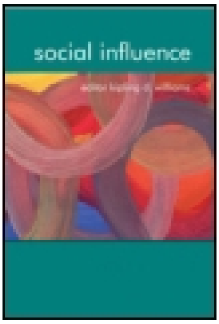

Social Influence
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/psif20

Reading between the lines: Subtle stereotype threat cues can motivate performance

Allison E. Seitchik [a], Jeremy Jamieson [b] & Stephen G. Harkins [a]

[a] Department of Psychology, Northeastern University, Boston, MA, USA

[b] Department of Clinical & Social Sciences, University of Rochester, New York, NY, USA

Version of record first published: 27 Nov 2012.

SOCIAL INFLUENCE, 2012
http://dx.doi.org/10.1080/15534510.2012.746206

Routledge
Taylor & Francis Group

Reading between the lines: Subtle stereotype threat cues can motivate performance

Allison E. Seitchik[1], Jeremy Jamieson[2], and Stephen G. Harkins[1]
[1]Department of Psychology, Northeastern University, Boston, MA, USA
[2]Department of Clinical & Social Sciences, University of Rochester, New York, NY, USA

This research examined the impact of subtle stereotype threat cues (i.e., no mention of group differences) on motivation. Recent research suggests that blatant manipulations of threat motivate targets to attempt to disprove relevant stereotypes, but this motivation can, in turn, undermine performance. On the other hand, research suggests that subtle cues lead individuals to expend resources so as to reduce uncertainty about the presence of bias. We tested the possibility that subtle threat could also motivate individuals to try to disprove stereotypes. The results indicate that similar to blatant threat, subtle threat cues motivated participants, and this motivation directly led to worse performance in this research because of an over-reliance on traditional solution approaches and a lack of flexibility (i.e., inflexible perseverance).

Keywords: Stereotype attitudes; Subtle threat; Motivation; Graduate Record Examinations.

Uncertainty occurs when an actor does not have full information about the stochastic environment (Rangel, Camerer, & Montague, 2008), and can have myriad negative effects such as eliciting negative affect (e.g., Demerath, 1993), promoting risky decisions (e.g., Doya, 2008), and harming interpersonal interactions (e.g., Richeson & Trawalter, 2005). Thus, it is no surprise that humans seek to reduce uncertainty (Gao & Gudykunst, 1990; Kagan, 1972). In fact, models of stress and coping suggest that uncertain situations which present a threat to the self motivate people to regulate their thoughts, feelings, and behaviors (e.g., Lazarus, 1991; Skinner & Brewer, 2002).

Address correspondence to: Allison E. Seitchik, Northeastern University, Department of Psychology, 360 Huntington Avenue, 125 Nightingale Hall, Boston, MA 02115, USA. E-mail: seitchik.a@husky.neu.edu

Stereotype threat is the concern about confirming, as self-characteristic, a negative stereotype about one's group (Steele & Aronson, 1995). By definition, stereotype threat represents a threat to the self. The target may feel uncertain about his/her prospects for responding successfully to this threat, as well as uncertain about whether a threat exists in the given situation in the first place. For example, a female who reports to her calculus course for an exam may notice for the first time that there are nine male students in the class for every female student. Because of gender-math stereotypes that suggest females underperform compared to males, the female student might wonder whether her sex impacts the evaluation of her work. The female student cannot be certain that gender-math stereotypes are relevant to this particular testing situation, but the situational cues suggest the possibility that she could be evaluated in the context of the negative stereotype. If uncertainty about threat is present, how are uncertainty processes reflected in the mechanisms underlying threat effects?

Converging evidence suggests that threat effects are multiply mediated via cognitive, affective, and motivational processes (Steele, Spencer, & Aronson, 2002). Most of the initial work on mechanisms focused on cognition (e.g., Schmader & Johns, 2003) and affect (e.g., Bosson, Haymovitz, & Pinel, 2004), and uncertainty reduction processes (particularly rumination) were prominently included in these models (see Schmader, Johns, & Forbes, 2008, for a review). More specifically, cognitive process models suggest that stigmatized individuals expend cognitive and emotional resources on reducing uncertainty about the presence of bias, resulting in cognitive processing deficits and debilitated performance (see Stone & McWhinnie, 2008). In other words, stigmatized individuals use cognitive resources thinking about whether negative group stereotypes apply to the current performance situation and, if so, what the relevant performance expectancies are. Performance is undermined as cognitive resources could be better applied to task execution rather than rumination.

In addition to cognitive processes, recent research takes seriously the idea that motivation directly contributes to the performance decrements observed under stereotype threat (e.g., Carr & Steele, 2009; Forbes, Schmader, & Allen, 2008; Jamieson & Harkins, 2007, 2009, 2011; Rydell, Rydell, & Boucher, 2010; Rydell, Shiffrin, Boucher, Van Loo, & Rydell, 2010). The crux of these explanations is that stigmatized individuals' efforts to avoid confirming negative stereotypes can have the paradoxical effect of harming performance (e.g., Jamieson & Harkins, 2009; Rydell, Shiffrin et al., 2010; Seibt & Forster, 2004). Similarly, stereotype reactance research suggests that stigmatized individuals react against negative stereotypes by shunning behaviors associated with their stigmatized group in favor of behaviors in-line with non-stereotyped groups (Kray, Thompson,

& Galinsky, 2001). The common thread among these perspectives is that motivation directly follows from perceptions of threat.

MOTIVATION AND STEREOTYPE THREAT

The current research relies on the framework provided by a motivational approach, the mere effort model (e.g., Harkins, 2006; Jamieson & Harkins, 2007, 2009). This model (and others: O'Brien & Crandall, 2003) argues that one consequence of stigmatized participants' motivation to disconfirm negative stereotypes is that it potentiates prepotent responses. When prepotent responses are correct, threat may actually improve performance—as shown in research demonstrating that stereotype threat facilitates simple task performance (Jamieson & Harkins, 2011; O'Brien & Crandall, 2003). However, when prepotent responses are incorrect and participants do not know it (which is quite often the case) or lack the knowledge/time for correction, then potentiating that response will debilitate performance. However, in those occasional cases where participants recognize that their prepotent tendencies are incorrect and they are given the opportunity to implement correction, performance can be facilitated.

Recent research applied the mere effort model to performance on a test comprised of two types of math problems—"solve" and "comparison"—which differ in the solution approach that tends to be most efficient (Jamieson & Harkins, 2009). Solve-type problems tend to be most efficiently solved by using the prepotent, traditional solution approach taught in U.S. schools: Directly applying equations/algorithms and computing answers (Gallagher & De Lisi, 1994; Gallagher et al., 2000). On the other hand, comparison problems require the test-taker to take an unconventional approach, such as using logic, estimation, and/or intuition to arrive at the correct answer. In fact, comparison problems often do not require any computations at all.

On comparison-type problems the conventional approach is not effective. Compared to non-threatened controls, females subject to stereotype threat inflexibly persevere with the conventional approach on these problems, which directly leads to performance decrements. Alternatively, on solve-type problems the conventional approach *is* effective. As long as the test-taker knows the correct equation, solving it will produce an answer. Given that threatened and non-threatened individuals do not differ in their latent math knowledge, no differences in solution rate were observed as a function of threat on these problems (Jamieson & Harkins, 2009).

CURRENT RESEARCH

To react against or be motivated by a negative stereotype, one must be certain that a threat exists. Because of this caveat, motivational processes in stereotype threat have been studied using "blatant threat" paradigms in which tasks are explicitly framed as measuring an attribute that relates to a negative ingroup stereotype (e.g., Carr & Steele, 2009; Forbes et al., 2008; Jamieson & Harkins, 2007, 2009; Kray et al., 2001; Rydell, Rydell et al., 2010; Rydell, Shiffrin et al., 2010; Seibt & Forster, 2004).

Less is known about how subtle threat cues impact motivational processes in stereotype threat. Stone and McWhinnie (2008) have suggested that the level of uncertainty may impact the conditions under which motivation manifests in stereotype threat conditions. Briefly, they argue that when tasks are presented as explicitly measuring attributes that relate to negative stereotypes, targets may be motivated to minimize mistakes and avoid confirming the negative stereotype. On the other hand, more subtle manipulations of threat may lead participants to expend resources reducing uncertainty, resulting in cognitive deficits (see Schmader & Johns, 2003). This analysis would suggest that motivational processes may not play a direct role in subtle stereotype threat paradigms.

Using the mere effort model as an organizing framework, the current research examined whether subtle and blatant manipulations of stereotype cues produce different patterns of performance in the context of gender-math stereotypes. If motivational processes stemming from both blatant and subtle threat directly impact performance, we expect to observe differences in performance as a function of problem type. Research shows that females subject to blatant stereotype threat try very hard to solve math problems, but rely almost exclusively on previously learned (i.e., prepotent) traditional solution approaches (cf. Carr & Steele, 2009) whereas males and non-threatened females are more flexible in the approaches they use to solve math problems (Jamieson & Harkins, 2009). The threatened females' inflexible perseverance directly leads to performance impairments on non-traditional comparison-type problems. On the other hand, if subtle cues cause stigmatized individuals to ruminate about whether negative group stereotypes apply to the current performance situation, females should perform more poorly on both types of math problems because cognitive research shows that experimentally reducing working memory capacity impairs math performance (e.g., Logie, Gilhooly, & Winn, 1994). In this case, we would expect to observe a participant gender $\times$ stereotype threat condition interaction.

METHOD

Participants

A total of 108 Northeastern University undergraduates participated in this experiment (54 males and 54 females) in exchange for course credit.

Procedure and materials

The subtle threat manipulation was adapted from Schmader and Johns (2003, Exp. 3), and the blatant threat manipulation was adapted from Jamieson and Harkins (2007). Participants in all conditions were exposed to two other "participants" (confederates), and the sex of the experimenter was the same as that of these "participants." In the subtle threat condition, a male confederate was already there filling out the consent form and working on practice problems when the participant arrived. In the no threat condition, the confederate was a female. The participants received a brief overview of the experimental session and were given a consent form to sign and practice problems to complete. The experimenter then escorted the first confederate out of the room to presumably go complete the math test in an adjacent cubicle. At this point, a second confederate, the same sex as the first, entered the room and sat down next to the participant. The experimenter then re-entered the room, greeted the second confederate as though s/he was a participant, and handed him/her a consent form and practice problems to fill out. Thus, participants were aware that either two males (subtle threat condition) or two females (no threat condition) were also completing the experiment.

In the blatant threat condition, participants were randomly assigned to either the male confederates/male experimenter or female confederates/female experimenter conditions. In this condition, threat is explicitly manipulated and the gender of the experimenter and confederates should not influence the perception of threat.

After the participants finished the practice problems, they were escorted to an adjacent cubicle by the experimenter. In the subtle stereotype threat condition, the experimenter explained that the goal of the study was to administer a math test to collect normative data on males and females. In the blatant threat condition, participants were told that they would be taking a math test which had been shown to produce gender differences. This explicit stereotype threat manipulation has been shown to produce performance effects in previous research (e.g., Brown & Pinel, 2003; Jamieson & Harkins, 2007; Keller, 2002; Keller & Dauenheimer, 2003; O'Brien & Crandall, 2003; Spencer, Steele, & Quinn, 1999). In the no threat condition, participants were told that the purpose of the study was to administer a problem-solving exercise to collect normative data on college students.

The math test was identical to that used by Jamieson and Harkins (2009). The test consisted of 30 multiple-choice problems from the quantitative section of the Graduate Record Exam (GRE). It included 15 comparison and 15 solve problems, and was presented as a paper and pencil test with scratch-paper provided. Because each problem actually appeared on a GRE test, we obtained performance norms as indexed by the proportion of test-takers answering each problem correctly. To construct the test, problems were selected by first randomly picking 12 problems of each type from problems that varied in their solution rates from 35% to 65%. The final three problems were picked so that mean overall accuracy averaged 50% for each type of problem (comparison range = 38–60%; solve range = 42–63%). The 12 randomly selected problems plus the final 3 made a total of 15 problems per problem type, resulting in 30 problems in total.

Problems were randomized throughout the test with the constraint that no one type of problem could appear in more than three consecutive problems. Of the first 16 problems, 8 were comparison and 8 were solve. Participants worked on the test for 20 minutes and were instructed to complete as many problems as accurately as possible. Participants were given two practice problems (one comparison, one solve) prior to beginning and could not use calculators.

After the math, test participants filled out test experience questionnaires. Two questions assessed perceptions of stereotype threat: "To what extent are there gender differences in performance on this task?" (1 = "no gender differences," 11 = "gender differences"); and "Who do you believe performs better on this task?" (1 = "males perform better," 6 = "males and females perform the same," 11 = "females perform better").

RESULTS

Unless otherwise noted, data were analyzed in 3 (threat condition: subtle stereotype threat vs blatant stereotype threat vs no stereotype threat) × 2 (participant gender: male vs female) × 2 (problem type: comparison vs solve) ANOVAs with condition and gender as between-subjects factors and problem type as a within-subjects factor. Planned contrasts (Kirk, 1995) were used to make relevant comparisons.

Perception of stereotype threat

The perceptions of threat measures were analyzed in 3 (condition: subtle threat vs blatant threat vs no threat) × 2 (participant gender: male vs female) between-subjects ANOVAs. There was a main effect for threat condition on the measure of the extent to which gender differences occurred on the task, $F(2, 102) = 7.08$, $p < .001$, $d = .53$. Planned contrasts (Kirk, 1995) revealed that subtle threat ($M = 4.47$, $SD = 2.77$) and blatant threat ($M = 5.17$, $SD = 2.72$) participants did not differ in the extent to which they reported that gender differences existed on the task, $F(1, 102) = 1.27$, $p = .26$. Thus, these means were combined and then compared to no threat participants. Results revealed that participants in the threat conditions reported that gender differences existed ($M = 4.82$, $SD = 2.75$) to a greater extent than no threat participants ($M = 2.89$, $SD = 2.33$), $F(1, 102) = 12.90$, $p < .001$, $d = .71$.

A marginal main effect of condition was found for whether males or females perform better on the task, $F(2, 102) = 2.62$, $p = .08$. Again, planned contrasts (Kirk, 1995) revealed that subtle threat ($M = 4.83$, $SD = 1.08$) and blatant threat ($M = 4.81$, $SD = 1.91$) participants did not differ in the extent to which they reported that males performed better than females, $F(1, 102) = .003$, $p = .96$, and, thus, were combined. Threatened participants believed that males outperform females to a greater extent ($M = 4.82$, $SD = 1.54$) than no threat participants ($M = 5.53$, $SD = 1.42$), $F(1, 102) = 5.26$, $p = .02$, $d = .45$. Thus, the subtle threat and blatant threat manipulations produced the perception of stereotype threat. That is, participants believed group differences existed on the test even though the experimenter made no mention of group differences in the subtle threat condition.

Math performance

Performance was first analyzed across problem type to test for the effect of stereotype threat on overall performance (see Figure 1). Planned contrasts (Kirk, 1995) revealed that subtle threat ($M = 41.66\%$, $SD = 17.06\%$) and blatant threat ($M = 44.40\%$, $SD = 16.06\%$) females did not differ in terms of overall performance, $F(1, 102) = .22$, $p = .64$, and, thus, these means were combined. Consistent with past findings, results revealed that females subject to threat performed more poorly ($M = 43.03\%$, $SD = 16.39\%$) than non-threatened females ($M = 53.11\%$, $SD = 18.50\%$), $F(1, 102) = 4.02$, $p = .048$, $d = .40$. The performance of males was unaffected by the threat manipulation. There was a marginally significant difference between subtle and blatant threat males in terms of overall performance, $F(1, 102) = 2.95$, $p = .09$. However, neither subtle threat nor blatant threat males differed from no threat males, $F(1, 102) = .58$, $p = .45$ and $F(1, 102) = .91$, $p = .34$, respectively. The Threat Condition $\times$ Participant Gender interaction suggested by this pattern of means was marginally significant, $F(2, 102) = 2.09$, $p = .129$. This pattern of performance replicates the traditional threat effect observed in stereotype threat research (e.g., Schmader & Johns, 2003).

To test for the possible effects of motivation, the percentage of problems participants answered correctly (number correct/number attempted) and the number of problems they attempted (i.e., the problems that participants provided an answer for) were analyzed as a function of problem type. All means and standard deviations are presented in Table 1.

Percentage correct. A planned contrast (Kirk, 1995) showed that females in the subtle and blatant threat conditions did not differ in the percentage of comparison-type problems answered correctly, $F(1, 102) = .30$, $p = .59$, and, thus, these means were combined and contrasted with no threat

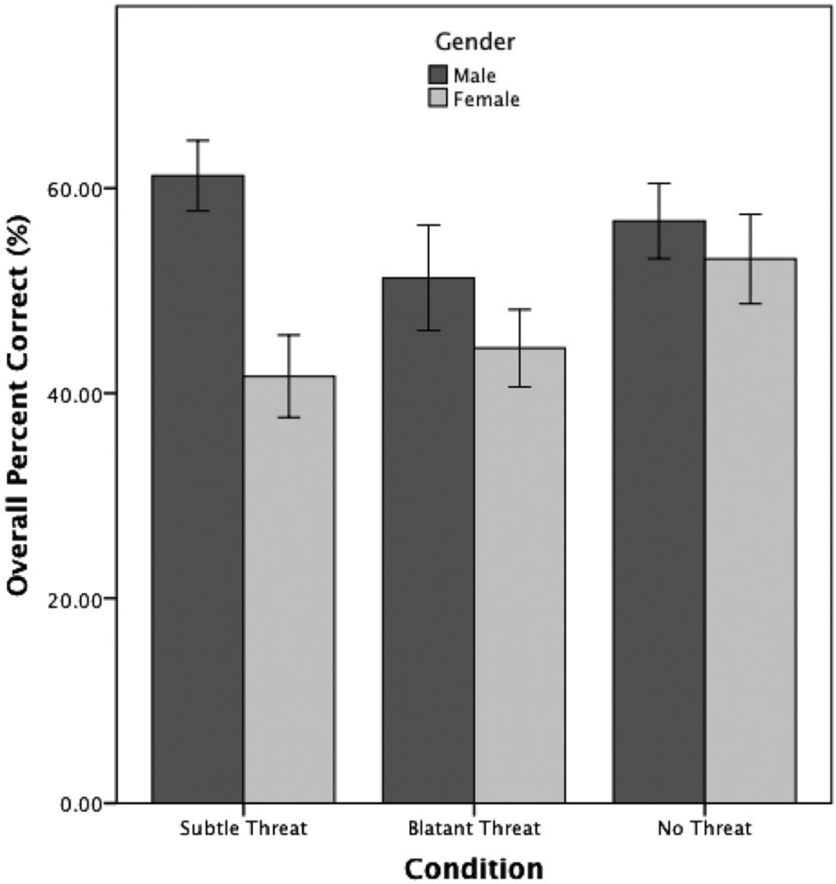

Figure 1. Total percentage correct as a function of participant gender and threat condition. Error bars represent ± 1 standard error of the mean.

females. Results showed that threat females performed more poorly than no threat females, $F(1, 102) = 18.12$, $p < .001$, $d = .84$. Females did not differ as a function of threat in the percentage of solve-type problems answered correctly: subtle threat vs blatant threat, $F(1, 102) = .20$, $p = .66$; combined threat vs no threat, $F(1, 102) = .09$, $p = .76$. Thus, the experience of both subtle and blatant threat impaired females' performance on the comparison-type problems, but did not impact their performance on solve problems.

Subtle threat males solved a greater percentage of comparison problems correctly than blatant threat males, $F(1, 102) = 6.80$, $p = .01$, $d = .52$. However, neither subtle nor blatant threat males differed significantly from no threat males, $F(1, 102) = 1.17$, $p = .28$ and $F(1, 102) = 2.33$, $p = .13$,

TABLE 1
GRE performance as a function of participant gender, stereotype threat condition, and problem type

		Performance variable							
		# Attempted comparison		*# Attempted solve*		*% Correct comparison*		*% Correct solve*	
Condition	*n*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
NST Males	18	7.94	1.80	7.83	1.69	50.90	22.76	63.45	16.25
ST Males	18	9.00	2.91	8.83	2.83	57.29	20.92	65.04	17.01
BST Males	18	6.94	2.36	7.50	1.69	41.88	25.55	59.93	24.63
NST Females	18	7.28	2.70	7.11	2.03	52.65	19.36	54.23	23.17
ST Females	18	8.83	2.96	8.44	2.45	29.25	21.46	54.46	25.03
BST Females	18	8.11	2.87	8.17	2.09	32.49	17.95	57.12	21.11

ST = Subtle threat; BST = Blatant threat; NST = No stereotype threat.

respectively. Males' percent correct on solve-type problems did not differ as a function of condition: subtle threat vs blatant threat, $F(1, 102) = .75$, $p = .39$; combined threat vs no threat, $F(1, 102) = .04$, $p = .84$.

These results produced a Threat Condition × Participant Gender × Problem Type interaction, $F(2, 102) = 2.95$, $p = .057$, $d = .34$. The main effect for gender, $F(1, 102) = 8.38$, $p = .005$, $d = .57$, must be interpreted in the context of the interaction.

Problems attempted. A planned contrast (Kirk, 1995) comparing the number of solve problems attempted by blatant and subtle threat females revealed that subtle threat females attempted the same number of solve-type problems as blatant threat females, $F(1, 102) = .54$, $p = .46$. These means were then combined and contrasted against the mean of the no threat females. Consistent with the findings using a blatant manipulation of stereotype threat (Jamieson & Harkins, 2009), females exposed to threat attempted more solve-type problems than controls, $F(1, 102) = 14.19$, $p < .001$, $d = .75$.

For comparison problems, planned contrasts (Kirk, 1995) revealed that females under subtle threat attempted more problems than blatant threat females, $F(1, 102) = 3.83$, $p = .05$, $d = .39$. Females subject to subtle threat also attempted more problems than no threat females, $F(1, 102) = 17.75$, $p < .001$, $d = .83$, as did blatant threat females, $F(1, 102) = 5.09$, $p < .03$, $d = .45$.

This pattern of performance indicates that both subtle and blatant threat females outperformed controls on the solve-type problems. Females subject to threat did not differ from no threat females in the percentage of solve problems correctly solved, but they solved more of these problems than no threat participants. On the other hand, the fact that threatened females attempted more comparison problems than no threat controls does not suggest better performance, because threatened females solved a significantly smaller percentage of comparison problems correctly than controls. That is, they attempted more problems but also got more of them wrong.

For males, contrasts (Kirk, 1995) revealed that subtle threat males attempted more solve-type problems than blatant males, $F(1, 102) = 13.07$, $p < .001$, $d = .72$, and also no threat males, $F(1, 102) = 7.39$, $p = .008$, $d = .54$, whereas blatant threat males attempted the same number of solve-type problems as no threat males, $F(1, 102) = .80$, $p = .37$. On comparison-type problems, contrasts revealed that subtle threat males attempted more problems than blatant threat males, $F(1, 102) = 8.30$, $p = .005$, $d = .57$, and also no threat males, $F(1, 102) = 31.36$, $p < .001$, $d = 1.11$. In addition, no threat males attempted more comparison-type problems than blatant threat males, $F(1, 102) = 7.39$, $p = .008$, $d = .54$.

The overall ANOVA produced only a main effect for stereotype threat condition, $F(2, 102) = 3.17$, $p = .046$, $d = .35$, perhaps because of the pattern of results for the males. However, in the crucial female/solve problem conditions, as was the case for the other dependent variables, we found that the performance of females under blatant and subtle threat did not differ and, replicating Jamieson and Harkins (2009), we found that threatened females attempted more solve problems than control females with no cost in accuracy. In addition, the pattern of findings in the other conditions does not challenge our argument that threatened females outperformed control females because they solved more problems at the same level of accuracy.

Solution approach. If perseverance with traditional solution approaches, indeed, accounts for the effects of subtle and blatant threat on test performance, females' tendency to use a solving approach should be potentiated by the experience of both subtle and blatant threat. To test this argument, two raters blind to condition computed the percentage of problems on which the participants' scratch-paper showed evidence that they used the solving approach, whether or not the attempt produced the correct answer. There was high inter-rater reliability, $r = .95$. For those few cases where the raters disagreed about a solution approach a third independent rater examined and rated the approach in question, and the problem was classified based on this rating.

Analysis of the solution approaches in a 3 (threat condition) $\times$ 2 (gender) $\times$ 2 (problem type) ANOVA produced a marginal Threat Condition $\times$ Participant Gender $\times$ Problem Type interaction, $F(2, 102) = 2.45$, $p = .091$. As shown in Table 2, for comparison problems, females subject to subtle threat did not differ from blatant threat females in the percentage of problems on which they used the solving approach, $F(1, 102) = 2.27$, $p = .13$,

TABLE 2
Percentage of problems on which the solving approach was used by males and females as a function of stereotype threat condition and problem type

		Solution approach (%)			
		Comparison problems		*Solve problems*	
Condition	*n*	*M*	*SD*	*M*	*SD*
NST Males	18	53.61	19.06	68.14	17.44
ST Males	18	58.51	16.72	76.59	11.03
BST Males	18	55.53	29.68	61.64	25.49
NST Females	18	57.31	14.66	82.08	14.53
ST Females	18	67.03	15.14	76.64	19.42
BST Females	18	74.13	17.33	77.94	20.56

ST = Subtle threat; BST = Blatant threat; NST = No stereotype threat.

and, thus, were combined. Females subject to subtle or blatant threat used the solving approach significantly more often than females not subject to threat on comparison problems, $F(1, 102) = 10.57$, $p = .002$, $d = .64$. In contrast, threat did not impact females' use of the solving approach on solve-type problems: subtle threat vs blatant threat, $F(1, 102) = .08$, $p = .78$; combined threat vs no threat, $F(1, 102) = 1.38$, $p = .24$.

Threat had no impact on how often males used the solving approach on comparison-type problems: subtle threat vs blatant threat, $F(1, 102) = .40$, $p = .53$; combined threat vs no threat, $F(1, 102) = .70$, $p = .40$. However, subtle threat males used the solving approach significantly more than blatant threat males on solve-type problems, $F(1, 102) = 10.06$, $p = .002$, $d = .63$. The main effects for gender, $F(1, 102) = 9.96$, $p = .002$, $d = .62$, and problem type, $F(1, 102) = 42.11$, $p < .001$, $d = 1.29$, should be interpreted in the context of the three-way interaction. All means and standard deviations are presented in Table 2.

Mediation

To test whether potentiation of the solving approach directly impaired comparison problem performance, we conducted a mediation analysis following the procedures suggested by Kenny, Kashy, and Bolger (1998) on the number of comparison problems solved incorrectly. As shown in Figure 2, the use of the prepotent solving approach mediated the debilitating effect of subtle stereotype threat on comparison problem performance, Sobel $Z = 2.04$, $p = .042$. Thus, under subtle threat, females' use of the solving approach mediated the effect of debilitation on comparison problems. Also, replicating the findings from Jamieson and Harkins

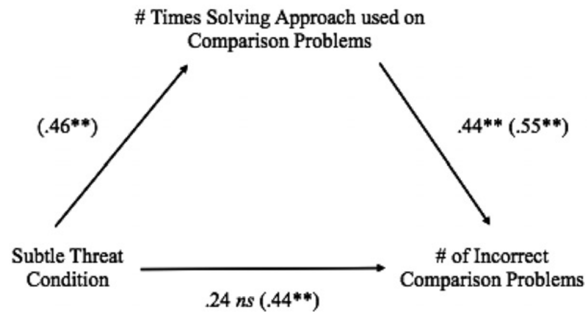

Figure 2. Number of times females used the prepotent solving approach on comparison trials as a mediator of number of comparison problems answered incorrectly. Coefficients in parentheses indicate zero-order correlations. Coefficients not in parentheses represent parameter estimates for a recursive path model including both predictors. Double asterisks (**) indicate parameter estimates or correlations that differ from zero at $p < .01$. Subtle stereotype threat condition is dummy coded (subtle stereotype threat = 1, no stereotype threat = 0).

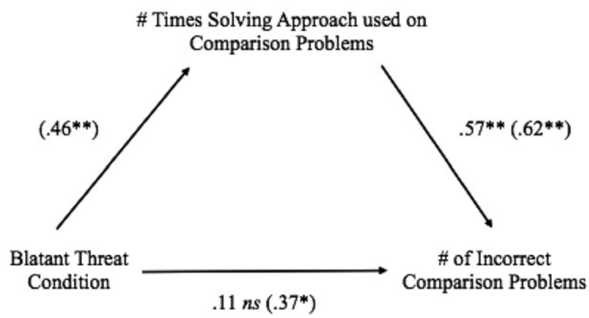

Figure 3. Number of times females used the prepotent solving approach on comparison trials as a mediator of number of comparison problems answered incorrectly. Coefficients in parentheses indicate zero-order correlations. Coefficients not in parentheses represent parameter estimates for a recursive path model including both predictors. Single asterisks (*) indicate parameter estimates or correlations that differ from zero at $p < .05$. Double asterisks (**) indicate parameter estimates or correlations that differ from zero at $p < .01$. Blatant stereotype threat condition is dummy coded (blatant stereotype threat = 1, no stereotype threat = 0).

(2009), the use of the prepotent solving approach mediated the debilitating effect of blatant stereotype threat on comparison problem performance, Sobel $Z = 2.33$, $p = .02$ (see Figure 3).

DISCUSSION

In the current experiment, we used a subtle manipulation of stereotype threat that was modeled on previous research (Schmader & Johns, 2003, Expt 3). Unlike blatant manipulations of threat, subtle threat manipulations require that participants rely on situational cues (e.g., their solo status) to make their threat appraisals. However, the subtle threat manipulation used in the current research produced the same pattern of GRE performance that was produced by an explicit, blatant threat manipulation in prior work (Jamieson & Harkins, 2009). Participants in both the subtle and blatant threat conditions were more apt to believe that gender differences existed on the test and that males performed better relative to females than controls, and females subject to either subtle or blatant threat performed more poorly on the test than no threat females and males in either condition.

When performance was examined as a function of problem type, subtle and blatant threat females outperformed no threat females on the solve-type problems by attempting more problems with no loss of accuracy, but threatened females performed much more poorly than the no threat females on the comparison-type problems as the experience of threat impaired threat participants' ability to solve the problems at a percentage that was above chance. Therefore, just like the blatant threat manipulation, the subtle stereotype threat manipulation impaired overall performance because the debilitating effect of threat on comparison problems outweighed the facilitation effect of threat on the solve-type problems.

Analysis of participants' solution approaches suggests that the debilitating effect of both subtle and blatant threat on comparison problem performance was the result of threatened females using the incorrect, but prepotent, solving approach more often than controls. This conclusion was supported by a mediation analysis showing that threatened females' reliance on the solving approach was directly responsible for their debilitated performance on comparison problems. This finding indicates that subtle threat cues and blatant threat cues led females to try very hard to solve the math problems in the manner in which they had been taught: Directly applying known formulas/equations and computing an answer. However, they pursued this approach to the exclusion of other solution approaches. Consistent with research by Carr and Steele (2009), when the prepotent solving was not successful (i.e., the comparison problems), threatened participants' lack of flexibility debilitated their performance.

The findings from the current research do not provide evidence that subtle threat cues lead participants to expend cognitive resources reducing uncertainty about the existence of threat. Instead, the pattern of performance observed in this research supports Jamieson and Harkins's (2007, 2009) motivation-based mere effort account. This outcome suggests the possibility that motivational mechanisms are involved in both subtle and blatant forms of stereotype threat, rather than different processes accounting for the effects of each, as was suggested by Stone and McWhinnie (2008).

It is not clear exactly what it is about the subtle threat manipulation that is producing motivation. We modeled our subtle threat manipulation on Schmader and Johns's (2003) paradigm, because it was cited by Stone and McWhinnie (2008) as an example of a subtle threat manipulation. However, this paradigm confounds the gender of the confederates and instruction. That is, participants were exposed to a male experimenter and male confederates and were told that the purpose of the study was to collect normative data from males and females on a math test (subtle threat) or they were exposed to a female experimenter and female confederates and told that the purpose of the study was to collect normative data from college students on a problem-solving test (no threat). Thus, the subtle threat effect could be due to the instructions (math test vs problem-solving test), the gender of the experimenter and confederates, or both.

In an effort to tease apart these components of the subtle threat manipulation, we collected additional data at the time we ran the experiment: A group of females was exposed to a female experimenter and female confederates and told the purpose of the study was to collect normative data from males and females on a math test, and another was exposed to a male experimenter and male confederates and told that the purpose of the study was to collect normative data from college students on a problem-solving test. These groups were combined with the subtle threat (male pod with math instructions) and the control (female pod with problem-solving instructions) groups from the main experiment so that we could examine overall math performance of females in a 2 ("Pod" Gender: male experimenter/confederates vs female experimenter/confederates) $\times$ 2 (Instruction: math test vs problem-solving test) ANOVA. This analysis produced only an instruction main effect, $F(1, 68) = 5.90$, $p < .02$, $d = .59$. Females given problem-solving instructions (control) solved a greater percentage of problems correctly ($M = 53.57\%$, $SD = 15.40\%$) than females given math instructions ($M = 43.98\%$, $SD = 17.68\%$). Neither the effect for "pod" gender, $F(1, 68) = .22$, $p = .64$, nor the interaction approached significance, $F(1, 68) = .50$, $p = .48$.

These results suggest that the subtle stereotype effects found in the current paper are likely due to the instructions the participants received (i.e., math test) and not to the gender of the experimenter and confederates. This finding is consistent with previous research in that none of the work of which we are aware has found that solo status alone (i.e., in the absence of any secondary instructions about the test or potential for evaluation) is sufficient to impair females' math performance (e.g., Croizet et al., 2004; Inzlicht & Ben-Zeev, 2000; Sekaquaptewa & Thompson, 2003).

The current research has implications for the future direction of stereotype threat research. Generally, researchers have paid little attention to motivation as a mediator of stereotype threat performance effects, even though the experience of threat is inherently motivating (nobody wants to confirm stereotypes). This and previous research (e.g., Jamieson & Harkins, 2007, 2009; Kray et al., 2001) suggests that females subject to threat do not simply accept their fate and resign themselves to performing poorly. Although they do temper expectations based on their awareness of stereotypes (e.g., Stone & McWhinnie, 2008), females also try very hard to disprove negative stereotypes directed at their group. Thus, the motivational processes argued for in this research offer a source of encouragement because the findings suggest that females react against being negatively typecast as poor performers in math and science. Without the desire to improve one's lot and the status of one's social groups, there would be little that researchers could do towards reducing the negative effects of stereotype threat on females' performance.

Manuscript received 20 April 2012
Manuscript accepted 31 October 2012
First published online 22 November 2012

REFERENCES

Bosson, J. K., Haymovitz, E. L., & Pinel, E. C. (2004). When saying and doing diverge: The effects of stereotype threat on self-reported versus non-verbal anxiety. *Journal of Experimental Social Psychology*, *40*, 247–255. doi: 10.1016/S0022-1031(03)00099-4.

Brown, R. P., & Pinel, E. C. (2003). Stigma on my mind: Individual differences in the experience of stereotype threat. *Journal of Experimental Social Psychology*, *39*, 626–633. doi: 10.1016/S0022-1031(03)00039-8.

Carr, P. B., & Steele, C. M. (2009). Stereotype threat and inflexible perseverance in problem solving. *Journal of Experimental Social Psychology*, *45*, 853–859. doi: 10.1016/j.jesp.2009.03.003.

Croizet, J. C., Desprès, G., Gauzins, M. E., Huguet, P., Leyens, J. P., & Mèot, A. (2004). Stereotype threat undermines intellectual performance by triggering a disruptive mental load. *Personality and Social Psychology Bulletin*, *30*, 721–731. doi: 10.1177/0146167204263961.

Demerath, L. (1993). Knowledge-based affect: Cognitive origins of 'good' and 'bad'. *Social Psychology Quarterly*, *56*, 136–147. doi: 10.2307/2787002.

Doya, K. (2008). Modulators of decision making. *Nature Neuroscience*, *11*, 410–416. doi: 10.1038/nn2077.

Forbes, C. E., Schmader, T., & Allen, J. J. B. (2008). The role of devaluing and discounting in performance monitoring: A neurophysiological study of minorities under threat. *Social Cognitive and Affective Neuroscience*, *3*, 253–261. doi: 10.1093/scan/nsn012.

Gallagher, A. M., & De Lisi, R. (1994). Gender differences in Scholastic Aptitude Test – Mathematics problem solving among high-ability students. *Journal of Educational Psychology*, *86*, 204–211. doi: 10.1037/0022-0663.86.2.204.

Gallagher, A. M., De Lisi, R., Holst, P. C., McGillicuddy-De Lisi, A. V., Morely, M., & Cahalan, C. (2000). Gender differences in advanced mathematical problem solving. *Journal of Experimental Child Psychology*, *75*, 165–190. doi: 10.1006/jecp.1999.2532.

Gao, G., & Gudykunst, W. B. (1990). Uncertainty, anxiety, and adaptation. *International Journal of Intercultural Relations*, *14*, 301–317. doi: 10.1016/0147-1767(90)90017-Q.

Harkins, S. G. (2006). Mere effort as the mediator of the evaluation-performance relationship. *Journal of Personality and Social Psychology*, *91*, 436–455. doi: 10.1037/0022-3514.91.3.436.

Inzlicht, M., & Ben-Zeev, T. (2000). A threatening intellectual environment: Why females are susceptible to experiencing problem-solving deficits in the presence of males. *Psychological Science*, *11*, 365–371. doi: 10.1111/1467-9280.00272.

Jamieson, J. P., & Harkins, S. G. (2007). Mere effort and stereotype threat performance effects. *Journal of Personality and Social Psychology*, *93*, 544–564. doi: 10.1037/0022-3514.93.4.544.

Jamieson, J. P., & Harkins, S. G. (2009). The effect of stereotype threat on quantitative GRE problems: A mere effort interpretation. *Personality and Social Psychology Bulletin*, *35*, 1301–1314. doi: 10.1177/0146167209335165.

Jamieson, J. P., & Harkins, S. G. (2011). The intervening task method: Implications for measuring mediation. *Personality and Social Psychology Bulletin*, *37*, 652–661. doi: 10.1177/0146167211399776.

Kagan, J. (1972). Motives and development. *Journal of Personality and Social Psychology*, *22*, 51–66. doi: 10.1037/h0032356.

Keller, J. (2002). Blatant stereotype threat and women's math performance: Self-handicapping as a strategic means to cope with obtrusive negative performance expectations. *Sex Roles*, *47*, 193–198. doi: 10.1023/A:1021003307511.

Keller, J., & Dauenheimer, D. (2003). Stereotype threat in the classroom: Dejection mediates the disrupting threat effect on women's math performance. *Personality and Social Psychology Bulletin*, *29*, 371–381. doi: 10.1177/0146167202250218.

Kenny, D. A., Kashy, D. A., & Bolger, N. (1998). Data analysis in social psychology. In D. Gilbert, S. T. Fiske, & G. Lindzey (Eds.), *Handbook of social psychology* (4th ed., Vol. 1, pp. 233–265). New York: McGraw-Hill.

Kirk, R. (1995). *Experimental design*. Pacific Grove, CA: Brooks/Cole Publishing Company.

Kray, L. J., Thompson, L., & Galinsky, A. (2001). Battle of the sexes: Gender stereotype confirmation and reactance in negotiations. *Journal of Personality and Social Psychology*, *80*, 942–958. doi: 10.1037/0022-3514.80.6.942.

Lazarus, R. S. (1991). *Emotion and adaptation*. New York: Oxford University Press.

Logie, R. H., Gilhooly, K. J., & Wynn, V. (1994). Counting on working memory in arithmetic problem solving. *Memory & Cognition*, *22*, 395–410.

O'Brien, L. T., & Crandall, C. S. (2003). Stereotype threat and arousal: Effects on women's math performance. *Personality and Social Psychology Bulletin*, *29*, 782–789. doi: 10.1177/0146167203029006010.

Rangel, A., Camerer, C., & Montague, P. R. (2008). A framework for studying the neurobiology of value-based decision making. *Nature Reviews Neuroscience*, *9*, 545–556. doi: 10.1038/nrn2357.

Richeson, J. A., & Trawalter, S. (2005). Why do interracial interactions impair executive function? A resource depletion account. *Journal of Personality and Social Psychology*, *88*, 934–947. doi: 10.1037/0022-3514.88.6.934.

Rydell, R. J., Rydell, M. T., & Boucher, K. L. (2010). The effect of negative performance stereotypes on learning. *Journal of Personality and Social Psychology*, *99*, 883–896. doi: 10.1037/a0021139.

Rydell, R. J., Shiffrin, R. M., Boucher, K. L., Van Loo, K., & Rydell, M. T. (2010). Stereotype threat prevents perceptual learning. *PNAS Proceedings of the National Academy of Sciences of the United States of America*, *107*, 14042–14047. doi: 10.1073/pnas.1002815107.

Schmader, T., & Johns, M. (2003). Converging evidence that stereotype threat reduces working memory capacity. *Journal of Personality and Social Psychology*, *85*, 440–452. doi: 10.1037/0022-3514.85.3.440.

Schmader, T., Johns, M., & Forbes, C. (2008). An integrated process model of stereotype threat effects on performance. *Psychological Review*, *115*, 336–356. doi: 10.1037/0033-295X.115.2.336.

Seibt, B., & Forster, J. (2004). Stereotype threat and performance: How self-stereotypes influence processing by inducing regulatory foci. *Journal of Personality and Social Psychology*, *87*, 38–56. doi: 10.1037/0022-3514.87.1.38.

Sekaquaptewa, D., & Thompson, M. (2003). Solo status, stereotype threat, and performance expectancies: The effects on women's performance. *Journal of Experimental Social Psychology*, *39*, 68–74. doi: 10.1016/S0022-1031(02)00508-5.

Skinner, N., & Brewer, N. (2002). The dynamics of threat and challenge appraisals prior to stressful achievement events. *Journal of Personality and Social Psychology*, *83*, 678–692. doi: 10.1037/0022-3514.83.3.678.

Spencer, S. J., Steele, C. M., & Quinn, D. M. (1999). Stereotype threat and women's math performance. *Journal of Experimental Social Psychology*, *35*, 4–28. doi: 10.1006/jesp.1998.1373.

Steele, C. M., & Aronson, J. (1995). Stereotype threat and the intellectual test performance of African Americans. *Journal of Personality and Social Psychology*, *69*, 797–811. doi: 10.1037/0022-3514.69.5.797.

Steele, C. M., Spencer, S. J., & Aronson, J. (2002). Contending with group image: The psychology of stereotype and social identity threat. In M. P. Zanna (Ed.), *Advances in experimental social psychology* (Vol. 34, pp. 379–440). San Diego, CA: Academic Press.

Stone, J., & McWhinnie, C. (2008). Evidence that blatant versus subtle stereotype threat cues impact performance through dual processes. *Journal of Experimental Social Psychology*, *44*, 445–452. doi: 10.1016/j.jesp.2007.02.006.