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# The effect of gender stereotype activation on challenge and threat motivational states ☆

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## Abstract

The effect of gender stereotype activation on challenge/threat motivational states was examined. Male and female participants completed a difficult math test described as either gender-biased or gender-fair, while continuous cardiovascular data were recorded. During the math test, women in the gender-biased condition exhibited a threatened motivational state, whereas women in the gender-fair condition exhibited challenge. The cardiovascular pattern of data was reversed for men, with men exhibiting challenge when a gender bias was implied, but threat when it was not. Motivational implications of stereotype threat and psychophysiological measurement are discussed.


*Keywords:* Challenge and threat; Stereotype threat; Gender stereotypes; Cardiovascular reactivity; Motivational states

According to stereotype threat theory (Steele & Aronson, 1995), performing in a domain in which one is negatively stereotyped produces feelings of anxiety, uncertainty, and discomfort. This discomfort, stemming from the knowledge that one's behavior might confirm a negative self-relevant stereotype, often results in confirmation of the stereotype. Hence, a consequence of experiencing this discomfort, termed *stereotype threat*, is often impaired performance; the performance of those under conditions of stereotype threat suffers compared to those who perform under less threatening conditions (Aronson et al., 1999; Croizet & Claire, 1998; Steele & Aronson, 1995).

This provocative finding gave rise to a broad base of empirical work on stereotype threat that has successfully identified groups whose members are likely to experience stereotype threat, the conditions under which performance will be affected, and even strategies that seem to protect negatively stereotyped targets from underperformance (see Steele, Spencer, & Aronson, 2002, for a review). In addition to the performance-based consequences of stereotype threat, these research efforts uncovered several other cognitive and affective consequences of activating a negative self-relevant stereotype, including decreased performance expectations (Cadinu, Maass, Frigerio, Impagliazzo, & Latinotti, 2003; Stangor, Carr, & Kiang, 1998), increased anxiety (Bosson, Haymovitz, & Pinel, 2004; Osborne, 2001), and reduced working memory capacity (Schmader & Johns, 2003). The purpose of the present investigation was to extend current understanding of the psychological effects of stereotype threat by examining a potential motivational consequence. We sought to

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investigate and measure these motivational processes as they occurred on-line, during performance, using continuous physiological measurement.

Physiological measurement techniques—especially those marking psychological states—may be particularly useful in revealing the psychological consequences of stereotype threat. The use of continuous recording of physiological data allows for an on-line assessment of the stereotype threat experience as it occurs. On-line measurement eliminates dependence on retrospective self-reports and minimizes the possibility of altering the experience itself by prompting people to actively reflect on it (Blascovich & Seery, 2007). Additionally, physiological measurement eliminates the need to rely on participants' ability, desire, or willingness to accurately report on their own experience. Several studies have emerged linking stereotype threat effects to physiological outcomes, such as increases in blood pressure (Blascovich, Spencer, Quinn, & Steele, 2001) and heart rate variability (Croizet et al., 2004), the latter of which mediated the performance effect. However, while some have shown physiological consequences of stereotype activation, few have utilized physiological measurement as an index of psychological states. With this in mind, we explored the psychological consequences of stereotype threat in the context of the biopsychosocial model of challenge and threat.

## Challenge and threat motivational states

Within the biopsychosocial model, challenge and threat represent anchors of a unidimensional bipolar motivational state. Challenge/threat results from relative evaluations of situational demands and personal resources, influenced by both cognitive and affective processes, in motivated performance situations. These situations are defined as goal-relevant and task engaging, requiring instrumental cognitive or cognitive-behavioral responses. Examples include delivering a speech, taking a test, or performing with another person on a cooperative or competitive task. The biopsychosocial model stipulates that the ratio of evaluated resources to demands determines whether an individual will be challenged or threatened during performance (e.g., Blascovich & Mendes, 2000). Specifically, when resources are evaluated as equaling or exceeding situational demands, challenge motivation results. When demands are evaluated as outweighing the resources necessary to cope with the task, threat motivation results. Although this specification may connote that challenge and threat are discrete states, these evaluations are meaningful in relative terms, such that an individual can be more or less challenged or threatened than another.

The proponents of the biopsychosocial model of challenge and threat (Blascovich & Mendes, 2000; Blascovich & Tomaka, 1996) rely on a physiological theory-based (i.e., Dienstbier, 1989), empirically validated (Blascovich, Seery, Mugridge, Norris, & Weisbuch, 2004; Tomaka, Blascovich, Kelsey, & Leitten, 1993; Tomaka, Blascovich, Kibler, & Ernst, 1997) set of physiological measures (see below) to index challenge and threat motivational states. Past research has utilized the cardiovascular markers of challenge and threat to clarify the psychological processes involved in a number of classic social psychological theories, confirming hypotheses derived from work, for example, on social comparison (e.g., Mendes, Blascovich, Major, & Seery, 2001), social facilitation (Blascovich, Mendes, Hunter, & Salomon, 1999), emotional disclosure (Mendes, Reis, Seery, & Blascovich, 2003), social stigma (Blascovich, Mendes, Hunter, Lickel, & Kowai-Bell, 2001), and self-esteem (Seery, Blascovich, Weisbuch, & Vick, 2004).

Here we predicted that situations that heighten the salience of a negative self-relevant stereotype would negatively affect evaluations of both situational demands and personal resources in a performance domain. Specifically, when stereotype threat is induced, the individual's ability to perform successfully in the task domain is called into question, either by suggesting that the test is biased, diagnostic of a negatively stereotyped ability, or that groups typically perform differently on the test. Such characteristics of the test should increase demand evaluations and therefore the likelihood of threat. Additionally, the negative stereotype may lead individuals to experience heightened uncertainty about their probability of success if they believe other group members have failed at the same task. Existing research is consistent with this idea, demonstrating that stereotype-threatened individuals report decreased expectations for their own performance (e.g., Cadinu et al., 2003) and increased feelings of self-doubt (Steele & Aronson, 1995) compared to the non-threatened. This sense of self-doubt, in turn, should decrease resource evaluations. Therefore, performing under conditions of stereotype threat should lead individuals to evaluate relatively low resources and high demands, and to exhibit the physiological pattern marking a threatened motivational state.

## Physiological markers of challenge and threat

Based on Dienstbier's (1989) physiological toughness theory, Blascovich and colleagues validated a pattern of four cardiovascular responses that index challenge and threat (Blascovich & Tomaka, 1996; Tomaka et al., 1993). These include heart rate (HR); ventricular contractility (VC), an index of the contractile force of the left ventricle; cardiac output (CO), a measure of the amount of blood pumped from the heart in liters per minute; and total peripheral resistance (TPR), a measure of the net constriction or dilation of the vasculature. Challenge is marked by activation of the sympathetic-adrenal-medullary (SAM) axis, which enhances cardiac performance—particularly HR and VC—and decreases systemic vascular resistance (TPR), an effect mediated by the release of epinephrine at the peripheral arteries. As a result of these effects, CO increases during challenge. In contrast, threat is marked by activation not only of the SAM axis, again increasing cardiac performance (HR and VC), but also by activation of the hypothalamic-pituitary-adrenocortical (HPA) axis, which inhibits the release of epinephrine, resulting in relatively higher TPR and little or no change in CO during threat.

## Overview

The current study tested the hypothesis that activating a negative self-relevant stereotype increases threat motivation as indexed by the challenge and threat patterns of cardiovascular response specified in the biopsychosocial model. Using a traditional stereotype threat paradigm (see Spencer, Steele, & Quinn, 1999), male and female participants took a difficult math test under time pressure. The math test was described as either having historically produced gender differences in performance (gender-biased condition) or not (gender-fair condition).

Predictions regarding the effect of the stereotype threat manipulation on women in this study followed directly from previous research showing negative performance effects under conditions of heightened stereotype salience for women (e.g., Spencer et al., 1999). Therefore, women were expected to exhibit a relative threat pattern in the gender-biased condition, presumably as a result of evaluating insufficient resources to meet the demands of the task. However, hypotheses regarding the effect of the stereotype threat manipulation on men were more exploratory in nature. Although some evidence suggests that stereotype threat manipulations do not influence the un-targeted groups' performance (e.g., Steele & Aronson, 1995), research on "stereotype lift" suggests that members of the non-stereotyped group receive a performance boost when an outgroup is stereotyped to perform poorly, but may suffer when the stereotype is specifically made irrelevant (Walton & Cohen, 2003). This research leads to the reasonable prediction that men would be relatively challenged during performance on a gender-biased test, a bias that supposedly favors their group. In contrast, we expected women in the gender-fair condition to exhibit a relative challenge pattern of cardiovascular response, presumably as a result of evaluating sufficient resources to meet task demands, whereas men would be relatively threatened by the implication that no gender differences exist on the test (cf., Walton & Cohen, 2003).

## Method

### *Participants*

One hundred and four students (51 male, 53 female) enrolled in an introductory psychology course participated in the study.[1] They received course credit in exchange for their participation.

### *Setting and measures*

Data collection took place in a social psychophysiology laboratory at the University of California, Santa Barbara. The laboratory consists of two data recording rooms equipped with computer monitors, audio/visual equipment, a speaker intercom system, and physiological recording equipment. Adjacent to the recording rooms are separate rooms for participant preparation and equipment control.

#### *Cardiovascular measures*

Cardiovascular response measures were collected continuously and non-invasively via impedance cardiography (Minnesota Impedance Cardiograph, model 304B), electrocardiography (Coulbourn ECG amplifier/coupler, model S75-11), and continuous blood pressure (Cortronics, model 7000) recording equipment. Impedance cardiography measurements involved the attachment of four mylar tape band electrodes. Electrocardiography signals were detected using either a Standard Lead II electrode configuration (additional spot electrodes on the right arm and both legs) or through the band electrodes. A blood pressure cuff provided continuous blood pressure measurements. Impedance cardiography and electrocardiography recordings provided data for the calculation of HR, VC, and CO, necessary for identifying challenge and threat states. Mean arterial blood pressure (MAP) recordings were included for the calculation of TPR via the formula: MAP/$CO \times 80$ (Sherwood et al., 1990). An interactive MS-DOS software program (Kelsey & Guethlein, 1990) was used to record and score the physiological data.

### *Procedures*

Upon arrival at the laboratory, individual participants were randomly assigned to one of two stereotype threat conditions: gender-biased or gender-fair. After being greeted by a female experimenter, participants were escorted into a preparation room where consent was obtained and the physiological sensors were applied. Participants were then led into the recording room where they sat in an upright, comfortable chair with a computer keyboard tray placed across their lap. A computer monitor was located in front of the chair at eye level. The experimenter then explained details of the recording room (i.e., use of the intercom system, presence of video recording equipment), asked for participant cooperation in sitting quietly while awaiting further instruction, and left the room. Participants were left alone in the recording room for the remainder of the study. The first set of audio instructions, pre-recorded by a female experimenter, asked participants to remain still until receiving further instructions. At this time, baseline cardiovascular measurements were recorded for a 5-min period.

Following the rest period, participants received audio instructions explaining that they would be taking the "Quantitative Comparisons Test" as part of an investiga-

[1] A total of sixteen participants were excluded from the final analyses due to the following: four were excluded for suspicion regarding the stereotype threat manipulation, eight for equipment malfunction, three for failing to follow experimental instructions, and one could not properly complete the task due to language difficulties. These losses resulted in 88 participants with complete physiological and performance data.

tion of physiological responses to tests of math ability. The math test included twelve quantitative comparisons (QC) taken from a GRE (graduate record exam) practice book.[2] Solving quantitative comparisons required participants to examine two quantities and determine if one was greater than the other, if the two were equivalent, or if such a comparison could not be determined from the information provided. The answer choices were presented in a multiple-choice format, with four possible response options (i.e., value 1 > value 2, value 2 > value 1, value 1 = value 2, comparison undetermined). The format and nature of the test was described, and participants were informed that each of the twelve items would appear on the computer monitor for 15 s. They were instructed to verbalize their responses so that the experimenter could record them in the control room. The taped instructions then led participants through two sample items, highlighting the multiple-choice format of the response set. It was then explained that whether or not participants provided a verbal response to each QC, the computer would automatically advance to the next item after 15 s had passed. Participants were not provided with any written aid for computation; all of the problems had to be solved mentally. We designed this relatively short, time-pressured test, in keeping with the norms in challenge and threat research, with several ideas in mind: (a) cardiovascular responses typically peak in the first minutes of a task (Blascovich & Tomaka, 1996), (b) movement artifact caused by writing during the test can interfere with measuring equipment (Blascovich & Tomaka, 1996), and (c) stereotype threat is most likely to occur when the test is sufficiently difficult to frustrate participants' abilities (Steele et al., 2002).

Once the quantitative comparisons test was explained, and participants had no further questions regarding the task, the stereotype threat manipulation was presented as part of the audio-taped instructions. The threat manipulation was modeled directly from prior studies of stereotype threat and women's math performance (e.g., Spencer et al., 1999) and began by reminding participants about the controversy surrounding gender differences in math performance. In the gender-biased condition, participants were told that the QC test had shown gender differences in performance in previous studies. Participants in the gender-fair condition, after hearing about the gender differences controversy, were told that the QC test had not shown gender differences in previous studies and that women and men had performed equally well on the test. Following this manipulation, participants began the QC test. At the completion of the test, participants were thoroughly debriefed and thanked for their participation.

## Results

### Analytic strategy

Cardiovascular reactivity values were calculated by subtracting the average value of the last baseline minute from the mean of the first two task minutes. In order to determine whether challenge and threat states were experienced during the performance task, we first assessed heart rate (HR) and ventricular contractility (VC) reactivity differences from 0 during the task minutes. We then performed analyses of variance (ANOVAs) to insure that increases in HR and VC occurred across conditions. Recall that HR and VC should increase during both challenge and threat. Multivariate analyses of covariance (MANCOVAs) were then conducted on both TPR and CO, followed by univariate analyses of the physiological reactivity variables. These analyses controlled for the effects of prior math ability (quantitative SAT score) and task engagement differences (HR and VC during the task minutes). Standardized indicators of prior math performance were included as they would likely influence individual resource and demand evaluations during the math test insofar as they correlate with participants' perceptions of their math ability. As we were most interested in the situational effects of stereotype activation on these perceptions, we deemed it prudent to control for prior performance thereby increasing power to detect these effects. Covarying HR and VC reactivity increases the power to detect differences in HPA activation given that changes in HR and VC are driven by SAM activation, a physiological response common to both challenge and threat states (as measured by HR and VC; see also Seery et al., 2004; Weisbuch-Remington, Mendes, Seery, & Blascovich, 2005).

### Physiological measures of challenge and threat

Two-tailed $t$ tests revealed significant differences from 0 in the average HR value, $t(87) = 12.45$, $p < .001$, and the average VC value, $t(87) = 9.26$, $p < .001$, across the first two task minutes.[3] As expected, analyses of variance revealed no differences in HR or VC reactivity by gender or condition, $F\text{s} < 1$.

We conducted a MANCOVA and follow-up ANCOVAs to test the hypothesis that gender and stereotype threat conditions would interact to affect TPR and CO in patterns indicative of challenge and threat. Recall that we

[2] The practice book included items that had been used in actual examinations in the past which provided normed performance data for selection criteria. Items were selected from a number of practice exams and matched for relative difficulty based on the percentage of prior examinees answering each item correctly. In order to create a sufficiently challenging test, QC items were included only if their prior solve rate did not exceed 70% correct.

[3] Three participants were excluded from the challenge and threat analyses because they did not demonstrate increases in HR and VC from baseline during the first two task minutes, as in previous research (Seery et al., 2004). These participants were included in all other analyses involving HR and VC.

predicted that women in the gender-fair condition would experience a relative challenge state, indicated by relatively lower TPR and higher CO from baseline, whereas men in this condition could experience a relative threat state, indicated by relatively higher TPR and lower CO. We expected the gender-biased condition to elicit the opposite response in men and women, such that women would be relatively threatened and men relatively challenged.

The MANCOVA revealed a marginal interactive effect of gender and threat condition on TPR and CO reactivity, multivariate $F(8,76) = 2.22$, $p = .07$. Subsequent ANCOVAs conducted on the individual dependent variables yielded the predicted interactions: CO $F(8,76) = 4.43$, $p < .05$; TPR $F(8,76) = 3.47$, $p < .05$. As can be seen in Figs. 1 and 2, the observed cell means corresponded to the predicted pattern, such that when gender differences were made explicitly irrelevant to the testing situation, women exhibited challenge relative to men. Specifically, women in this condition had higher CO and lower TPR than men, CO $F(1,76) = 6.126$, $p < .05$; TPR $F(1,76) = 4.35$, $p < .05$. When the test was described as gender-biased, women were threatened relative to men. Specifically, women in this condition tended to demonstrate lower CO and higher TPR than men, CO $F(1,76) = 2.99$, $p = .07$; TPR $F(1,76) = 1.72$, $p < .18$. No significant main effects for gender or condition emerged in multivariate or univariate analyses, $p$s > .13.[4]

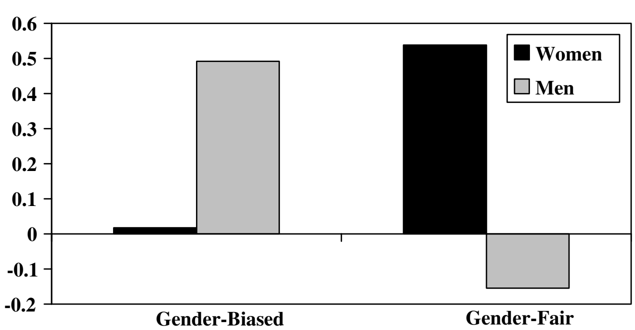


Fig. 1. Adjusted cardiac output means by stereotype threat condition during math performance.

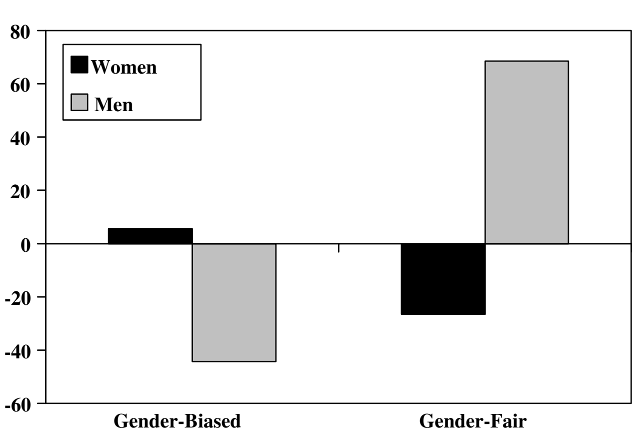


Fig. 2. Adjusted total peripheral resistance means by stereotype threat condition during math performance.

## Discussion

The current investigation focused on the impact of activating a performance-based gender stereotype on challenge and threat. We expected women under stereotype-threatening conditions to exhibit the threat pattern of cardiovascular reactivity, theoretically as a result of evaluating insufficient personal resources to meet the situational demands of a difficult math test. In light of research showing that members of non-stereotyped groups tend to experience a performance boost when a negative stereotype of an outgroup is salient (Walton & Cohen, 2003), we believed that men could also be affected by the stereotype threat manipulation. Specifically, we proposed that taking a test in a positively stereotyped domain could enhance resource and diminish demand evaluations, resulting in a challenge state among male participants. Our data supported these predictions, showing that women were relatively threatened during performance when the task was characterized as gender-biased, whereas men were relatively challenged when they believed gender differences in performance were expected. Alternatively, we expected women for whom stereotype threat was minimized to exhibit the challenge pattern, theoretically as a result of perceiving sufficient resources to meet test demands. For men, however, taking a test that is described as gender-fair essentially removes the stereotypic assumption that men should outperform women, or that men have an advantage in this domain. This characterization of the test, we believed, could result in a threat state. Our results supported these predictions as well, demonstrating that women were relatively challenged during performance when the task was characterized as gender-fair, whereas men were relatively threatened when they believed they were taking a non-biased test.

Somewhat surprisingly, the men in this study were more physiologically reactive than the women, demonstrating relatively stronger challenge and threat states under similar conditions. Although unexpected, the heightened reactivity among male participants may be an artifact of conducting the study with female experimenters. Previous research has

[4] Performance data were collected, but not included here as we did not anticipate replicating performance differences as a result of stereotype threat conditions in this study. Previous stereotype threat research demonstrating gender differences in math ability tested upper-level math students and provided them ample time and tools (e.g., use of written calculations) to complete the test items. While quite normal for use in our laboratory, our testing procedures were rather distinct from those used in prior studies. Specifically, the testing conditions (e.g., 15 s time limits, mental arithmetic) were deemed necessary to ensure task engagement and so as not to interfere with physiological measurement. These procedures resulted in a math test that was too difficult to allow tests of between-group differences among our introductory psychology student sample.

shown that sensitivity to stereotype threat effects can vary with the presence of outgroup members (Inzlicht & Ben-Zeev, 2000; Sekaquaptewa & Thompson, 2003), which may have resulted in higher stakes for the male participants in this study (i.e., feeling the need to justify the positive stereotype of superior math ability to the outgroup). However, prior studies of outgroup presence and stereotype threat have demonstrated only that presence of an outgroup member affects those who are negatively stereotyped. As men were not the negatively stereotyped group in this case, it is unclear if the presence of a negatively stereotyped outgroup member would affect them in a similar negative manner.

Our findings represent one of the first investigations into the psychological effects of stereotype threat *during* performance. While many studies have addressed a variety of cognitive and affective effects of stereotype threat manipulations (e.g., Bosson et al., 2004; Schmader & Johns, 2003; Stangor et al., 1998), investigation of the motivational consequences of stereotype threat has been surprisingly overlooked in these efforts (see Keller & Dauenheimer, 2003, for an exception). Applying the biopsychosocial model of challenge and threat, our data demonstrate the impact of stereotype threat manipulations on motivational states of both targets and non-targets, specifically as evaluations of personal resources and task demands are affected in the performance situation.

However, our data leave open the question of how changes in motivational states affect subsequent performance in stereotype-threatening situations. For example, it is reasonable to predict that those who evaluate their resources as failing to meet task demands during performance (i.e., experiencing a threatened motivational state) would be more vulnerable to underperformance than those who experience challenge. Testing this mediational model is a promising direction for future research, particularly given the relative difficulty of assessing the psychological effects of stereotype threat through traditional self-report procedures.

The relatively recent history of stereotype threat research has revealed a number of cognitive, affective, and behavioral consequences of performing under conditions of stereotype threat, including reductions in working memory (Schmader & Johns, 2003), declining performance expectations (e.g., Cadinu et al., 2003), increases in self-doubt (Steele & Aronson, 1995), and decreased performance in the stereotyped domain (Steele et al., 2002). The present research contributes to current understanding of the psychological experience of stereotype threat by exploring a motivational consequence, demonstrating the effect of stereotype threat on challenge and threat during performance. As research continues to reveal the underlying psychological processes of stereotype threat, psychophysiological measurement should prove informative in capturing this experience and further explicating the mechanisms involved.

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