# Research article

# Reducing stereotype threat in order to facilitate learning

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## Abstract

*Recent stereotype threat research has demonstrated that negative stereotypes about women's math ability can impair their mathematical learning. This experiment extends this research by examining whether presenting "gender fair" information can reduce learning decrements (on a focal and transfer task) and if the timing of this information matters. Women (N = 140) and men (N = 60) were randomly assigned to one of four conditions: control, stereotype threat only, stereotype threat removed before learning, and stereotype threat removed after learning. Compared with women in the control condition and women who had stereotype threat removed before learning, learning and transfer were poorer for women in the stereotype threat only condition and women who had stereotype threat removed after learning but before learning assessment. Men's learning and transfer were unaffected by condition. These findings suggest that a manipulation that can reduce performance deficits can also reduce learning decrements if it is presented before learning occurs. Copyright © 2011 John Wiley & Sons, Ltd.*

Since the seminal work of Steele and Aronson (1995), social psychologists' knowledge about when and how stereotype threat affects members of negatively stereotyped groups has accumulated rapidly (see Schmader, Johns, & Forbes, 2008; Steele, Spencer, & Aronson, 2002). This research has demonstrated that situations where people's behavior can confirm negative stereotypes about their ingroup's abilities lead to the experience of stereotype threat (Steele, 1997). For example, when women completing math tasks become concerned about confirming the negative stereotype that "women are bad at math," they perform more poorly on math tasks (e.g., Spencer, Steele, & Quinn, 1999); these women have increased arousal (e.g., Ben-Zeev, Fein, & Inzlicht, 2005), decreased executive functioning (e.g., Beilock, Rydell, & McConnell, 2007; Schmader & Johns, 2003), and an increased number of negative thoughts (Cadinu, Maass, Rosabianca, & Kiesner, 2005). Given this research, it is now clear that when negatively stereotyped individuals attempt to execute a previously learned skill, stereotype threat can harm their performance through several different psychological mechanisms (see Schmader & Beilock, in press).

Recent work has shown that stereotype threat can also reduce people's ability to learn new information (Mangels, Good, Whiteman, Mansicalco & Dweck, in press; Rydell, Rydell & Boucher, 2010; Rydell, Shiffrin, Boucher, Van Loo & Rydell, 2010; Taylor & Walton, 2011). For instance, Rydell et al. (2010) demonstrated that women experiencing stereotype threat have difficulty attending to and storing into memory the mathematical rules and operations being learned. Presumably because stereotype threat reduced women's

working memory capacity and/or increased their level of arousal, women had difficulty encoding mathematical information (e.g., Eysenck, 1976; Unsworth & Engle, 2005), thwarting successful learning. When unlearned information was necessary for skill execution, performance suffered. Rydell et al. (2010) also showed that stereotype threat can even reduce women's performance on math problems that are not usually affected by stereotype threat (i.e., easy problems; Beilock et al., 2007) and that stereotype threat can interfere with learning more abstract mathematical concepts and generalizing this knowledge to a novel task involving similar principles.

Considering that stereotype threat has been shown to have detrimental consequences for women's performance and learning in mathematics, it is important to better understand how to reduce its influence. Research has identified several means through which *performance* deficits caused by stereotype threat can be reduced. For instance, stereotype threat's detrimental impact on women's math performance can be reduced by labeling the test as "gender fair" (i.e., explicitly stating that men and women perform equally on the test; Spencer et al., 1999). Several of these manipulations have been tested in the lab and successfully utilized in real-world interventions to reduce stereotype threat's impact on the performance of grade school and college students (see Yeager & Walton, 2011).

In light of the new evidence that stereotype threat impacts learning and considering that many domains impacted by stereotype threat involve both learning and performance, it is a crucial next step to determine whether these same manipulations can also reduce stereotype threat-based learning decrements.

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Further, examining how stereotype threat-based learning decrements can be reduced may explain why past stereotype threat interventions have been so successful and why others may fail to completely eliminate stereotype threat-based decrements. More specifically, many previous interventions introduce the intervention before any learning and performance of new information has occurred (i.e., early in the school year; Cohen, Garcia, Apfel, & Master, 2006; Cohen, Garcia, Purdie-Vaughns, Apfel and Brzustoski, 2009). Therefore, the timing of the intervention may be critical to its success as interventions may be less impactful when they exclusively focus on removing stereotype threat from the performance situation and not the situation in which learning occurred.

In the present research, we therefore examined whether a manipulation that has been previously shown to reduce stereotype threat's impact on performance (i.e., "gender fair" information) could also reduce the negative impact of stereotype threat on women's ability to learn mathematical rules and operations. To examine this, we gave half of the participants "gender fair" information. By telling women that they are completing a math task that does not show gender differences, past work has shown that stereotype threat and its impact on performance can be alleviated (e.g., Spencer et al., 1999). This "gender fair" information is effective because women's performance on the math test is no longer perceived as a valid way to confirm or disconfirm the negative stereotype about women's math ability. The belief that the test cannot confirm negative stereotypes alleviates women's worries about verifying the negative stereotypes with their personal performance, thereby preventing performance decrements (Steele, 1997). Thus, we predicted that "gender fair" information given about the mathematical learning tasks can similarly reduce the detrimental effect of stereotype threat on women's ability to learn mathematical rules and operations.

We additionally explored when the best time to intervene with this manipulation would be in order to eliminate stereotype threat's detrimental effects on learning for women. Specifically, although the manipulation of "gender fair" information has been shown to be successful in eliminating stereotype threat-based performance decrements on tests of previously learned math skills (e.g., Spencer et al., 1999), this manipulation may only be effective at eliminating stereotype threat on learning of novel tasks prior to learning the elements required for task completion. This work can therefore potentially provide boundary conditions for when one known stereotype threat-reducing manipulation will be successful at attenuating learning effects. To examine this hypothesis, we manipulated when the "gender fair" information was presented in relation to the mathematical learning session. In addition to a control condition (i.e., no stereotype threat information), we had three stereotype threat conditions: a stereotype threat only condition (i.e., no "gender fair" information was presented), a stereotype threat condition in which threat was eliminated by the "gender fair" intervention before learning occurred, and a stereotype threat condition in which threat was eliminated by the intervention after learning occurred but before learning was assessed.

We expected that eliminating stereotype threat before the learning session would improve women's learning (i.e., learning in this condition should be comparable with control women) because the encoding of information from the stereotyped domain would no longer be hindered by threat. However, when stereotype threat is present during the learning session and an intervention is not presented until after learning has occurred, there should still be evidence of stereotype threat-based learning deficits (i.e., comparable learning to women in the stereotype threat only condition). Even though stereotype threat may no longer be felt or experienced by women in this condition after finding out that the upcoming learning assessments are "gender fair," stereotype threat should still reduce learning because the rules and concepts presented during learning should be poorly encoded.

For learning and assessment, we utilized the abstract math learning paradigm from Kaminski, Sloutsky, and Heckler (2008). This paradigm has a focal task, where participants explicitly learn the rules of a mathematical concept, and a transfer task, where participants are not given task-specific learning but must apply the mathematical concept learned in the focal task to the transfer task. Therefore, this paradigm allows us to assess stereotype threat's impact on learning in two distinct ways: participants' ability to learn the mathematical concept taught in the focal task and participants' ability to "transfer" this knowledge from the focal task to the transfer task. Furthermore, Kaminski et al. (2008) showed that abstract learning paradigms produce small transfer deficits (i.e., inability to apply learned information to a similar task) compared with other learning paradigms. Thus, if women under threat show a substantial transfer deficit, we can be more certain that the drop was due to stereotype threat and not specific aspects of the learning tasks.

We expected that women would show poor learning and transfer of what is learned in the stereotype threat only and the stereotype threat removed after learning conditions. Considering that success on the transfer task depends greatly upon successful learning on the focal task, the poorest transfer was predicted for women in these two conditions because their learning of the rules from the focal task was expected to be relatively weak. Learning and transfer should be strong and equivalent for women in the control and the stereotype threat removed before learning conditions, as the successful transfer of information should necessitate successful learning on the focal task. Thus, compared with women not experiencing threat during learning, we expected poorer learning for women who were experiencing threat during learning on the focal task, and this poor learning should lead to comparable deficits or quite possibly exacerbated deficits on the transfer task (see Rydell et al., 2010). Men were also included in this experiment because having non-stereotyped participants allows us to examine whether or not the impact of stereotype threat on learning is specific to members of the stereotyped group. We expected that men would not experience stereotype threat and did not expect the experimental manipulations to affect their ability to learn or transfer this learning.

## METHOD

### Participants and Design

Undergraduates ($N = 204$) (142 women, 62 men) participated for course credit. They were randomly assigned to one of four conditions: control, stereotype threat only, stereotype threat

removed by "gender fair" information before learning, or stereotype threat removed by "gender fair" information after learning (see Table 1). Following Kaminski et al. (2008), we removed the data from four participants who scored at or below chance (37.5%) on the focal learning task. Thus, the final sample consisted of 200 participants (140 women, 60 men).

## Procedure

### Stereotype Threat Manipulation

At the beginning of the experiment and as an introduction to the focal task, the stereotype threat manipulation was presented. In the control condition, participants were told that the study explores problem-solving skills, but no reference to gender was made. In the three conditions that included stereotype threat information, participants were told that the research was investigating why women are generally worse at math than men. The stereotype threat information of Beilock et al. (2007) was modified in order to ensure that the tasks were perceived as connected to the stereotyped domain: participants were told that they would complete "problem-solving tasks that involve using mathematical principles."

### Manipulation of "Gender Fair" Information

In the two conditions that included "gender fair" information, participants were informed that "Today, you have been randomly assigned to learn and work on math tasks that do NOT show gender differences. This means that men and women perform equally well on the math tasks you are completing today." (see Spencer et al., 1999). For participants in the stereotype threat removed before learning condition, this information was presented on the computer screen following the stereotype threat manipulation. For participants in the stereotype threat removed after learning condition, this information was presented after the learning session, but preceding the assessment of learning, for the focal task.

### Mathematical Learning Session

The learning session entailed learning the rules for the focal task. The focal task was described as a task of deciphering hieroglyphics from a language that used three symbols (see Kaminski et al., 2008). The ability to correctly utilize this "language" depended on participants understanding the concept of the commutative mathematical group of order 3 using the addition operation; this concept is defined by several principles which were communicated via the rules for the focal task. More specifically, participants were told: (i) the language involved only three symbols (closure law); (ii) the ordering of the symbols did not matter (commutative and associative laws); (iii) a diamond paired with a flag equaled a diamond, and a circle paired with a flag equaled a circle (identity law, with the flag as the identity); (iv) a circle and a diamond equaled a flag (inverse law); (v) two circles equaled a diamond; and (vi) two diamonds equaled a circle.

### Focal Task Learning Assessment

After reading the rules, participants completed a set of 24 questions to assess how well they learned to decipher the hieroglyphics (see Kaminski et al., 2008).

### Applying Learning to the Transfer Task

Next, participants completed the transfer task which used exactly the same underlying mathematical principles as the focal task but included different objects to represent the three symbols and had a new cover story. In this task, participants were asked to predict the outcomes of a "pointing game." In this fictional game, one child pointed to certain objects, and, given the objects that the child had already pointed to, the other children guessed the final object that would be pointed to, using certain rules to make their predictions. The participants' task was to predict the final object that would be pointed to after seeing the objects that had already been chosen. The three objects were directly equivalent to those from the focal task: a broach (diamond), a bottle (circle), or a ring (flag).

Participants learned that the rules of this pointing game were similar to the rules involved in the first task: (i) a bottle paired with a ring equaled a bottle; (ii) a bottle and a broach equaled a ring; (iii) two bottles equaled a broach; and (iv) two broaches equaled a bottle. Because these instructions were extremely impoverished, participants were dependent upon past learning. Specifically, participants only read the cover story about the "pointing game," saw the four rules presented above, and were told that "The rules of the last system you learned are like the rules of this game." Participants completed 24 questions (mathematically equivalent to those used for the focal task) that assessed their ability to apply the rules learned in the focal task to this new task (see Kaminski et al., 2008).

## RESULTS

### Focal Task Learning

A 2 (gender) × 4 (experimental condition: control, stereotype threat only, stereotype threat removed before learning,

Table 1.    Order of the manipulations and measures in each of the experimental conditions

|  | Step 1 | Step 2 | Step 3 | Step 4 (if needed) |
|---|---|---|---|---|
| Control condition | Control message | Learning session | Learning assessment | |
| Stereotype threat only condition | Stereotype threat message | Learning session | Learning assessment | |
| Stereotype threat removed before learning condition | Stereotype threat message | Gender fair information | Learning session | Learning assessment |
| Stereotype threat removed after learning condition | Stereotype threat message | Learning session | Gender fair information | Learning assessment |

stereotype threat removed after learning) analysis of variance (ANOVA) was conducted on the measure of focal task learning. A main effect of gender was obtained, $F(1, 192) = 9.95$, $p = .002$, $\eta_p^2 = .049$; however, it was qualified by the predicted two-way interaction, $F(3, 192) = 2.78$, $p = .042$, $\eta_p^2 = .042$ (see Table 2). The simple effect of condition was not significant for men, $F < 1$, but it was significant for women, $F(3, 192) = 7.82$, $p < .001$, $\eta_p^2 = .109$. Women in the control and the stereotype threat removed before learning conditions exhibited greater learning on the focal task than women in the stereotype threat only and the stereotype threat removed after learning conditions. Focal task learning did not differ between women in the control and the stereotype threat removed before learning conditions and between women in the stereotype threat only and the stereotype threat removed after learning conditions.

*Transfer of Learning*

A 2 (gender) × 4 (experimental condition) ANOVA was conducted on the measure of transfer success. A main effect of gender was obtained, $F(1, 192) = 7.01$, $p = .009$, $\eta_p^2 = .035$; however, it was qualified by the predicted two-way interaction, $F(3, 192) = 3.50$, $p = .017$, $\eta_p^2 = .052$ (see Table 2). The simple effect of experimental condition was not significant for men, $F < 1$, but it was significant for women, $F(3, 192) = 5.25$, $p = .002$, $\eta_p^2 = .076$. Showing the same pattern of results as those for the focal task, women in the control and the stereotype threat removed before learning conditions exhibited greater transfer on the transfer task than women in the stereotype threat only and the stereotype threat removed after learning conditions. Transfer did not differ between women in the control and the stereotype threat removed before learning conditions and between women in the stereotype threat only and the stereotype threat removed after learning conditions.

To examine if women who learned under threat experienced greater difficulties applying information learned on the focal task to the transfer task, we conducted a 2 (gender) × 4 (experimental condition) × 2 (task type) repeated-measures ANOVA. The three-way interaction was not significant, $F(3, 192) = 1.29$, $p = .28$, $\eta_p^2 = .020$. To more closely examine the impact of gender and threat during learning on transfer deficits, we combined the stereotype threat only and stereotype threat removed after learning conditions (stereotype threat when learning) and the control and stereotype threat removed before learning conditions

(no stereotype threat when learning) and conducted a 2 (gender) × 2 (stereotype threat when learning, no stereotype threat when learning) × 2 (task type) repeated-measures ANOVA. The three-way interaction for this analysis was marginally significant, $F(1, 196) = 3.59$, $p = .06$, $\eta_p^2 = .018$ (see Figure 1).

As expected, a significant transfer deficit was found for women in the stereotype threat when learning conditions, $F(1, 76) = 23.67$, $p < .001$, $\eta_p^2 = .237$. There was no transfer deficit for men in these conditions, $F < 1$. In the no stereotype threat when learning conditions, women and men showed significant transfer deficits [women: $F(1, 62) = 8.59$, $p = .005$, $\eta_p^2 = .122$; men: $F(1, 35) = 9.34$, $p = .004$, $\eta_p^2 = .211$]. Although we did not expect this pattern of results considering our earlier work with these tasks, it is not uncommon for there to be some drop in proportion of correct responses from the focal task to the transfer task (see Kaminski et al., 2008), even though such drops tend to be relatively small. Why the transfer deficits were greater in these conditions than in our past work, we cannot be certain.

*Mediational Analyses*

Given the significant transfer deficit for men in the no stereotype threat when learning conditions and the lack of transfer deficits for men in the stereotype threat when learning conditions, it is possible that our findings for transfer deficits are driven by the men in our sample. We therefore sought to provide more convincing evidence that the stereotype threat manipulation is particularly impairing women's focal task learning and, thereby, their transfer of learned information. More specifically, we examined whether focal task learning significantly mediates the relation between the stereotype threat manipulation and transfer for women and not men.

Using Preacher and Hayes's (2008) bias-corrected bootstrapping procedure (with 1000 resamples), a mediational analysis was conducted for women to determine if learning on the focal task accounts for the impact of the stereotype threat manipulation on the transfer task. For this analysis, stereotype threat was re-coded to $-1$ for control and stereotype threat removed before learning and $+1$ for stereotype threat only and stereotype threat removed after learning. As displayed in Figure 2, the manipulation of stereotype threat showed a reduced ability to predict transfer when focal task learning was included

Table 2. Learning on the focal task and ability to transfer on the transfer task as a function of gender and the timing of "gender fair" information

|  | Control condition | ST only | ST + gender fair before learning | ST + gender fair after learning |
|---|---|---|---|---|
| Focal task learning |  |  |  |  |
| Men | .69a | .68a | .67a | .67a |
| Women | .64a | .55b | .69a | .57b |
| Ability to transfer |  |  |  |  |
| Men | .59a | .68a | .60a | .63a |
| Women | .60a | .49b | .62a | .48b |

*Note*: Means (proportions of correct responses) in a row with different subscripts were significantly different at the $p < .05$ level. ST, stereotype threat.
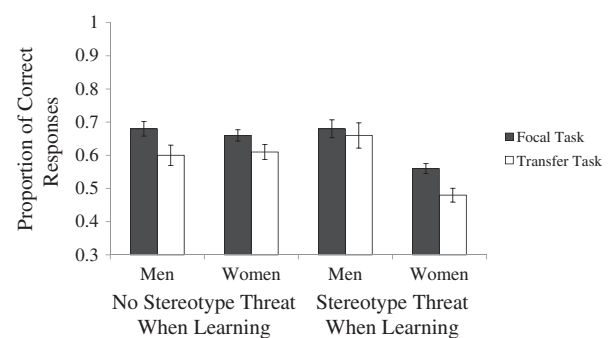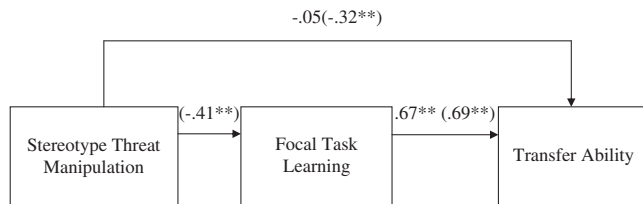


Figure 1. Focal task learning and ability to transfer onto the transfer task as a function of gender and stereotype threat during learning. The error bars represent the standard error of the mean

-.05(-.32**)

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┌──────────────┐   (-.41**)   ┌──────────────┐   .67** (.69**)   ┌──────────────┐
│  Stereotype  │─────────────▶│  Focal Task  │──────────────────▶│   Transfer   │
│    Threat    │              │   Learning   │                   │   Ability    │
│ Manipulation │              │              │                   │              │
└──────────────┘              └──────────────┘                   └──────────────┘
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**Note**. \*\*=*p*<.01, \*=*p*<.05. Standardized beta weights for the direct relations between variables are presented in parentheses. Standardized beta weights for the indirect relations between variables are presented outside of the parentheses.

Figure 2. The mediation of the relation between the stereotype threat manipulation and transfer ability (i.e., score on the transfer task) by focal task learning for women only

in the model. The bias-corrected 95% confidence interval for the indirect effect of focal task learning on the relation between the stereotype threat manipulation and transfer did not include zero ($-.077$ to $-.031$), indicating that focal task learning mediates the relation between the stereotype threat manipulation and transfer of learned information. Because there was no relation between the stereotype threat manipulation and focal task learning, $t(58) = .041$, $p = .97$, and the relation between the stereotype threat manipulation and transfer was not significant, $t(58) = 1.32$, $p = .19$, men's transfer of learned information was not mediated by focal task learning. A conclusion confirmed by a bias-corrected 95% confidence interval that included zero ($-.028$ to $.036$). Thus, for women and not men, focal task learning fully accounts for the effect of stereotype threat during learning on ability to transfer, and there is no direct effect of stereotype threat during learning on ability to transfer.

## DISCUSSION

This experiment showed that women who were experiencing stereotype threat during learning did not adequately learn the rules of the focal task or transfer those rules to a second, mathematically equivalent task. Women experiencing threat during learning, either because they did not receive "gender fair" information or they received "gender fair" information after the learning session, showed poorer learning on the focal task than women in a control condition or women who had stereotype threat removed before learning. Furthermore, a similar data pattern emerged for the transfer task: being under stereotype threat while learning the rules of the focal task particularly hurt women on this later task involving the same mathematical concepts. To the extent that mathematical learning is cumulative, this reduced learning and ability to generalize across similar tasks for women under stereotype threat when learning could be especially problematic. It could reduce performance on future tasks that utilize the same underlying concepts and inhibit more advanced forms of mathematical learning that are reliant on this earlier learning, even if the advanced material is learned in non-threatening environments. Men's learning was not affected by stereotype threat or the placement of the intervention, indicating that learning deficits due to threat were specific to the stereotyped group.

The results from this experiment also suggest that there is an optimal time to present interventions meant to eradicate

the effect of stereotype threat on learning. To effectively reduce the negative impact of stereotype threat on learning (and performance based on this learning), this experiment is one of the first to suggest that it is best to reduce stereotype threat before learning begins. If information that is necessary for skill execution is not properly encoded into memory because of stereotype threat, manipulations that later reduce threat, even though they may make women feel better during assessment, will not be able to aid recall or improve performance based on this poorly encoded information.

By empirically demonstrating how timing is critical when intervening in the hopes of decreasing stereotype threat's effect on learning, this work provides suggestive evidence as to how real-world interventions that eliminate stereotype threat may operate (e.g., Cohen et al., 2006, 2009). For example, Cohen et al. (2009) showed that a self-affirmation manipulation, presented at the start of the school year, drastically reduced the achievement gap between minority and non-minority middle-school students over a 2-year period. When considering our findings that intervening is most beneficial if carried out before learning occurs, our work suggests that the timing of the intervention of Cohen et al. (2009) was likely critical in determining its success. Presenting the self-affirmation manipulation early on, before students had a chance to learn in that environment, should have improved students' ability to learn the material being taught. It is possible that this initial success in learning allowed students to get an initial foothold in the classroom, leading to increased knowledge and subsequent successes.

The work to date on stereotype threat and learning does leave several questions unanswered. Two of these are especially noteworthy in the context of the present research. First, it is unclear if encoding of new information could be impaired because one's working memory is reduced or one has psychologically disengaged from the stereotyped domain (e.g., Major, Spencer, Schmader, Wolfe, & Crocker, 1998). Second, it could be that different types of manipulations that eliminate the impact of threat on learning may be more long-lasting than others. For example, the "gender fair" manipulation used in this research may not translate to other mathematical learning tasks where the task's "gender fairness" is not explicitly stated. However, other manipulations, for example self-affirmation (e.g., Cohen et al., 2009), that have to do more with general personal beliefs could be more effective as long-term interventions because they are not tied to specific tasks within the stereotyped domain. Research examining which interventions are most likely to reduce stereotype threat during learning is needed to determine how to best reduce threat's detrimental impact on learning.

## CONCLUSION

This work shows that women under stereotype threat during learning show deficits on an initially learned task and that those learning deficits can extend beyond the initial task to related tasks involving the same concepts. These results also suggest that the best time to provide an intervention meant to curb stereotype threat-based learning effects is before learning

has occurred. Real-world programs attempting to eliminate the impact of threat on learning and subsequent performance might benefit from relatively easy interventions such as presenting "gender fair" information, but these programs should be especially beneficial if they are administered before teaching stereotyped individuals new skills. Learning environments that have been "cleared" of negative stereotypes about women and math should facilitate mathematical learning for women and will hopefully play some small role in increasing their entry into majors and careers that require advanced math.

## ACKNOWLEDGEMENTS

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