Arousal and stereotype threat[☆]

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Abstract

Seemingly insignificant features of the context can undermine the quantitative performance of skilled females—an effect attributed to stereotype threat. The present studies tested the hypotheses that stereotype threat triggers arousal, and that attributions about that arousal could moderate the effects of stereotype threat on performance. To examine whether arousal is triggered by stereotype threat, we conducted two experiments in which female participants were asked to take a math test under conditions of stereotype threat or not. In Study 1, women under stereotype threat performed *better* on an easy threat-irrelevant task, but *worse* on a difficult threat-irrelevant task than women not under threat. In Study 2, threatened women underperformed on a math test, but this underperformance was attenuated for women directed to misattribute their arousal. These results suggest that arousal—and how arousal is attributed—may play an important role in the debilitating effects of stereotype threat.
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A body of literature on *stereotype threat* (Steele, 1997; Steele, Spencer, & Aronson, 2002) has provided a powerful and productive account of how social context contributes to creating, perpetuating, or eliminating underperformance that has hindered stigmatized groups from realizing their intellectual potential. Stereotype threat occurs when targets of stereotypes alleging their inferiority in a relevant domain are reminded of the possibility of confirming these stereotypes, resulting in performance deficits. Examples of stereotyped groups and their threatened domains include women in math (Inzlicht & Ben-Zeev, 2000; Schmader, 2002; Shih, Pittinsky, & Ambady, 1999; Spencer, Steele, & Quinn, 1999), European Americans in sports (Stone, Lynch, Sjomel-ing, & Darley, 1999), and African Americans, Latinos, and students of low socioeconomic status in a number of intellectual domains (e.g., Aronson, Quinn, & Spencer, 1998; Croizet & Claire, 1998; Gonzales, Blanton, & Williams, 2002; Steele & Aronson, 1995).

Despite the enthusiasm that this line of research has generated, there is still much to be learned about the specific mechanisms that underlie stereotype threat. A number of potential mediators have been explored thus far, such as low self-efficacy, evaluation apprehension, and attentional distraction, and these have met with varying degrees of promise (Spencer et al., 1999; Steele et al., 2002). It is clear that continuing to identify and understand these mechanisms will be an important pursuit in future research.

Some empirical work has focused on the possible role of anxiety in stereotype threat. Osborne (2001) found correlational evidence consistent with the idea that race differences in math and verbal achievement, and gender differences in math achievement, may be at least partially mediated by anxiety. Osborne analyzed high school

seniors' performance on standardized verbal and math tests. After completing the tests, students reported how anxious they had felt on a variety of items. Unfortunately, however, Osborne noted that this study failed to determine whether stereotype threat actually existed during test administration, which implies that phenomena other than stereotype threat may have been responsible for the partial mediation of anxiety. Thus, Osborne's results are consistent with the idea that anxiety is a mediator of threat, but further evidence is required to support this idea more fully. In addition, Spencer et al. (1999) found that self-reported anxiety was related to both performance deficits and threat. However, controlling for level of anxiety did not significantly reduce the direct relationship between threat and test performance. Again, these results do not rule out anxiety as a mediator of stereotype threat, but the evidence thus far is lacking.

Some promising results have been found concerning the potential role of arousal (Ben-Zeev et al., in press; Blascovich, Spencer, Quinn, & Steele, 2001; O'Brien & Crandall, 2003). There is, of course, a connection between anxiety and arousal. Anxiety is positively associated with adrenal–corticol responses, which are characteristic of heightened arousal (Dienstbier, 1989; Folkman & Lazarus, 1986). Specifically, test anxiety has been linked to increased skin conductance response (SCR) and cardiac reactivity (Cassady & Johnson, 2001). Whether or not test anxiety proves to be an important mediator of underperformance due to stereotype threat, there is evidence to suggest that arousal can play a significant role in stereotype threat effects. For example, Blascovich et al. (2001) found that the blood pressure of African American participants taking a test under stereotype threat rose faster and remained higher relative to the blood pressure of White participants or non-threatened African American participants. The African American participants under threat also exhibited worse performance on difficult items on the Remote Associates Test. Thus, increased physiological reactivity was associated with decreased intellectual performance.

O'Brien and Crandall (2003) have also reported results consistent with the hypothesis that arousal may be a mediator of stereotype threat. O'Brien and Crandall drew from the long history of work on social facilitation (e.g., Zajonc, 1965) and reasoned that if stereotype threat triggers arousal, then participants under stereotype threat should not only show impaired performance on difficult tests (in which the dominant response would be failure), but also exhibit enhanced performance on easy tasks (in which the dominant response would be success). As predicted, women taking math tests under conditions of stereotype threat performed worse on a difficult math test, but better on an easy math test, relative to women not under stereotype threat.

Using two very different methodologies, therefore, the studies of Blascovich et al. (2001) and O'Brien and Crand-all (2003) point to the potential role that arousal may play in stereotype threat effects. The two studies reported in the present paper were designed to test this idea further, and extend the previous work in two important ways.

First, in Study 1 we employed the same reasoning as O'Brien and Crandall in using a social facilitation paradigm to pursue indirect evidence for the presence of arousal in stereotype threat conditions. In our study, however, we felt it was essential to test for performance impairment and enhancement in domains *not* related to the stereotype threat. Both theoretical and empirical work suggests that stereotype threat is most likely to be experienced for individuals when they are challenged and even frustrated, when they are working at the frontier of their skills and knowledge (Steele, 1997; Steele et al., 2002). For example, Spencer et al. (1999) found that women experienced stereotype threat on a math test only when the test was very difficult. Blascovich et al. found evidence for stereotype threat affecting the performance of the African American participants in their experiment primarily on difficult items. In O'Brien and Crandall's study, therefore, it is unclear the extent to which the women would have been experiencing stereotype threat when taking the easy math test. Based on previous work on stereotype threat, it seems plausible that the experience of taking a relatively easy math test would reduce stereotype threat effects among the women. The better performance these women exhibited on the easy test therefore may not have been due to arousal enhancing the dominant response but to something else, such as relief or feelings of increased efficacy. To avoid this problem, we designed Study 1 to examine evidence for social facilitation effects under conditions that would preserve the stereotype threat while manipulating the difficulty of the performance—performance in a domain unrelated to the stereotype threat itself. This manipulation would provide a more stringent test of the presence of arousal under stereotype threat.

Study 2 was designed not only to provide additional evidence for the effect of arousal, using a different methodology, but also to examine further the parameters of this effect. That is, can arousal, in and of itself, be sufficient for causing stereotype threat effects, or might it depend on factors such as an individual's cognitive appraisal of the arousal? In other words, is underperformance due merely to excessive arousal, or must the arousal be construed in a particular manner that might trigger particular debilitating responses?

Study 1

A key aspect of social facilitation theory is that arousal facilitates individuals' performance on easy well-learned tasks and impairs performance on difficult or novel tasks (Zajonc, 1965). Stereotype threat effects typically emerge

when individuals are attempting to perform tasks that are very difficult for them, which lie at the frontier of individuals' knowledge and abilities (Steele, 1997, 2002).

If arousal is implicated in stereotype threat effects, however, it stands to reason that this arousal should *improve* performance on relatively easy tasks in which the dominant response is success. One possible implication of this reasoning is that under conditions of stereotype threat, performance in the threatened domain should be facilitated rather than impaired if the performance is on an easy task. A Heisenbergian problem could potentially arise here, however, if a task is easy, then threat itself is reduced. This exactly is our concern with the results of O'Brien and Crandall (2003). Although their research is consistent with the hypothesis that stereotype threat triggers arousal, it is important to test this hypothesis further while de-coupling the presence or absence of stereotype threat with the difficulty of the task confronted by participants.

To circumvent this problem, we had participants perform a task that was completely unrelated to the threatened domain. Specifically, we placed high math-identified women under stereotype threat and no threat conditions. All women believed they were about to take a math test. While waiting for the test to begin, half of the women performed an extremely easy, familiar task: Writing their name. The other half, in contrast, performed a more difficult, unfamiliar task: Writing their name backward. This paradigm has been used in previous social facilitation research (e.g., Schmitt, Gilovich, Goore, & Joseph, 1986). The prediction was straightforward: If arousal plays a role in stereotype threat, then stereotyped individuals under threat will do *better* on the easy task but *worse* on the difficult task in comparison to individuals in the no-threat condition.

Method

Participants

Research on stereotype threat suggests that performance deficits will emerge primarily among individuals who are invested in and identified with the threatened domain (Aronson et al., 1999; Steele, 1997, 2002). For this study, therefore, we selected undergraduate students from an introductory psychology class at Williams College who had indicated on a questionnaire completed several weeks earlier that doing well in courses concerning math was important to them (i.e., they provided a rating of four or greater on a 7-point scale, ranging from "not at all important" to "extremely important"). Thirty-nine female students from this sample participated in the study to receive credit for their introductory psychology class. Although the focus of this study was on the effects of stereotype threat on women, we included

male students in the experimental sessions to heighten the potential for stereotype threat (cf. Inzlicht & Ben-Zeev, 2000, 2003); a total of 20 male students from the same population participated in this study.

Procedure

The experimental sessions consisted of mixed-sex groups ranging from 7 to 14 students. Participants were told that the study involved performing a series of cognitive tasks. They read instructions that explained that they soon would be taking a very challenging difficult standardized test of their ability in math. Based on manipulations used by Spencer et al. (1999), we randomly assigned half the participants to the *no-threat* condition and half to the *threat* condition. Participants in the no-threat condition read that this particular standardized test was chosen in part because previous research had shown that there were no gender differences in performance on this test. Because the default for women who care about math and who are confronted with a very difficult math test in a mixed-sex setting is the experience of stereotype threat, we provided no information about gender differences to participants in the threat condition.[1]

Participants read that before taking the math test, they were to engage in a brief unrelated cognitive task. Participants were assigned randomly to either an *easy* or a *difficult* task. The easy task consisted of writing their first and last names in cursive repeatedly for 20 s. Writing their names is, of course, a well-learned, easy task for college students. For participants in the difficult task condition, we had participants write their names in an unfamiliar, novel way: They wrote their first names backward repeatedly in cursive for 20 s. Thus, our dependent variable was the number of times participants completed the well-learned or novel name-writing task. Despite the instructions about the math test and other cognitive tasks to come, the experiment concluded with this name-writing task.[2]

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[1] To ensure that this manipulation would be a valid manipulation of stereotype threat, we conducted a pilot test of these procedures on students from the same population. Consistent with the intent of the manipulation, women (but not men) did significantly worse on a math test following the threat instructions than following the no-threat instructions.

[2] The purpose of this study was to find evidence for the presence of increased arousal for women who are under stereotype threat relative to women not under threat, and therefore it was not necessary for participants to actually take the test, as long as they had *expected* to do so. Although we could have added the test anyway, one reason why we decided to drop test performance from our design was because of concern that the manipulation of the difficulty of the task might itself influence subsequent test performance. Indeed, pilot testing bolstered this concern, as participants, independent of other factors, did tend to perform worse on a math test if they had first done a difficult task rather than an easy task.

Results and discussion

We predicted that if stereotype threat triggers arousal, then women under stereotype threat should do *better* on the easy task but *worse* on the difficult task than women in the no-threat condition. As can be seen in Fig. 1, the results of a two-way analysis of variance (ANOVA), with the frequency of task completion as the dependent variable, supported this prediction, $F(1, 35) = 13.95$, $p < .001$. Consistent with our predictions, women under stereotype threat performed significantly better on the easy task ($M = 8.56$, $SD = 1.13$) than did women not under threat ($M = 6.00$, $SD = 1.70$), $F(1, 35) = 5.75$, $p < .03$, Cohen's $d = .79$, whereas women in the threat condition performed significantly worse on the difficult task ($M = 5.30$, $SD = 2.16$) than did women not under threat ($M = 8.30$, $SD = 3.50$), $F(1, 35) = 8.36$, $p < .007$. This constitutes a large effect size, Cohen's $d = .98$. Neither main effect approached significance.

Because the male participants should not have experienced stereotype threat, we expected their task performance to be unaffected by our manipulations. The two-way ANOVA on their data revealed no reliable effects (all F's < 1.01). A three-way ANOVA, adding gender to the two-way ANOVA reported above, revealed a significant three-way interaction, $F(1, 51) = 4.15$, $p < .05$, consistent with the prediction that the interaction between threat and task difficulty would be strong for women but not for men.

These results, therefore, provide further support for the notion that stereotype threat can trigger arousal. Moreover, by demonstrating these effects on tasks completely unrelated to the domain under threat, this study provides even clearer evidence of this point than did the research of O'Brien and Crandall (2003), while at the same time supporting the conclusions they reached.
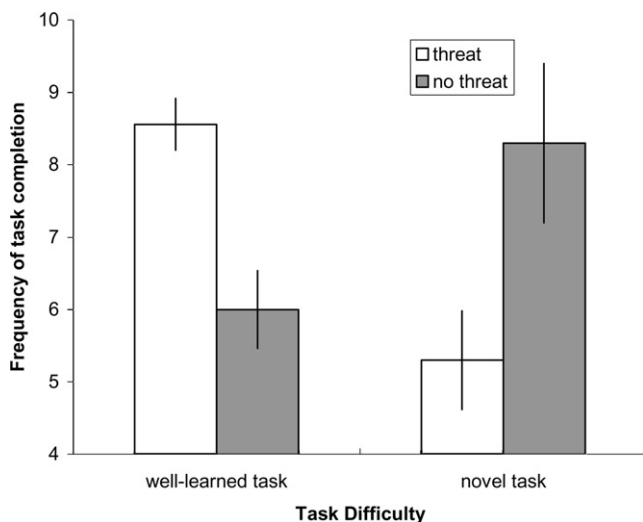

Fig. 1. Number of times task was completed as a function of stereotype threat and difficulty of task. Error bars represent standard error.

Study 2

Study 2 was designed, in part, to provide further converging evidence for the role of arousal in stereotype threat via a different classic paradigm—specifically, the misattribution paradigm. The misattribution paradigm has been used successfully in many studies over the years to assess the role of arousal as a mediating variable without relying either on self-report or invasive procedures (e.g., Olson, 1988; Savitsky, Medvec, Charlton, & Gilovich, 1998; Zanna & Cooper, 1974, 1976).

A second purpose of Study 2, however, was to examine more closely the parameters of arousal in this process. According to the classic Yerkes and Dodson (1908) law of physiological arousal, performance is optimal at intermediate levels of arousal and decreases when arousal is either low or high, resulting in an inverted-U shaped function. The most straightforward prediction from the Yerkes–Dodson law is that stereotype threat may interfere with performance by triggering arousal that exceeds an optimal level.

A Yerkes–Dodson model of arousal seems useful for investigating stereotype threat but offers what might be an overly simplistic explanation of this phenomenon. The design of Study 2 allows us to begin to address the question of whether the mere presence of arousal due to stereotype threat should lead to underperformance, or whether the effect is contingent on additional factors, such as the individual's construal of the meaning of that arousal, and its apparent relevance to the threat in question.

In Study 2, therefore, some women under conditions of stereotype threat were given the opportunity to attribute the negative arousal presumably triggered by the threat to a benign source, rather than to the stereotype or the threatened domain. If misattributing the arousal to the benign source eliminates the underperformance associated with the stereotype threat, it would suggest that the mere presence of the arousal might not be sufficient to mediate the underperformance caused by stereotype threat. Rather, it would seem that the process is more nuanced, more contingent on cognitive appraisals and responses, than would be suggested by a simple Yerkes–Dodson based model. On the other hand, if misattribution does not attenuate the underperformance effect, the Yerkes–Dodson based model would remain tenable, although the study would not add support for the presence of arousal under stereotype threat.

Method

Participants

We had 128 Brown University undergraduates complete the Mathematics Identification Questionnaire (MIQ; Brown, 2000) and indicate their math SAT scores. From these, 37 students were selected on the basis of having scored above the theoretical midpoint of

the MIQ ($M = 6.03$, $SD = .87$) and scored 600 or above on the math portion of the SAT ($M = 696.76$, $SD = 56.82$). These 37 highly identified female undergraduates participated in exchange for credit toward a course requirement or for payment of $7.

Procedure

Two males and two females served as experimenters, so that half of the participants were greeted by a male experimenter and half by a female experimenter. To minimize any expectancy effects, experimenters were present in the lab only when absolutely necessary (e.g., to pass out the math test) and participants listened to audiotaped recordings of the instructions for the experiment.

Stereotype threat manipulation. Inzlicht and Ben-Zeev (2000, 2003) showed that female participants who were very good in math performed more poorly with two male partners than with two female partners. We used a similar manipulation of stereotype threat in the present study. Female participants were randomly assigned to either same-sex (three female students) or minority (one female student with two male confederates) conditions. According to the cover story, the goal of the study was to develop a new educational training program to improve student performance on standardized achievement tests. They also learned that as part of the study they would take a math test, the results of which would be reported orally to the group.

Misattribution manipulation. Participants learned further that one of the factors being studied was the effect of subliminal noise on test performance. All participants were seated in front of a large machine that was introduced as the subliminal noise generator. To illustrate how the audio generator worked, participants were exposed to a series of audible tones that increased in frequency, culminating in a subliminal tone of 20,000 Hz—a "silent tone" well beyond the range of human hearing. Participants were then informed that they would be exposed to this tone for the duration of the math test. Participants in the *control* group were told that the subliminal noise would have no discernible physical effects on them. In contrast, those in the *misattribution* condition were told that the noise was associated with a number of side effects, and that previous participants had noted an increase in arousal, nervousness, and heart rate. They were told not to be alarmed if they felt these side effects and were assured that any such side effects would be temporary. Next, all participants were given the math test.

Math test. Participants had 20 min to complete the math test. The math test consisted of 20 difficult multiple-choice items culled from the GRE test guide (Educa-

tional Testing Service, 1994). Each math item was, on average, answered correctly by only one-third of test takers in past samples.

Manipulation check. At the conclusion of the test all participants completed a brief questionnaire. In addition to filler items was a set of four items concerning how anxious or nervous the subliminal noise made the participants feel. Using a 7-point Likert scale ranging from *1* (strongly disagree) to *7* (strongly agree), participants responded to the following items: "I feel that the subliminal noise made me feel nervous," "The side-effects of the subliminal noise did not make me feel jumpy," "I was thinking about the possible side-effects of the subliminal noise," and "The subliminal noise did not affect me in any way at all." The four individual measures of misattribution were reverse coded when necessary and combined into one measure ($\alpha = .70$).

Results and discussion

Manipulation check

Participants' responses on the manipulation check were subjected to a 2×2 analysis of covariance (ANCOVA), using self-reported SAT scores as the covariate, which revealed a main effect for the misattribution manipulation, $F(1, 31) = 5.81$, $p < .025$, Cohen's $d = .54$.[3] As predicted, participants in the misattribution condition were more likely to attribute nervousness and arousal to the subliminal noise ($M = 2.59$, $SD = 1.11$) than were the participants in the control group ($M = 2.01$, $SD = 1.05$).

Test performance

Most importantly, the 2×2 ANCOVA on number of math problems answered correctly, with SAT scores as the covariate, revealed a significant interaction between the manipulations of sex-composition and misattribution, $F(1, 31) = 6.06$, $p < .02$ (see Fig. 2). Simple-effects analyses revealed that among women not given the misattribution information, the typical stereotype threat effects emerged: Females in the minority group did significantly worse ($M = 6.34$, $SD = 2.43$) than did females in the same-sex group ($M = 8.82$, $SD = 2.40$), $F(1, 31) = 5.44$, $p < .03$. This constitutes a large effect size, Cohen's $d = 1.03$. In contrast, there were no significant differences between minority participants ($M = 7.97$, $SD = 2.33$) and same-sex participants ($M = 6.61$, $SD = 2.43$) in the misattribution condition, $F(1, 31) = 1.44$, ns. No other effects approached significance.

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[3] The data from a participant in the same-sex control group were dropped from all analyses because her response on the manipulation check indicated that she believed the subliminal noise affected her performance, despite the instructions to the contrary. Her score (5.75) was identified as an outlier by the Extreme Studentized Deviate Statistic, ESD (19) = 2.69, $p < .05$ (Rosner, 1995).
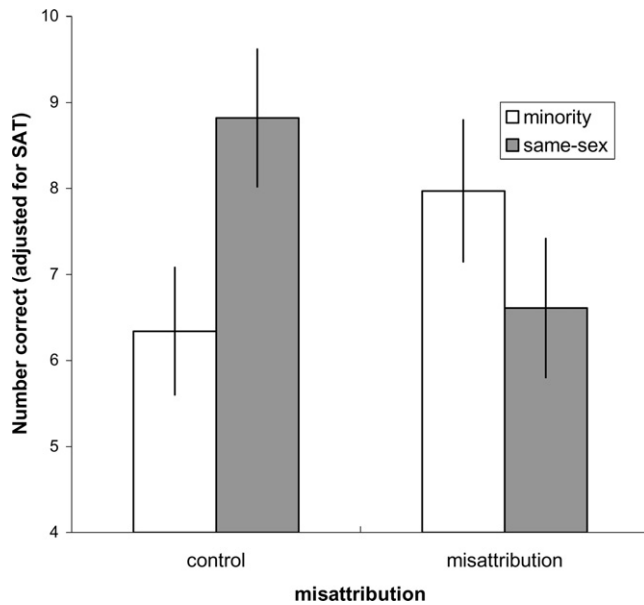
that this arousal can play an important role in performance. In Study 1, women under threat performed better on an easy task and worse on a hard task, relative to their counterparts who were not under threat—a result suggesting the role of arousal. In Study 2, performance deficits associated with stereotype threat were attenuated when women were given an opportunity to misattribute their arousal to an external source. Taken together, both of these experiments suggest that arousal may have an important role as a mediator of threatening intellectual environments.

However, a number of important questions remain to be explored. For example, through what process does arousal impair performance? When arousal is attributed to the threat, it may trigger strategies designed to suppress thoughts about the threatening stereotype, cause lowered expectations, lead to self-handicapping, reduce attentional focus, or engage any of the other mechanisms that have been proposed in the literature (e.g., Schmader & Johns, 2003; Stangor, Carr, & Kiang, 1998; Steele et al., 2002; Wheeler, Jarvis, & Petty, 2001; Wheeler & Petty, 2002). One useful direction of future research would be to establish the potential relation of arousal with each of these factors. For example, currently we are examining the role of cognitive appraisals of the stereotype threat context as threatening versus challenging, and whether these appraisals have differential effects on physiological arousal (cortisol vs. adrenaline release), and, in turn, on intellectual performance (Dienstbier, 1989; Folkman & Lazarus, 1986; Tomaka, Blascovich, Kelsey, & Leitten, 1993; Tomaka, Blascovich, Kibler, & Ernst, 1997) (for a review of our theoretical framework, see Ben-Zeev et al., in press).

Another set of questions concerns whether there are qualitative and quantitative differences among various instantiations of stereotype threat and whether the role of arousal is similar across them. For example, is the relation between threat and arousal the same when stereotype threat is triggered by the diagnosticity of a test as by the gender composition of the test takers? Indeed, the latter manipulation may cause underperformance by two separate but potentially additive mechanisms: stereotype activation and low performance expectations (Sekaquaptewa & Thompson, 2003). It is reasonable to infer that the manipulation used in Study 2 worked primarily through stereotype threat. Based on Sekaqauptewa and Thompson's work it would seem that the relatively private nature of the written test used in this study is more conducive to stereotype rather than non-stereotype expectancy effects. Furthermore, recent work by Inzlicht, Aronson, Good, and McKay (2003), using the same procedure as that used here, found evidence for stereotype activation but not lowered performance expectations. Even so, subtle differences may exist among the various threat-inducing contexts, and

Fig. 2. Number of items correct, corrected for SAT, as a function of sex-composition of group and misattribution. Error bars represent standard error.

This interaction suggests that arousal may have an important role as a mediator of stereotype threat. Women's performance deficits in the presence of men were attenuated when they were given an opportunity to misattribute their arousal to an external source. Furthermore, far from exhibiting performance deficits, women who were in the minority actually showed a trend for performance surfeits in the misattribution condition. That is, they tended to do better on the math test than did minority females not given the opportunity to misattribute their arousal. Although this difference was not significant, it does suggest, along with the social facilitation results of Study 1, a trend that future research may revisit. When a threat in the air is diverted, even temporarily, then the target may experience performance facilitation effects rather than simply avoiding underperformance.

Furthermore, the results suggest a role of arousal that may be more complex than a simple Yerkes–Dodson-based model would suggest. Although women under threat should have experienced arousal in either attribution condition, those who were directed to misattribute the arousal to a source unrelated to the threat did not show the performance deficits associated with stereotype threat. Arousal triggered by stereotype threat may not necessarily impair performance on a difficult threat-relevant test—how the individual construes the arousal may moderate this process.

General discussion

The findings of the present studies support the hypothesis that stereotype threat triggers arousal, and

the role of arousal in these may be variable. Indeed, it may be worth noting that among the women in the same-sex conditions of Study 2, those who received the misattribution instructions showed a non-significant trend toward worse performance than the women not in the misattribution condition. Although it is very speculative, especially given the non-significance of the findings, one explanation may stem from the possibility that women in the same-sex groups did experience some degree of stereotype threat due to the difficulty of the test, despite the absence of men in the room. For these participants, the misattribution instructions may have heightened rather than deflated the threat because the level of arousal itself, like the threat, was relatively slight, whereas the suggestion that the subliminal noise would interfere with their performance might have raised concerns about the difficulty of the test, possibly lowering expectations somewhat. Whatever the case in this study, future research will need to look closer at how stereotype threat is activated and what implications the type of activation may have for various proposed mediating variables.

In sum, the results of the two studies reported here suggest that threatening intellectual environments can produce performance-impairing arousal. Moreover, the results of Study 2 imply that the threatened individual's attribution of that arousal may play an important role in determining whether or not arousal will lead to underperformance. The misattribution paradigm may also offer an approach to mitigating some stereotype threat effects. Perhaps interventions that redirect the focus away from worries about the self or one's group may help lift the burden of stereotype threat. Some work by Fein (e.g., Fein, 1999) suggests that self-affirmation can buffer the self against the threatening implications of failure in high-pressure situations, and so it too may moderate the pernicious link between threatening environments and performance deficits. As the evidence builds in support of the power and pervasiveness of stereotype threat, it becomes all the more important to identify the critical mechanisms that may underlie it. The present findings point to arousal as one such mechanism and encourage research efforts to integrate arousal with additional mechanisms that impact situational underperformance as a result of stereotype threat.

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