role of situation and picture cues in projective measurement of the achievement motive. In J. W. Atkinson (Ed.), *Motives in fantasy, action, and society: A method of assessment and study* (pp. 644–663). Princeton, NJ: Van Nostrand.
Häusser, J. A., Mojzisch, A., & Schulz-Hardt, S. (2011). Endocrinological and psychological responses to job stressors: An experimental test of the job demand–control model. *Psychoneuroendocrinology, 36*(7), 1021–1031.
Kirschbaum, C., Pirke, K. M., & Hellhammer, D. H. (1993). The 'Trier Social Stress Test' – A tool for investigating psychobiological stress responses in a laboratory setting. *Neuropsychobiology, 28*(1–2), 76–81.
Kivlighan, K. T., Granger, D. A., & Booth, A. (2005). Gender differences in testosterone and cortisol response to competition. *Psychoneuroendocrinology, 30*(1), 58–71.
Klinger, E. (1967). Modeling effects on achievement imagery. *Journal of Personality and Social Psychology, 7*, 49–62.
Koestner, R., & McClelland, D. C. (1992). The affiliation motive. In C. P. Smith (Ed.), *Motivation and personality: Handbook of thematic content analysis* (pp. 205–210). New York: Cambridge University Press.
Kudielka, B. M., Hellhammer, D. H., & Wüst, S. (2009). Why do we respond so differently? Reviewing determinants of human salivary cortisol responses to challenge. *Psychoneuroendocrinology, 34*(1), 2–18.
Kuhl, J. (2001). *Motivation und Persönlichkeit: Interaktionen psychischer Systeme [Motivation and personality: Interactions of mental systems]*. Göttingen, Germany: Hogrefe.
Lam, S., Dickerson, S. S., Zoccola, P. M., & Zaldivar, F. (2009). Emotion regulation and cortisol reactivity to a social-evaluative speech task. *Psychoneuroendocrinology, 34*(9), 1355–1362.
Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal, and coping*. New York: Springer.
McAdams, D. P., & Vaillant, G. E. (1982). Intimacy motivation and psychosocial adjustment: A longitudinal study. *Journal of Personality Assessment, 46*, 586–593.
McClelland, D. C. (1961). *The achieving society*. New York: Free Press.
McClelland, D. C. (1987). *Human motivation*. New York: Cambridge University Press.
McClelland, D. C., Atkinson, J. W., Clark, R. A., & Lowell, E. L. (1953). *The achievement motive*. New York: Appleton-Century-Crofts.
McClelland, D. C., & Koestner, R. (1992). The achievement motive. In C. P. Smith (Ed.), *Motivation and personality: Handbook of thematic content analysis* (pp. 143–152). New York: Cambridge University Press.
McClelland, D. C., Koestner, R., & Weinberger, J. (1989). How do self-attributed and implicit motives differ? *Psychological Review, 96*, 690–702.
Moors, A. (2010). Automatic constructive appraisal as a candidate cause of emotion. *Emotion Review, 2*(2), 139–156.
Morgan, C., & Murray, H. A. (1935). A method for investigating fantasies: The thematic apperception test. *Archives of Neurology and Psychiatry, 34*, 289–306.
Musty, R. E., & Kaback, L. (1995). Relationships between motivation and depression in chronic marijuana users. *Life Sciences, 56*(23–24), 2151–2158.
Orlofsky, J. L. (1978). Identity formation, nAchievement, and fear of success in college men and women. *Journal of Youth and Adolescence, 7*(1), 49–62.
Pang, J. S., & Schultheiss, O. C. (2005). Assessing implicit motives in U.S. College students: Effects of picture type and position, gender and ethnicity, and cross-cultural comparisons. *Journal of Personality Assessment, 85*(3), 280–294.
Pang, J. S. (2010). The achievement motive: A review of theory and assessment of n Achievement, hope of success, and fear of failure. In O. C. Schultheiss & J. C. Brunstein (Eds.), *Implicit motives* (pp. 30–70). New York, NY: Oxford University Press.
Passelergue, P., & Lac, G. (1999). Saliva cortisol, testosterone and T/C ratio variations during a wrestling competition and during the post-competitive recovery period. *International Journal of Sports Medicine, 20*(2), 109–113.
Reeve, J., Olson, B. C., & Cole, S. G. (1987). Intrinsic motivation in competition: The intervening role of four individual differences following objective competence information. *Journal of Research in Personality, 21*(2), 148–170.
Sapolsky, R. M. (2002). Endocrinology of the stress-response. In J. B. Becker, S. M. Breedlove, & D. Crews (Eds.), *Behavioral endocrinology* (2nd ed., pp. 409–450). Cambridge MA: MIT Press.
Schroth, M. L. (1987). Relationships between achievement-related motives, extrinsic conditions, and task performance. *Journal of Social Psychology, 127*, 39–48.
Schultheiss, O. C. (2013). The hormonal correlates of implicit motives. *Social and Personality Psychology Compass, 7*(1), 52–65.
Schultheiss, O. C., & Brunstein, J. C. (2005). An implicit motive perspective on competence. In A. J. Elliot & C. Dweck (Eds.), *Handbook of competence and motivation* (pp. 31–51). New York: Guilford.
Schultheiss, O. C. (2008). Implicit motives. In O. P. John, R. W. Robins, & L. A. Pervin (Eds.), *Handbook of personality: Theory and research* (3rd ed., pp. 603–633). New York: Guilford.
Schultheiss, O. C., Wirth, M. M., & Stanton, S. J. (2004). Effects of affiliation and power motivation arousal on salivary progesterone and testosterone. *Hormones and Behavior, 46*(5), 592–599.
Spangler, W. D. (1992). Validity of questionnaire and TAT measures of need for achievement: Two meta-analyses. *Psychological Bulletin, 112*, 140–154.
Stanton, S. J., & Schultheiss, O. C. (2007). Basal and dynamic relationships between implicit power motivation and estradiol in women. *Hormones and Behavior, 52*(5), 571–580.
Stanton, S. J., & Schultheiss, O. C. (2009). The hormonal correlates of implicit power motivation. *Journal of Research in Personality, 43*, 942–949.
Stroud, L., Salovey, P., & Epel, E. (2002). Sex differences in stress responses: Social rejection versus achievement stress. *Biological Psychiatry, 52*(4), 318.
Wiemers, U. S., Sauvage, M. M., Schoofs, D., Hamacher-Dang, T. C., & Wolf, O. T. (2013). What we remember from a stressful episode. *Psychoneuroendocrinology, 38*(10), 2268–2277.
Wiemers, U. S., Schoofs, D., & Wolf, O. T. (2013). A friendly version of the Trier Social Stress Test does not activate the HPA axis in healthy men and women. *Stress, 16*(2), 254–260.

Winter, D. G. (1994). *Manual for scoring motive imagery in running text* (4th ed.). Ann Arbor: Department of Psychology, University of Michigan (unpublished manuscript).
Winter, D. G. (1992). Power motivation revisited. In C. P. Smith (Ed.), *Motivation and personality: Handbook of thematic content analysis* (pp. 301–310). New York: Cambridge University Press.
Wirth, M. M., & Schultheiss, O. C. (2006). Effects of affiliation arousal (hope of closeness) and affiliation stress (fear of rejection) on progesterone and cortisol. *Hormones and Behavior, 50*, 786–795.
Wirth, M. M., Welsh, K. M., & Schultheiss, O. C. (2006). Salivary cortisol changes in humans after winning or losing a dominance contest depend on implicit power motivation. *Hormones and Behavior, 49*(3), 346–352.