See Your Way to Success:
Imagery Perspective Influences Performance under Stereotype Threat

DISSERTATION

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By

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Abstract

Women in science, technology, engineering, and math (STEM) fields may experience negative outcomes due to the threat of the stereotype that women are not as good at math as men. When encountering this threat, what might allow women to protect themselves against it?

This dissertation investigates how manipulating the visual perspective (own 1st-person vs. observer's 3rd-person) used to visualize a past success could inoculate women against stereotype threat. First, I outline how stereotype threat occurs, detailing how information about the ingroup (i.e., women), the ability (i.e., math skills), and the self combines in order to create a fear of confirming the negative stereotype against one's group. Then, I outline a model of visual imagery perspective, arguing that third-person (vs. first-person) imagery can facilitate processing where people integrate the imagined event with their broader sense of self. Therefore, I argue that visualizing a past math success from the third-person (vs. first-person) perspective can protect women against stereotype threat by connecting the success with their broad sense of self, thereby allowing them to perform as well as if they had encountered no stereotype threat.

Next, I describe the method and results of two experiments that show support for the idea that third-person (vs. first-person) imagery can protect women against stereotype threat in the context of STEM skills. The first experiment takes place in a naturally-occurring math classroom, while the second experiment controls for more environmental factors by taking place in a psychology laboratory. Both experiments manipulate the visual imagery perspective (first- vs. third-person) used to imagine a past math success before encountering a math test, which is manipulated to be framed as provoking stereotype threat or not, which is then measured for performance. The results of both experiments are discussed in detail, along with recommendations for future research to clarify the results of these two studies.

Finally, I integrate the results of the present research with existing theories and findings in stereotype threat and imagery perspective, then describe potential applications for these findings in order to help improve the performance and experience of women in STEM.

Dedication

To my parents, who have always supported and encouraged me in all that I do.

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Chapter 1: Introduction

> “Every group that I've studied with for a class has been all guys. I feel pressure, and I ask myself, 'If I don't understand this, are they judging me because I'm a girl? I feel like I put in extra work outside the classroom just so when we do get together and study, I don't mess up and I don't fail because if I do fail, I don't want them to look at me and think that I failed because I am a girl. If I don't do well, I fear the reaction of 'OK, well she's a woman and didn't do well, so she shouldn't be in (engineering) anyway.'”
>
> - Dana Willsey, Missouri University engineering student
>
> (O’Leary, The Columbia Missourian, 2012)

Although Dana -- and many others like her -- may have experienced success in engineering throughout her life, she also clearly has had some negative experiences throughout her time as an engineer. In fact, women like her may be at a disadvantage because of the negative stereotype that exists about their gender’s ability in science and math (Spencer, Steele, & Quinn, 1999). The knowledge that this negative stereotype about their group exists in society may make these women feel extra pressure to perform, thereby decreasing their actual ability to perform in the moment – a phenomenon called stereotype threat (Steele & Aronson, 1995). How can we protect women in science and math fields from experiencing such pressure and impaired performance? The present research explores this question by having women visualize a past math success from different visual imagery perspectives in order to protect women against these negative outcomes.

Women in science, technology, engineering, and math (STEM)

Despite the fact that more women attain post-secondary degrees than men, women are underrepresented in science, technology, engineering, and math (STEM) fields (US Department of Education, 2012). Although the workforce in the United States is roughly equally made up of women (48%) and men (52%), STEM jobs in the United States are disproportionately held by men (76%) as opposed to women (24%) (Beede, Julian, Langdon, McKittrick, Khan, & Doms, US Department of Commerce, 2011).

Some have suggested that this discrepancy is due to differences in innate skill in science and math between genders (Ripley, 2005), pointing to the fact that gender differences emerge on the math sections of standardized tests such as the SAT and ACT whereby women perform worse than men (Halpern, Benbow, Geary, Gur, Hyde, & Gemsbacher, 2007; AAUW, 2008; AAUW, 2010).

However, the story seems to be more complicated than that. In high school, women and men are equally likely to have done well in prerequisite math and science courses (Brainard & Carlin, 1998; US Department of Education, National Center for Education Statistics, 2000; Vogt, Hocevar, & Hagedom, 2007). However, even among these equally high math achievers, women are less likely than men to pursue math, computer science, engineering, or physical sciences in college (Lubinski & Benbow, 2006). Specifically, only 15% of freshmen women entering college plan to major in a

STEM field compared to 29% of freshmen males (NSF, 2009). Biological explanations for this difference, such as sex differences in brain structure and hormones, have not been able to present conclusive evidence for women's underrepresentation in STEM fields, at least above and beyond other social factors (Ceci, Williams, & Barnett, 2009).

Stereotype threat

One social factor that may help explain this discrepancy between genders in STEM fields is stereotype threat. When someone is under stereotype threat, she feels at risk of confirming a negative stereotype about her group; this risk creates a "threat in the air" which then undermines the group member's ability to perform up to her ability (Steele, 1997). For example, when African Americans were given a test described as investigating personal factors involved in verbal skills (thus creating a threatening situation for African American students who know there exists a negative stereotype about their verbal skills compared to Caucasian students), they performed worse than Caucasians on that test. However, when the test was described as investigating psychological factors (thereby making the test non-diagnostic of individual skill and alleviating the threat), African Americans performed equally as well as Caucasians (Steele & Aronson, 1995). The framing of the test was a powerful situational factor that, once changed, alleviated the performance differences between races, suggesting these observed differences may not be rooted in biology.

In addition to race differences in performance, stereotype threat has also been shown to account for gender differences. When women were given a math test described as producing gender differences, and thus containing threatening information about a stereotype relevant to their group, women performed worse than men. However, when they were given the same math test described as producing no gender differences, and thus alleviating the threat, women performed equally to men (Spencer, Steele, & Quinn, 1999).

Mechanism behind stereotype threat. Initially, researchers believed that this stereotype threat effect operated through anxiety, such that the fear of confirming a negative stereotype about one's group led individuals from that group to become too anxious to perform up to their ability (Steele, 1997; Steele, Spencer & Aronson, 2002). However, more recent work has suggested that anxiety is not the only way that stereotype threat can inhibit performance.

Although the negative outcomes of stereotype threat can be created through anxiety in some instances, stereotype threat can also operate more broadly through several means by taxing the working memory of threatened individuals (Schmader, Johns, & Forbes, 2008). Specifically, some cue in the individual or environment signals potential threat to a person, who then begins to search for evidence that they might be confirming a negative stereotype about their group. This leads them to constantly monitor their performance for failure, attempting to suppress negative thoughts and feelings, which taxes their working memory. With less working memory capacity available to use on the task, threatened individuals suffer performance deficits (Schmader & Johns, 2003; Schmader, 2010).

This process of stereotype threat only occurs if three links are present: those between the ingroup, the self, and the ability (Schmader, Johns, & Forbes, 2008). In the situation of stereotype threat, the ingroup and ability are related through awareness of the stereotype that the target's group does not perform as well in this skill. The self and ability are linked through strong identification with the domain. Finally, the ingroup and the self are connected through strong identification with the ingroup identity; in the case of women and STEM, women who identify more strongly with their gender experience stereotype threat more than women who identify less strongly with their gender (Schmader, 2002).

Linking the ingroup and the ability. These three links could be created and strengthened through multiple means, leading to many potential cues in the individual and environment which could lead to situations of stereotype threat. In order to experimentally recreate the link between ingroup and ability, scientists have used manipulations which range from direct to subtle. For example, researchers have strengthened this link by explicitly telling participants about the stereotype that gender differences exist in STEM skills (Beilock, Rydell, & McConnell, 2007; Keller, 2002). More subtly, researchers have also mentioned to participants that gender differences have been found on the test before -- although giving no explicit direction of the effect (O'Brien & Crandall, 2003; Spencer et al, 1999). This link between the ingroup and the ability can also be bolstered by simply mentioning that the experimenters are interested in exploring gender differences -- again with no specific information given about the direction of these differences (Brown & Pinel, 2003; Johns, Schmader, & Martens, 2005; McIntyre, Paulson, & Lord, 2003; Delgado & Prieto, 2008; Rosenthal et al, 2007). Unfortunately for stereotyped group members, sometimes this link is so strong within societal beliefs that people do not even need to be reminded of it in order to experience stereotype threat; in fact, the threat can simply be "in the air" if the group stereotype is well-known in society (Steele, 1997).

Fortunately for stereotyped group members, this link between the ingroup and the ability can also be weakened (not just strengthened) within the situation in order to prevent stereotype threat. For example, when the test is framed as fair to multiple groups, people perform better than when the test is not explicitly referred to as fair (Blascovich, Spencer, Quinn, & Steele, 2001; Spencer et al, 1999; Wout, Danso, Jackson, & Spencer, 2008). Similarly, when the test is framed as non-diagnostic (for example, designed to investigate learning versus innate ability or labeled as a problem-solving task versus a test), stigmatized individuals perform better than when the test is framed as diagnostic of the stereotyped skill (Johns, Inzlicht, & Schmader, 2008; Taylor & Walton, 2011; Good et al, 2008; Steele & Aronson, 1995; Spencer et al, 1999; Brown & Day, 2006).

Simple cues in the environment can also subtly indicate that the ingroup does or does not belong in situations requiring this ability. For example, having a female experimenter or evaluator can lead women to experience less stereotype threat in STEM domains than having a male experimenter or evaluator (Marx & Goff, 2005; Marx & Roman, 2002; Wout, Shih, Jackson, & Sellers, 2009). Similarly, numerical representation of genders within the students themselves can cue stereotype threat. When women took a math test with two other students, they performed better when those two other students were female than when they were a male and a female or two males; men were unaffected by these numerical representation cues (Inzlicht & Ben-Zeev, 2000).

Unfortunately, these changes in the test and environment are difficult for stereotyped individuals themselves to make; instead, these changes rely on the test-makers and institutions themselves to be mindful when describing and administering their tests, which may not always be plausible. However, the other two links (between ingroup and self; between self and ability) might be more susceptible to change from the stereotyped individual herself, given their inclusion of the self.

Linking the ingroup and the self. The strength of the link between the ingroup and the self can also strongly influence whether an individual experiences stereotype threat, since it links the individual's performance to the group which has been negatively stereotyped, thereby creating the potential threat against the individual herself. For example, when women were asked to indicate their gender before taking a math test (thereby endorsing their membership in the female ingroup), they performed worse than when they were asked to indicate their gender after taking the test (Schmader & Johns, 2003). In addition, when gender identity was linked to performance, women who identified more strongly with their gender were more likely to experience stereotype threat and perform poorly than women who identified less strongly with their gender (Schmader, 2002).

Unfortunately, this link between the ingroup and the self might also be difficult for stereotyped individuals themselves to break. If women in STEM wanted to avoid stereotype threat by breaking this link, they would be tasked with downplaying their female identity, both externally to others and internally to themselves, and this might not even work if others still identify them as belonging to the "female" group.

Linking the self and the ability. Therefore, the final necessary link for stereotype threat -- that between self and ability -- might be the best candidate for stereotyped individuals to be able to change. However, this link gets strengthened in many of the real-world situations in which stereotyped group members find themselves. For example, individuals under stereotype threat perform even worse when they are told they will receive follow-up feedback on their performance than when they are not told about any follow-up feedback (Martens et al, 2006; Schmader & Johns, 2003; Johns et al, 2008). Unfortunately, women in STEM are likely to expect (and subsequently encounter) many forms of follow-up feedback in their academic and professional journeys, thereby putting them at an even stronger risk of performing under their ability. Similarly, individuals under stereotype threat also perform even worse when their performance on the test is linked to general intelligence, future academic potential, or generally future success in life than when these links are not specified (Rydell, McConnell, & Beilock, 2009; Seibt & Forster, 2004; Schmader et al, 2009; Danaher & Crandall, 2008). Unfortunately, in the real world, stereotyped individuals know that their performance on academic and professional tasks will be seen as an indicator of their general intelligence or future potential, again thereby putting them at increased risk for stereotype threat deficits in performance.

However, there might be some hope for stereotyped group members in shifting which part of the self is linked to the relevant ability because importantly, the effect of stereotype threat depends on which aspects of the self are activated at the time. When Asian women had their gender identity activated, they performed worse on a math test than a control group where no identity was activated since the relevant stereotype is that women perform worse on math tasks than men. However, when Asian women had their ethnic identity activated, they performed better on a math test than a control group since here the relevant stereotype is that Asians perform better than Whites on math tasks (Shih, Pittinsky, & Ambady, 1999).

Given that women who are interested in or pursuing STEM fields are likely talented in math and have likely experienced math successes in the past, they should have many positive past successes on which to draw in order to activate a helpful identity. However, even these women can be impaired in the moment if the links between the self, ingroup, and ability set up a situation of stereotype threat.

Linking the self to success in the ability. One way to protect against these impairments could be by having women remember and visualize their past experiences of success. Memories of past events can help inform what people think of their personal identity (Singer & Salovey, 1993), and therefore reminding women that they have succeeded in the past in this domain might help bolster their current performance.

Often when people recall memories of past events, these memories are accompanied by visual imagery (Brewer, 1988; Conway, 1996). In addition, when people recall memories or imagine future events, they can picture these events in their mind's eye from different visual perspectives (Nigro & Neisser, 1983). Specifically, the same event can be pictured from either the first-person or the third-person perspective. With the first-person perspective, individuals see the event in their mind's eye from their own visual perspective, as if through their own eyes. In contrast, with the third-person perspective, individuals see the event in their mind's eye as if from an observer's visual perspective, seeing themselves in the image as well as their surroundings.

Visual imagery perspective

Importantly, the visual perspective that people use to picture an event influences how they process that event (Libby & Eibach, 2011; Libby, Shaeffer, & Eibach, 2009; Shaeffer, Libby, & Eibach, 2015). Specifically, first-person (vs. third-person) imagery facilitates processing where people understand the event in terms of associations evoked by its concrete properties. In contrast, third-person (vs. first-person) imagery facilitates processing where people attempt to integrate the event with broader abstract knowledge they have about themselves and the event. For example, people were more likely to forecast their future behaviors and emotions in correspondence with their propositional beliefs about themselves (explicit personal values and preferences) when using third-person imagery vs. first-person imagery (and more likely to forecast their future behaviors and emotions in correspondence with their associative evaluations when using first-person imagery vs. third-person imagery) (Libby, Valenti, Hines, & Eibach, 2013).

In addition, visual imagery perspective can influence the conclusions people make about the pictured event, especially when certain events mean more when considered in the broader abstract context of the self. For example, when people visualized events where they failed to act, third-person (vs. first-person) imagery led people to regret those inactions more, since inaction is most regrettable when considering the broader abstract meaning of that event (Valenti, Libby, & Eibach, 2011). Since third-person imagery facilitates processing that integrates pictured events with broader abstract frameworks about the self and the event, visualizing events with particular broad relevance for the self from the third-person (vs. first-person) perspective might lead people to make more self-relevant conclusions.

Given third-person imagery's power to link an event with broader abstract knowledge about the self, it could be used to help bolster stereotyped individuals' self to ability link, thereby protecting them against the negative effects of stereotype threat. This research specifically investigates whether visualizing a past math success from the third-person perspective (vs. first-person perspective) can protect women from stereotype threat, allowing them to perform up to ability on a math test.

Chapter 2: Study 1

The goal of Study 1 was to examine whether visualizing past domain-related successes from the third-person, as opposed to first-person, perspective could be protective against stereotype threat for women taking a math test. Because stereotype threat effects are strongest for those who identify highly with the domain (Schmader 2002), I decided to explore my predictions within a real-world math classroom at a university. I recruited students in a Calculus II course (the second in a three-course sequence) to participate in this study and asked these students to visualize a past math success from either the first-person or the third-person perspective, then attempt to solve a series of math-related problems which were described in a way that induced stereotype threat or not.

I hypothesized that for women, visualizing a past domain-related success from the third-person perspective could be protective against stereotype threat since it invokes a sense of the self as the kind of person who does well at math, thereby allowing the threat to not be as threatening to the participant. In contrast, I hypothesized that for women, visualizing a past domain-related success from the first-person perspective would not be protective against stereotype threat since this kind of imagery focuses on more concrete details of the event without tying it to more broad self-beliefs. I did not hypothesize strong predictions for men, since they would not be threatened by any negative stereotypes about their group in this design. If anything, I expected they might experience stereotype lift (Walton & Cohen, 2003) when presented with the threat information or a performance lift when visualizing past successes from the third-person perspective (since this could raise their own self-beliefs), but I did not expect an interaction between perspective and threat for men.

Method

Participants

Sixty-seven math students (29 male, 36 female) at The Ohio State University were recruited to participate in this study during their normal class time in their normal classroom. These students were currently taking Calculus II, a second-level math class (the second in a three-course sequence) usually taken by sophomores who need upper level math for their major (typically required of science and math majors).

Procedure Overview

Participants arrived to their math classroom and heard from their instructor that they had the opportunity to participate in a study that day where their participation was voluntary. They each received a packet from the male experimenter who told them to put their name on the packet and begin whenever they were ready.

Each packet contained the imagery perspective manipulation, then the stereotype threat manipulation, then the math test, and finally some questions about participants' general demographics.

After participants finished the packet, they saw instructions to return it to the experimenter and remain seated while other students finished. After everyone had finished, I debriefed participants and allowed them to ask any questions they might have, taking particular care to explain stereotype threat and its effects in order to avoid any negative long-term effects for participants, since learning about stereotype threat can help women perform better in situations of threat (Johns et al, 2005).

Design

I randomly assigned participants to experience one level of each of our two manipulations (imagery perspective and stereotype threat) and measured their gender. This created a 2 (imagery perspective: first- vs. third-person) X 2 (stereotype threat: threat vs. no threat) X 2 (gender: male vs. female) design.

Manipulations

Imagery perspective. First, all participants were asked to picture, "A time in the past when you did well on a math test or some task involving numbers." However, they were randomly assigned to then see instructions that would instruct them to visualize this event from either the first-person or third-person perspective. Those assigned to imagine the event from the first-person perspective were told:

> With the first-person visual perspective, you see the scene from the visual perspective you would have if you were actually experiencing the event. That is, you are looking out at your surroundings through your own eyes. Please be sure to use only the first-person visual perspective when you are asked to picture the event.

In contrast, those assigned to visualize the event from the third-person perspective were told:

> With the third-person visual perspective, you see the scene from the visual perspective an observer would have if you were actually experiencing the event. That is, you see yourself in the image, as well as your surroundings. Please be sure to use only the third-person visual perspective when you are asked to picture the event.

All participants then answered a series of questions to check their use of the manipulated perspective. Specifically, participants indicated if they understood what we meant by the perspective directions (yes or no). They also indicated whether they were picturing the event from the assigned visual perspective; specifically, participants who were assigned to use the first-person perspective indicated if they were picturing the event "from the visual perspective you would have if you were actually experiencing the event," while participants who were assigned to use the third-person perspective indicated if they were picturing the event "from the visual perspective an observer would have if you were actually experiencing the event" (yes or no).

Participants also indicated how vivid their mental image was (5-point scale from "perfectly clear and as vivid as normal vision" (1) to "no image at all" (5)), how easy it was to picture their scene from the first-person or third-person perspective, depending on condition (7-point scale from "extremely easy" (1) to "extremely difficult" (7) with "neither easy nor difficult" as the midpoint), as well as to what extent it seemed like the event they were picturing in their mind was really happening as they imagined it (5-point scale from “the event seems extremely real, just like it is actually happening” (1) to “the event does not seem real at all” (5)).

Stereotype threat. After the imagery section, participants saw instructions for the next part of the study, which varied depending on condition. Specifically, participants who were in the threat condition saw:

> For this part of the study, we would like you to complete several problems on a math test. We are interested in how people perform in math testing situations. This test often shows strong differences in the performance between men and women. Because men often perform better than women on this test, we need you to indicate your gender. Please write on the line below whether you are male or female.

This manipulation induces stereotype threat by framing the task as a “math test” to raise evaluative concern, mentioning the gender math-related stereotype, and forcing participants to indicate their membership in one of the groups relevant to the stereotype.

In contrast, participants who were in the no-threat condition saw:

> For this part of the study, we would like you to complete several problems. We are interested in how people go about solving these problems.

This manipulation minimizes any potential stereotype threat by framing the task as “problems” which are not necessarily linked to the math domain. These manipulations were based on previous stereotype threat literature showing that test framing, stereotype endorsement, and evaluative concern can increase threat (Kray, Thompson, & Galinsky, 2001; Beilock et al, 2007; Steele & Aronson, 1995).

Measures

Math test. Participants then encountered 11 questions from the math portion of the Graduate Record Exam (GRE). These questions were multiple choice, each with five possible answers, and participants were asked to circle the best of the answer choices given. Ultimately, participants' performance on the math test was scored by calculating the total number of questions they answered correctly.

Background information. Participants also answered some questions about their math background. Specifically, they gave open-ended responses indicating their SAT math score (if they could remember it) and how many math or science courses they had taken at Ohio State, and then indicated on a 5-point scale (from "not at all important" (1) to "extremely important" (5)) how important it was to them that they did well and were good at math.

Finally, participants indicated if they had ever participated in a similar study (yes or no, and if yes, to describe the similarities further), if they had ever heard of stereotype threat before (yes or no, and if yes, to describe what they thought it was), and what their gender was (male or female). Participants were then debriefed and thanked for participating in the study.

Results

Imagery

Participants were able to visualize a past success that was relatively vivid (*M* = 2.48, *SD* = 0.75; where 2 = clear and reasonably vivid and 3 = moderately clear and vivid), easy to picture (M = 2.57, SD = 1.34; where 2 = very easy and 3 = somewhat easy), and real-seeming (M = 2.85, SD = 1.03; where 2 = the event seems very real and 3 = the event seems moderately real). In addition, there were no differences in the vividness, ease, or realness of the imagery between conditions, nor were there any significant interactions with perspective, threat, or gender on vividness, ease, or realness of imagery used as a dependent variable.

Performance

I predicted that, for women, imagery perspective would moderate the traditional stereotype threat effect such that women who imagined a previous success from the first-person perspective would show the typical stereotype threat effect of lower performance when under threat (vs. no threat), while women who imagined a previous success from the third-person perspective would be protected against stereotype threat and therefore not show the typical effect, instead showing equal performance when under threat (vs. no threat).

In order to test this hypothesis, I calculated the total number of questions that participants answered correctly on the 11-question math test (with a possible score from 0 questions correct to 11 questions correct). I then submitted those scores to a 2 (imagery perspective: first- or third-person perspective) X 2 (stereotype threat: threat or no threat) X 2 (gender: male or female) analysis of variance (ANOVA).

Perspective X Threat for Women. Since theoretically I was most interested in women and my primary predictions were for them, I explored the two-way (perspective X threat) interaction for them.

For women, there was a marginally significant two-way interaction between perspective and threat, $F(1, 59) = 3.35$, $p = .07$ (see Figure 1). As predicted, women who used first-person imagery experienced worse performance under threat vs. no threat, $F(1, 59) = 6.58$, $p = .01$ (threat: $M = 6.14$, $SE = 0.69$; no threat: $M = 8.56$, $SE = 0.61$). However, also as predicted, women who used third-person imagery performed equally well under threat vs. no threat, $F(1, 59) = 0.00$, $p = 1.00$ (threat: $M = 8.00$, $SE = 0.53$; no threat: $M = 8.00$, $SE = 0.72$).

In addition, as predicted, among women under threat, those who used third-person imagery performed better than those who used first-person imagery, $F(1, 59) = 4.69$, $p = .04$ (third-person: $M = 8.00$, $SE = 0.51$; first-person: $M = 6.14$, $SE = 0.69$). In contrast, among women under no threat, perspective had no significant effect on performance, $F(1, 59) = 0.36$, $p = .55$.

Finally, there was a marginally significant main effect of threat such that women under threat performed worse than those under no threat, $F(1, 59) = 3.67$, $p = .06$ (threat: $M = 7.07$, $SE = 0.43$; no threat: $M = 8.28$, $SE = 0.46$). There was no main effect of perspective, $F(1, 59) = 1.07$, $p = .31$.

Effects in the Perspective X Threat X Gender Model. I expected the perspective X threat interaction to be moderated by gender as well, but it was not. Contrary to my predictions, there was no significant three-way interaction between imagery perspective, stereotype threat, and gender, $F(1, 59) = 0.05$, $p = 0.82$ (see Figure 1).

However, there was a significant two-way interaction between perspective and threat, $F(1, 59) = 7.59$, $p = .01$. After using first-person imagery, participants experienced worse performance under threat vs. no threat, $F(1, 63) = 8.96$, $p = .01$ (threat: $M = 5.93$, $SE = 0.52$; no threat: $M = 8.06$, $SE = 0.49$). However, after third-person imagery, participants performed no differently under threat vs. no threat, $F(1, 63) = 1.44$, $p = .23$ (threat: $M = 7.71$, $SE = 0.43$; no threat: $M = 6.94$, $SE = 0.49$).

In addition, among those under threat, third-person imagery led to better performance than first-person imagery, $F(1, 63) = 7.06$, $p = .01$ (third-person: $M = 7.71$; first-person: $M = 5.93$). In contrast, among those not under threat, perspective had no significant effect on performance, $F(1, 63) = 2.67$, $p = .11$.

Finally, there was a significant main effect of gender such that women performed better than men, $F(1, 59) = 4.81$, $p = .03$ (women: $M = 7.68$, $SE = 0.33$; men: $M = 6.63$, $SE = 0.35$).

Within this three-factor model, there were no other significant two-way interactions or main effects (see Table 1).

Although I did not find a significant three-way interaction, it is possible that different processes could be responsible for the effects in each gender, particularly since recent work has shown men can experience broad social identity threat in some situations of stereotype threat (Murphy & Walton, 2013; Murphy, 2015). Although there was no statistical difference in the effects for men and women in these results, since theoretically I did not predict the same results for men, I further explored the two-way interaction within men.

Effect	F statistic	p-value
Main effect of perspective	$F(1, 59) = 0.63$	$p = 0.43$
Main effect of threat	$F(1, 59) = 2.44$	$p = 0.12$
Main effect of gender	$F(1, 59) = 4.81$	$p = 0.03$
Perspective X threat interaction	$F\ (1, 59) = 7.59$	$p = 0.01$
Perspective X gender interaction	$F(1, 59) = 0.32$	$p = .57$
Threat X gender interaction	$F(1, 59) = 0.92$	$p = 0.34$
Perspective X threat X gender interaction	$F(1, 59) = 0.05$	$p = 0.82$

Table 1: F-statistics for main effects and interactions on performance in Study 1.

Perspective X Threat for Men. Although my primary predictions were not for men, given that the three-way interaction with gender was not significant, I looked further into the effects within men as well to see if there was evidence of a reliable effect within men alone.

For men, there was a marginally significant two-way interaction between perspective and threat, $F(1, 59) = 4.06$, $p = .06$. However, among men who used first-person imagery, threat did not affect performance, $F(1, 59) = 2.54$, $p = .12$. Threat also did not affect performance among men who used third-person imagery, $F(1, 59) = 1.35$, $p = .26$.

In addition, among men who read stereotype threat-consistent information, perspective did not affect performance, $F(1, 59) = 2.17$, $p = .15$. Perspective also did not affect performance among men who read no stereotype threat-consistent information, $F(1, 59) = 1.69$, $p = .21$.

Finally, for men, there were no main effects of threat ($F(1, 59) = 0.16$, $p = .70$) or perspective ($F(1, 59) = 0.02$, $p = .88$).

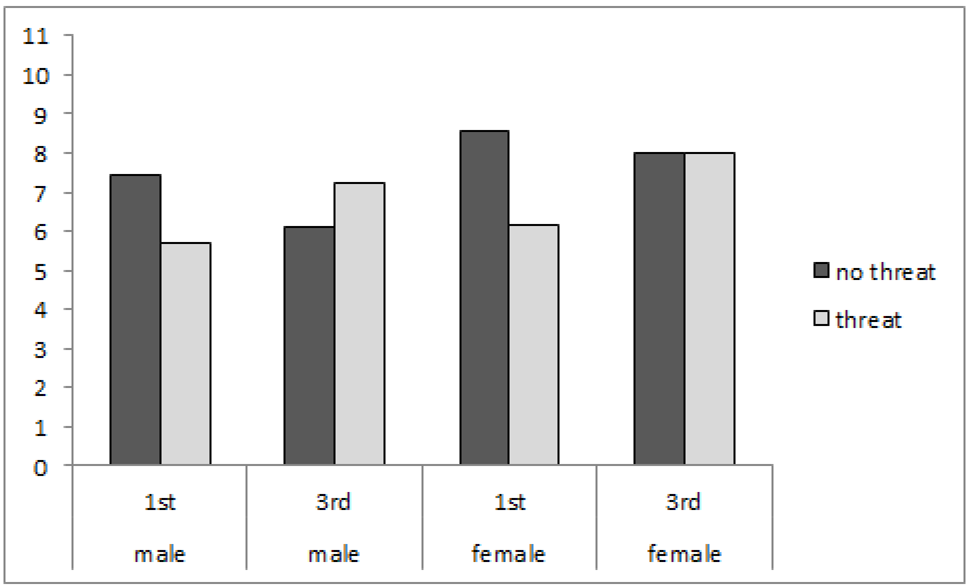


Figure 1: Total number of questions answered correctly for men and women, depending on imagery perspective and threat, in Study 1.

Correlations with math importance. At the end of the survey, participants indicated how important it was to them to be good at math. Although there were no significant interactions with perspective, threat, or gender on math importance used as a dependent variable, there was a correlation between math importance and performance for certain conditions.

Specifically, women under threat showed worse performance as they cared more about math, $r(20) = -0.45$, $p = 0.05$. However, women under no threat showed no relationship between performance and math importance, $r(16) = 0.13$, $p = 0.63$.

In addition, men under threat showed no relationship between performance and math importance, $r(15) = -0.25$, $p = 0.36$, nor did men under no threat, $r(16) = -0.01$, $p = 0.97$.

However, a regression analysis predicting performance from perspective, threat, gender, and math importance did not reveal a significant three-way interaction between threat, gender, and math importance (see Table 2).

Effect	B	SE	t	p
Perspective	0.03	0.28	0.09	0.93
Threat	-0.34	0.28	-1.21	0.23
Gender	0.76	0.28	2.72	0.01
Math importance	-0.53	0.37	-1.46	0.15
Perspective X threat	0.66	0.28	2.36	0.02
Perspective X gender	-0.02	0.28	-0.06	0.95
Perspective X math importance	0.51	0.37	1.39	0.17
Threat X gender	-0.20	0.28	-0.71	0.48
Gender X math importance	-0.43	0.37	-1.18	0.24
Threat X math importance	-0.34	0.37	-0.94	0.35
Perspective X threat X gender	-0.16	0.28	-0.57	0.57
Threat X gender X math importance	-0.01	0.37	-0.02	0.98
Perspective X gender X math importance	0.34	0.37	0.93	0.36
Perspective X threat X math importance	-0.09	0.37	-0.25	0.80
Perspective X threat X gender X math importance	-0.07	0.37	-0.20	0.84

Table 2. Regression results predicting performance from perspective, threat, gender, and math importance in Study 1.

Discussion of Study 1 Results

Although I did not find the three-way interaction predicting performance that I predicted in Study 1, further exploration shows that I did find evidence for some of my predictions. Specifically, women experienced performance deficits under threat (vs. no threat), except for when they initially used third-person imagery to visualize a past success. After using third-person imagery, women were able to perform equally well under threat (vs. no threat).

The correlation between math importance and performance within women under threat suggests that these women were actually experiencing stereotype threat, given that women who care more about math are likely to feel the most threat and pressure to perform. Although I did not find a significant four-way interaction between perspective, threat, gender, and math importance, this could be due to low sample size and little variation on the math importance measure ($M = 3.56$, $SD = 0.74$) since all participants were currently taking a math course. However, it might be the case that my results were weakened by including some women in the class who did not actually care that much about math (e.g., perhaps they were taking the course solely as a requirement). This suggests that these effects could be even stronger if I recruited solely women who were strongly identified with math, consistent with previous research that found highly math-identified women experienced more stereotype threat than low math-identified women (Schmader, 2002).

In addition, I found some unpredicted results among men. However, it is unclear exactly what differences might be occurring in men given that none of the simple effects were significant for them. In addition, they showed no evidence of a relationship between how much they cared about being good at math and how well they performed.

Nonetheless, the lack of a significant three-way interaction suggests that men and women were not experiencing different effects here, though there could be a different process in play for the two genders. Recent research has suggested that men can experience a broad form of social identity threat in STEM situations if there are cues to suggest their group is no longer privileged in this context (Murphy & Walton, 2013; Boucher & Murphy, 2015; Murphy, 2015). Therefore, some cues in our study could have created a different form of identity threat within men than women. For example, although the math class that I used for this study was taught by a male professor (a stereotypical cue), that professor mentioned that he personally believed his female students were better at math than his male students. (In reality, this belief could be true given that I found women performed better than men on average on this test.) It could be the case that this professor mentioned this belief in class multiple times before the students participated in this study, perhaps setting up a culture of non-traditional STEM cues. In addition, the math class that I used contained more females than males (36 vs. 31) which might have cued a non-traditional STEM environment.

These subtle cues may have been enough to make men feel that their typical gender advantage in this environment was not as secure as usual, thereby creating a different type of threat for them as well. Therefore, perhaps encountering threat information – even when it explicitly indicated that their group was at an advantage – led men to feel that their performance was being evaluated in comparison to women, a group which they might sense is becoming equal or superior to them in the STEM context (due to subtle cues in their classroom environment). Therefore, this comparison might have been threatening enough to men's sense of their own math skill that they also experienced deficits in performance when under threat, except for when they used protective third-person imagery first (similar to the predictions and effects for women).

Although these subtle cues could have hurt men, they also should have helped women feel more accepted than usual in a STEM environment. This sense of belonging can help women feel less stereotype threat (Murphy & Walton, 2013), and therefore it might have weakened the overall effects in this study. However, it is also possible that, although their general classroom environment cued some belonging for women in STEM, my use of strong stereotype threat manipulations undid that helpful effect for women, at least for the duration of the study. In addition, women in STEM have likely encountered many past experiences consistent with stereotype threat, making their default experience one of stereotype threat. Therefore, any cue that negative stereotypes about their group could be threatening in this situation could be capable of creating stereotype threat and overcoming the potentially helpful effect of non-stereotypical belonging cues in their classroom environment.

In any case, subtle influences like these can cue both men and women to make assumptions about who belongs in the math classroom environment, and therefore I sought to control for these cues in Study 2 in order to allow better exploration of the effects of my manipulations alone.

Chapter 3: Study 2

The goal of Study 2 was to replicate the findings from Study 1 with a more controlled lab setting. Using a lab setting allowed me to control for aspects that could have influenced the results in Study 1, such as the numerical representation in the class (more women than men) and the classroom culture in the specific class that I used for Study 1 (where the instructor admitted he sometimes mentioned to the class that typically women were more anxious but outperformed men in his class). Controlling for these cues can allow better exploration of the effects of my manipulations alone.

For this study, I retained the same imagery perspective and stereotype threat manipulations as the previous study, as well as the same 11-question math test dependent variable. In addition, I added some questions assessing belonging in the domain, in order to explore whether third-person perspective imagery of past domain-related successes could extend its protection to broader issues of whether the person or the person's gender belongs in these types of math-related environments, which could then lead to broader consequences of identification with the domain and retention in it. I also added some questions assessing self-beliefs, in order to explore my proposed mechanism, namely that third-person perspective imagery of past math-related successes increases the self-belief that one is good at and belongs in math, which then protects against stereotype threat.

Method

Participants

Sixty-seven current students at The Ohio State University (33 males, 34 females) were recruited through flyers placed around campus advertising the opportunity to participate in a paid study. If they were interested, students could go to a website where they could fill out a small pre-survey to see if they would qualify to participate. The pre-survey asked for demographic information, including their major. I then invited those who indicated that they were currently a science, technology, engineering, or math (STEM) major. These students, therefore, all had direct and current experience with environments that could cue stereotype threat, and they were all likely to care about their performance in the domain. I told these students that they were eligible to participate in a thirty-minute study for $5, and that they should sign up for a session if they were interested.

Procedure

STEM students who responded to the invitation to participate then signed up for an in-lab session. At their designated date and time, students came into the lab in mixed-gender groups of 2-5 and were told by the male experimenter that their participation was voluntary. They then received a packet containing all the necessary materials for the study. Similar to Study 1, participants imagined a past math-related success from either the first-person or third-person perspective (depending on condition), then they encountered the 11 math questions described in a way that either induced stereotype threat or not (depending on condition). Next, participants actually took the math test, and then (new to this study), they indicated their belonging during the study, their math-related self-beliefs, as well as some details about their experience during the study and their general demographics. When they were finished, participants returned the packet to the male experimenter where they were debriefed, thanked, and paid the $5 compensation for their participation.

Materials

Imagery perspective, stereotype threat, and math test. These materials were exactly the same as in Study 1.

Belonging. After completing the math test, participants indicated their belonging in the study and in the domain in general. These questions were adapted from previous studies exploring belonging in stereotype threat situations (Murphy & Walton, 2013; Murphy & Zirkel, in press). Specifically, participants indicated how true they felt the following statements were on a 5-point scale from "not at all true" (1) to "extremely true" (5): I would belong in a math class; I can see myself being part of a math class; during the study, I felt like I belonged here; if future studies used similar tasks to these, I would belong in those studies; I would like to participate in studies with similar tasks in the future.

Self-beliefs. After indicating their belonging, participants answered some questions about their self-beliefs relevant to the domain. Specifically, participants indicated how true they felt the following statements were on a 5-point scale from "not at all true" to "extremely true": I can see myself taking more math classes in the future; I am a math person. Participants also indicated how much they liked math as a subject (7-

point scale from “I really dislike math” (1) to “I really like math” (7) with “I neither like nor dislike math” as the midpoint (4)), and how much they considered themselves more inclined to math and science or the arts and humanities (7-point scale from “Definitely more of an arts/humanities person” (1) to “Definitely more of a math/science person” (7), with “Equally an arts/humanities and math/science person” as the midpoint (4)).

Background information. Next, participants provided some information about their math background, including their SAT math score (open-ended), their ACT math score (open-ended), how many math courses they had taken at OSU (open-ended), their most recent grade on a math course or exam (open-ended), and how long it had been since they had taken a math class (5-point scale: currently taking a math class, a semester since, a year since, over a year since, and never taken a math class).

Finally, participants indicated their gender (open-ended), their major (open-ended), whether they had participated in a similar study before (yes or no, and if yes, please describe it further), and whether they had ever heard of stereotype threat before (yes or no, and if so, please describe it further).

Results

Imagery

As in Study 1, participants were able to visualize a past success that was relatively vivid (M = 2.30, SD = 0.75), easy to picture (M = 2.59, SD = 1.28), and real-seeming (M = 2.67, SD = 1.08). In addition, there were no differences in the vividness, ease, or realness of the imagery between conditions, nor were there any significant interactions with perspective, threat, or gender on vividness, ease, or realness of imagery used as a dependent variable.

Performance

As in Study 1, I predicted that, for women, imagery perspective would moderate the traditional stereotype threat effect such that women who imagined a previous success from the first-person perspective would show the typical stereotype threat effect of lower performance when under threat (vs. no threat), while women who imagined a previous success from the third-person perspective would be protected against stereotype threat and therefore not show the typical effect, instead showing equal performance when under threat (vs. no threat).

In order to test this hypothesis, I again calculated the total number of questions that participants answered correctly on the 11-question math test (with a possible score from 0 questions correct to 11 questions correct) and then submitted those scores to the following tests.

Perspective X Threat for Women. As in Study 1, my primary predictions were for women, and therefore I further explored the two-way interaction of perspective and threat within women by submitting their performance scores to a 2 (perspective: first- vs. third-person) X 2 (stereotype threat: threat vs. no threat) ANOVA.

Unlike in the previous study, for women there was no significant two-way interaction between perspective and threat, $F(1, 59) = 1.25$, $p = .27$. However, the means were broadly consistent with predictions such that women who used third-person imagery and encountered threat information did not suffer performance deficits and in fact may have experienced a performance boost (see Figure 2).

In addition, on average, perspective did have a marginally significant effect on performance, $F(1, 59) = 3.49$, $p = .07$. Women who used third-person imagery performed better than women who used first-person imagery (third-person: $M = 8.60$, $SE = 0.81$; first-person: $M = 6.72$, $SE = 0.60$).

However, on average, performance was not affected by threat, $F(1, 59) = 1.38$, $p = .25$.

Effects in the Perspective X Threat X Gender Model. As in Study 1, I expected the perspective X threat interaction to be moderated by gender as well, but it was not. I submitted the performance scores to a 2 (imagery perspective: first- vs. third-person perspective) X 2 (stereotype threat: threat vs. no threat) X 2 (gender: male vs. female) ANOVA. Contrary to my predictions, there was no significant three-way interaction between imagery perspective, stereotype threat, and gender, $F(1, 59) = 0.19$, $p = .67$ (see Figure 2).

Unlike in Study 1, in this study there was also no significant two-way interaction between imagery perspective and stereotype threat, $F(1, 59) = 1.67$, $p = .20$. Also unlike in the previous study, gender did not have a significant effect on performance this time, $F(1, 59) = 0.37$, $p = 0.55$.

Also inconsistent with Study 1, there was a marginally significant two-way interaction between gender and threat, $F(1, 59) = 3.19$, $p = .08$. Among people under no threat, women performed marginally worse than men, $F(1, 59) = 2.67$, $p = .11$ (women:

M = 7.07, *SE* = 0.51); men: *M* = 8.63, *SE* = 0.80). In contrast, among people under threat, women performed no worse than men, $F(1, 59) = 0.75$, $p = .39$ (women: *M* = 8.25, *SE* = 0.73; men: *M* = 7.48, *SE* = 0.51). However, threat had no significant effect on performance for women, $F(1, 59) = 1.77$, $p = .19$, or men, $F(1, 59) = 1.45$, $p = .23$.

In addition, participants who used third-person imagery performed better than those who used first-person imagery, $F(1, 59) = 8.02$, $p = .01$ (third-person: *M* = 8.78, *SE* = 0.45, first-person: M=6.94, SE=0.47).

Within this three-factor model, there were no other significant two-way interactions or main effects (see Table 3).

Effect	F statistic	p-value
Main effect of perspective	$F(1, 59) = 8.02$	$p = .01$
Main effect of threat	$F(1, 59) = 0.001$	$p = 0.98$
Main effect of gender	$F(1, 59) = 0.37$	$p = .55$
Perspective X threat interaction	$F(1, 59) = 1.67$	$p = .20$
Perspective X gender interaction	$F(1, 59) = 0.003$	$p = .96$
Threat X gender interaction	$F(1, 59) = 3.19$	$p = .08$
Perspective X threat X gender interaction	$F(1, 59) = 0.19$	$p = .67$

Table 3. F-statistics for main effects and interactions on performance in Study 2.

Perspective X Threat for Men. Although there was no statistical difference in the effects for men and women in these results, again since there could be different processes at work for the genders, I looked further into the effects within men as well.

For men, there was also no significant two-way interaction between perspective and threat, $F(1, 59) = 0.49$, $p = .49$.

On average, perspective did have a significant effect on performance, $F(1, 59) = 5.09$, $p = .03$. Men who used third-person imagery performed better than men who used first-person imagery (third-person: $M = 8.96$, $SE = 0.46$; first-person: $M = 7.15$, $SE = 0.66$).

However, on average, performance was not affected by threat, $F(1, 59) = 2.03$, $p = .17$.

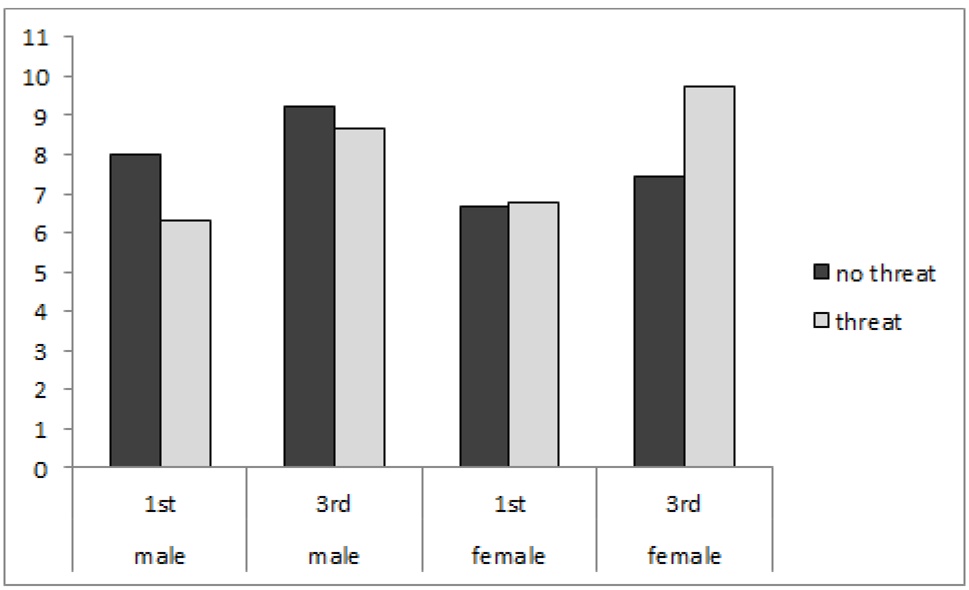


Figure 2: Total number of questions answered correctly for men and women, depending on imagery perspective and threat, in Study 2.

Belonging

In order to assess belonging, I created a standardized average of the five belonging measures (Cronbach's $\alpha = 0.92$).

I predicted that, for women, imagery perspective would moderate the traditional stereotype threat effect such that women who imagined a previous success from the first-person perspective would show a stereotype threat effect of lower belonging when under threat (vs. no threat), while women who imagined a previous success from the third-person perspective would be protected against stereotype threat and therefore not show the typical effect, instead showing equal belonging when under threat (vs. no threat).

Perspective X Threat for Women and for Men. Given that my strongest theoretical predictions were for women, I first looked at the two-way perspective X threat interactions for each gender by submitting the composite belonging scores to a 2 (imagery perspective: first- vs. third-person perspective) X 2 (stereotype threat: threat vs. no threat) ANOVA.

Contrary to predictions, the perspective X threat interaction for women was not significant, $F(1, 59) = 1.81$, $p = .19$. However, it was similar to the pattern of means that we predicted and the pattern of means for performance (see Figure 3)..

In contrast, the perspective X threat interaction for men was not consistent with the pattern of means for performance, nor was it significant, $F(1, 59) = 0.15$, $p = .70$.

Effects in the Perspective X Threat X Gender Model. In order to explore the effect of gender on this interaction, I then submitted the composite belonging scores to a

2 (imagery perspective: first- vs. third-person perspective) X 2 (stereotype threat: threat vs. no threat) X 2 (gender: male vs. female) ANOVA.

Contrary to my predictions, there was no significant three-way interaction between imagery perspective, stereotype threat, and gender, $F(1, 59) = 1.82$, $p = .18$. However, again the pattern of means was somewhat consistent with predictions in that women who used third-person imagery and encountered threat did not suffer deficits in belonging and if anything might have experienced a boost (see Figure 3).

There were also no significant two-way interactions between imagery perspective and threat, $F(1, 59) = 0.62$, $p = .44$; between imagery perspective and gender, $F(1, 59) = 0.19$, $p = .66$; nor between threat and gender, $F(1, 59) = 0.77$, $p = .38$.

However, belonging was affected by perspective, $F(1, 59) = 4.55$, $p = .04$. Participants who used third-person imagery felt more belonging than those who used first-person imagery (third-person: $M = 0.36$, $SE = 0.17$; first-person: $M = 0.15$, $SE = 0.18$).

In contrast, belonging was not affected by threat, $F(1, 59) = 0.05$, $p = .83$, nor by gender, $F(1, 59) = 0.002$, $p = .96$.

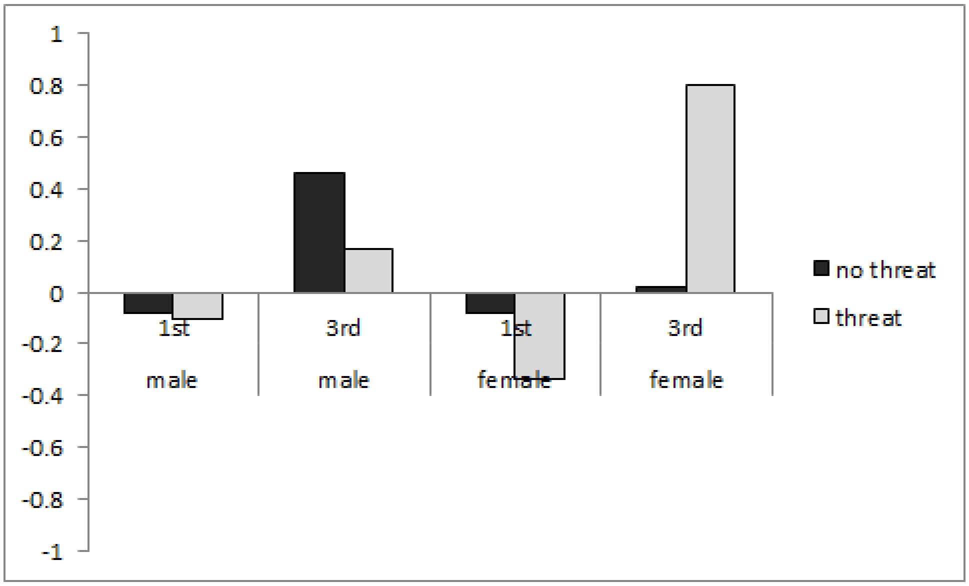


Figure 3: Belonging for men and women, depending on imagery perspective and threat, in Study 2.

Unfortunately, there were not enough participants in this sample to provide enough statistical power to perform a full analysis in order to explore whether belonging mediated performance or moderated the other effects on performance given the sample size and the large number of factors in the model (Fritz & MacKinnon, 2007; Hayes, 2013). However, belonging was significantly correlated with performance, $r(67) = 0.69$, $p = .001$ overall. In fact, belonging was highly correlated with performance for women, $r(34) = 0.79$, $p = .001$, though it was also moderately correlated with performance for men, $r(33) = 0.53$, $p = .002$.

Specifically, belonging was highly correlated with performance for women under threat, $r(18) = 0.81$, p= .001, and women under no threat, $r(17) = 0.79$, p = .001. Belonging was also correlated with performance for men under threat, $r(16) = 0.59$, p =

.004. However, belonging was not correlated with performance for men under no threat, $r(17) = 0.31$, p = .36.

Self-Beliefs

In order to assess math-related self-beliefs, I created a standardized average of the four self-belief measures (Cronbach's $\alpha = 0.88$).

I predicted that, for women, imagining a past success from the third-person perspective would promote women who imagined a previous success from the third-person perspective (vs. first-person) to be more likely to connect this success with their broader sense of self and therefore express more math-related self-beliefs. I predicted that these self-beliefs would be protective against stereotype threat and therefore would not differ depending on whether women encountered threat or no threat information.

In contrast, I predicted that imagining a past success from the first-person perspective would promote women who imagined a previous success from the first-person perspective (vs. third-person perspective) to be less likely to connect this event with their broader sense of self and therefore less likely to endorse math-related self-beliefs. I predicted that this lack of protective math self-beliefs would lead women who then encountered stereotype threat information to be less likely to endorse math-related self-beliefs (than women who encountered no threat information).

Perspective X Threat for Women and for Men. Given that my strongest theoretical predictions were for women, I first looked at the two-way perspective X threat interactions for each gender by submitting the composite self-beliefs scores to a 2 (imagery perspective: first- vs. third-person perspective) X 2 (stereotype threat: threat vs. no threat) ANOVA.

Contrary to predictions, the perspective X threat interaction for women was not significant, $F(1, 59) = 2.46$, $p = .13$. However, it was similar to the pattern of means that I predicted and the pattern of means for performance (see Figure 4).

The perspective X threat interaction for men was also not significant, $F(1, 59) = 0.18$, $p = .67$.

Effects in the Perspective X Threat X Gender Model. In order to explore the effect of gender on this interaction, I then submitted the composite self-beliefs scores to a 2 (imagery perspective: first- vs. third-person perspective) X 2 (stereotype threat: threat vs. no threat) X 2 (gender: male vs. female) ANOVA.

Contrary to my predictions, there was no significant three-way interaction between imagery perspective, stereotype threat, and gender, $F(1, 59) = 0.74$, $p = .39$. However, again the pattern of means was somewhat consistent with predictions in that women who used third-person imagery and encountered threat did not suffer deficits in math self-beliefs and if anything experienced a boost (see Figure 4).

There were also no significant two-way interactions between imagery perspective and threat, $F(1, 59) = 2.07$, $p = .16$; between imagery perspective and gender, $F(1, 59) = 0.25$, $p = .62$; nor between threat and gender, $F(1, 59) = 0.97$, $p = .33$.

However, self-beliefs were affected by perspective, $F(1, 59) = 9.32$, $p = .003$. Participants who used third-person imagery expressed more math self-beliefs than those who used first-person imagery (third-person: $M = 0.45$, $SE = 0.16$; first-person: $M = 0.25$, $SE = 0.16$).

In contrast, self-beliefs were not affected by threat, $F(1, 59) = 0.11$, $p = .74$, nor by gender, $F(1, 59) = 0.001$, $p = .97$.

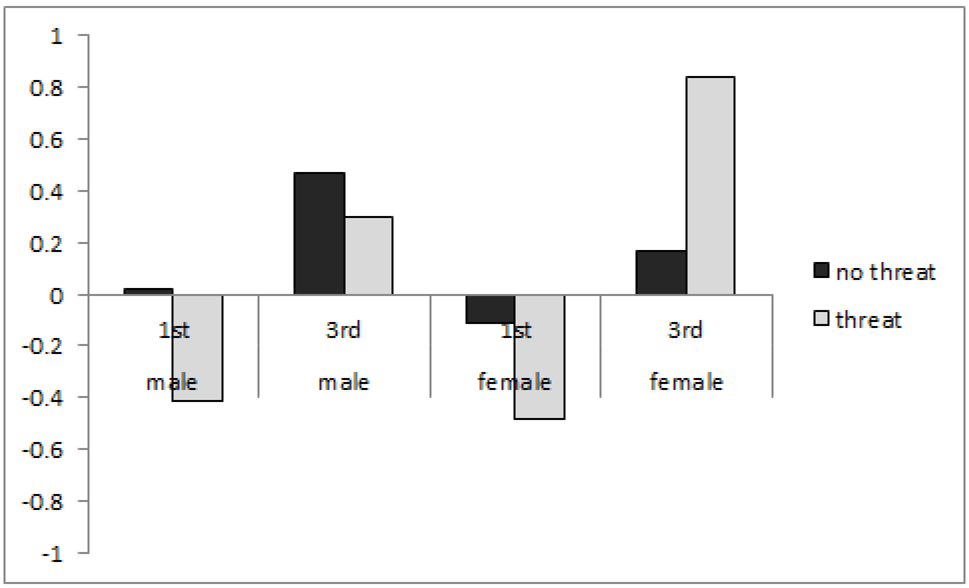


Figure 4: Math self-beliefs for men and women, depending on imagery perspective and threat, in Study 2.

Unfortunately, there were not enough participants in this sample to provide enough statistical power to perform a full mediation analysis in order to explore whether self-beliefs mediated performance given the small sample size and large number of factors in the model (Fritz & MacKinnon, 2007; Hayes, 2013). However, self-beliefs were significantly correlated with performance, $r(67) = 0.52$, $p = .001$. In fact, self-beliefs were highly correlated with performance for women, $r(34) = 0.60$, $p = .001$, while they were moderately correlated with performance for men, $r(33) = 0.40$, $p = .02$.

Specifically, self-beliefs were highly correlated with performance for women under threat, $r(18) = 0.74$, p= .01, and moderately correlated for women under no threat, $r(17) = 0.51$, p = .001. In addition, self-beliefs were marginally correlated with performance for men under threat, $r(16) = 0.39$, p = .08. However, self-beliefs were not correlated with performance for men under no threat, $r(17) = 0.17$, p = .63.

Discussion of Study 2 Results

Although I did not find the three-way interaction that I predicted in Study 2, further exploration shows that I did find patterns for women which were consistent with some of my predictions. Specifically, women who used third-person imagery to visualize a past success and then encountered threat showed patterns suggesting they were not experiencing deficits in performance, belonging, or math self-beliefs. However, the three-way interaction (perspective X threat X gender) and the two-way interaction (perspective X threat) for each gender were not statistically significant, suggesting that I can only cautiously speculate on this pattern of means.

In addition, in this study I found a consistent main effect of perspective where third-person imagery led to higher performance, belonging, and math self-beliefs than first-person imagery. Given that this effect did not depend on threat or gender, it suggests a more broad application of third-person imagery. Consistent with other research on third-person imagery, imagining events from the third-person perspective could have positive benefits beyond instances of stereotype threat (Libby, Shaeffer, Eibach, & Slemmer, 2007; Grossmann & Kross, 2014).

In addition, participants might not have experienced strong stereotype threat in this study. Although in the lab I was able to control for many of the environmental cues that might have been influencing the results in Study 1, I might have inadvertently controlled for the very aspects that create stereotype threat.

For example, Study 2 was run in classrooms in the psychology building, where participants might not have been very concerned about the assessment of their math skills. In addition, participants might not have felt much evaluative pressure since they did not know the researcher or experimenter, whereas in Study 1, participants performed the study in the same room as their math classmates and professor.

Finally, although all participants in Study 2 were STEM majors, they were not all from the same year or math background. Therefore, they likely experienced variable amounts of stereotype threat-consistent cues in their background and daily life. In addition, this may have led to a sample containing more advanced math students. Since stereotype threat is more likely with a difficult (vs. easy) test (Spencer et al, 1999), it might be the case that the more skilled students in Study 2 were not as likely to experience stereotype threat on the same test we used in Study 1.

Therefore, it might be the case that many of the participants in Study 2 were not actually experiencing strong stereotype threat. This potential difference, along with finding that on average participants performed better after third-person (vs. first-person) imagery, suggests that third-person imagery might be more broadly helpful to people in situations that are less difficult or at least only slightly anxiety-provoking.

However, the pattern of means of these results at least does not contradict with my predictions for women under stereotype threat, suggesting that future research is necessary to clarify these results.

Chapter 4: General Discussion

Two experiments demonstrate evidence suggesting that women who use third-person (vs. first-person) imagery to visualize a past math success might be better able to perform under stereotype threat. Study 1 examined students in a real math classroom and revealed that women who used third-person (vs. first-person) imagery were equally able to perform when under threat as when under no threat. However, results from this study did not clearly suggest a different effect for men, which would be expected if the pattern for women reflected stereotype threat. Therefore, Study 2 extended these results by examining the effects in a controlled lab setting with a wider range of STEM students. Study 2 again suggested through its pattern of means that women who used third-person (vs. first-person) imagery might be able to perform well under threat, as well as feel more belonging in math settings and indicate more math-related self-beliefs, though these results did not reach significance. In addition, results for men were again not significantly different from women. In fact, on average, people experienced higher performance, belonging, and math self-beliefs when they engaged in third-person (vs. first-person) imagery, regardless of threat or gender. These findings suggest that third-person imagery may be more broadly helpful in certain situations, even beyond stereotype threat. The following sections discuss some questions inspired by the results of these two studies and propose plans for future research to closely examine these questions. In addition, these sections integrate the findings of the present research with existing research in imagery perspective and stereotype threat.

Future Research Directions

Given that there are many potential reasons why I did not find all of my predicted effects in these two studies, future research can explore these potential factors and provide converging evidence for the actual processes at work in these situations.

Sample recruitment. First, these and future studies could benefit from recruiting a larger sample in order to gain statistical power to most effectively explore the potential mechanisms and effects. However, obtaining these samples might be difficult given the nature of the problem; groups under stereotype threat tend to disidentify with and leave the fields where they are stereotyped against (Major, Spencer, Schmader, Wolfe, & Crocker, 1998; Steele, James, & Barnett, 2002), and therefore they are relatively few in number (US Department of Commerce, 2011). Ideally, however, future studies could recruit a large number of women who are highly math-identified STEM majors currently in at least one STEM class, as these women would be embedded daily in the environmental cues which contribute to stereotype threat. Therefore, these women are the most susceptible to falling prey to stereotype threat and also stand the most to gain from this intervention.

It would also be important to recruit students of a similar year in classes (unlike in Study 2) in order to avoid potential differences in the exposure to stereotype threat-consistent cues in their career as well as potential differences in perceived difficulty of the tests. Stereotype threat effects seem to be strongest when stigmatized group members encounter a difficult (vs. easy) test (Spencer et al, 1999), although some work suggests that test difficulty only affects the anxiety that people feel and not their actual performance (Stricker & Bejar, 2004). In any case, recruiting a highly math-identified large sample of participants who have current experience in STEM fields could help gain enough statistical power to clarify the processes at work in these situations.

Exploring mediation. An ideal sample could also allow better exploration of the proposed mediator – self-beliefs – which could also be measured differently in future studies for converging evidence. These two studies do not have sufficient statistical power to fully explore mediation by self-beliefs, even though they show correlations between self-beliefs and performance that are not inconsistent with this hypothesis. Future studies could more fully explore this process by increasing sample size as well as by varying how they measure self-beliefs. For example, future studies could include more sensitive measures that can capture more subtle changes in self-beliefs instead of the relatively stable measures used here. I asked participants whether they were a math kind of person or good at math in general, which might be too stable of a measure to truly capture the potentially small changes in math-related self-concept created by our manipulations (particularly when these changes are measured by 5-point Likert scales).

In addition, future research could explore self-beliefs related not only to the ability but also to the group. Although I predicted that third-person imagery of a past math success would lead women to tie that skill to their overall self-concept, it could also lead women to make other inferences about their self-concept. Measures of gender identification (vs. just domain identification as in these studies) could explore whether our manipulations also lead women to identify less with the ingroup (i.e., females) as protection against the negative stereotype that applies to their ingroup, consistent with previous work showing that women who were strongly identified with math responded to stereotype threat by disavowing some feminine characteristics (Pronin, Steele, & Ross, 2004). Such measures would allow us to gain evidence for the proposed mechanism for women, but could also potentially explore this and other potential mechanisms for men.

Potential explanations for men. Given that men do not significantly show consistent effects across these two studies, it is hard to know exactly what they are experiencing; however, future research can manipulate different factors in order to explore the processes at work in men in these situations.

Specifically, future research could manipulate situational cues, given that non-traditional cues in the environment can induce more general social identity threat in the traditionally favored group (Murphy & Walton, 2013; Boucher & Murphy, 2015). For example, men who thought they would be evaluated on their math performance by a female tutor (a non-traditional authority figure in the math field) experienced decreased performance on a math task compared to men who thought they would be evaluated by a male tutor, consistent with stereotype threat effects (Murphy, 2015). Broadly, any threat to the sense that one's group belongs and succeeds in that context might create social identity threat (Walton & Cohen, 2007; Murphy & Walton, 2013; Boucher & Murphy, 2015; Walton, Murphy, & Ryan, 2015; Murphy & Zirkel, in press).

In Study 2 specifically, the psychology research building might have served as a non-traditional cue since women outnumber men in psychology (and therefore likely more women than men were represented in the building that day). In addition, Study 2 was inadvertently tied to the researcher's (female) name through the sign-up email sent to participants, even though the actual study was run by a male experimenter. If participants noticed these details, these non-traditional cues might have lessened the stereotype threat felt by women and also created a weak social identity threat in men that led to the potential (though not significant) effects they demonstrate in these studies.

Future research can directly manipulate (and otherwise control for) these situational cues in order to explore these hypotheses more thoroughly. For example, one study could manipulate perspective in a similar way (first- vs. third-person perspective) as well as threat in a new way – through the presence or absence of nontraditional cues. If men show decreased performance when non-traditional cues are present (i.e., when they are feeling threat) -- and then show no more deficits when we first have them visualize a past success from the third-person perspective -- they in fact might be experiencing broad social identity threat in this situation as well as in our studies. However, if men show similar patterns of performance deficits even when traditional cues are present (and non-traditional cues are controlled for), that suggests they might be experiencing something else entirely in these situations which is causing their performance to suffer when encountering the stereotype threat information.

Different manipulations to further explore the processes at work for threat. In order to support the idea that stereotype threat actually is occurring in these situations (at least for women if not also for men), future studies should use different manipulations of threat and different measures of performance for convergent validity. These conceptual replications could help show that third-person imagery of successes actually alleviates stereotype threat in a bevy of situations, not just in this particular context with this particular test. In addition, future studies could explore these hypotheses for different stereotypes and different groups, showing that these effects are not specific to gender comparisons or math skills but instead can be broadened to any individual who is threatened by an unfair negative stereotype about their group.

Different manipulations of threat could also disentangle which parts of the current manipulation are necessary or sufficient to create threat in the stigmatized individuals as well as clarify whether visual imagery perspective acts on one particular part. Although these studies used mostly explicit cues to endorse stereotype threat (increasing evaluative concern, indicating this test is biased, endorsing the relevant stereotype and its direction, requiring people to indicate their group membership), certain cues -- both in research and real-world situations -- could be called upon more in associative processing, therefore becoming more harmful if people are using first-person imagery which facilitates this associative processing, particularly if these cues are available at the time of the imagery.

For example, if women were engaging in imagery and then taking a math test in an environment well-known for its bias against women, the environment might be able to cue a strong negative association between their ingroup and the skill. Based on the proposed model of how imagery perspective functions, this strong negative association might be called upon more in first-person imagery when processing the visualized event, thereby potentially further undermining women's potential to perform up to ability.

However, these associations may not be enough to change performance under stereotype threat. Although some have suggested that stereotype threat might operate through evaluative associations toward the skill (Kawakami, Steele, Cifa, Phills, & Dovidio, 2008), other models of stereotype threat have suggested that performance impairments might operate mostly through broad beliefs affecting processing capacity (Schmader et al, 2008; Forbes & Schmader, 2010). Specifically, when threatened, women who were trained to have a positive attitude toward math by strengthening the associations between “I like” and “math” were in fact more motivated to choose to work on math problems, but this training had no effect on their working memory capacity or actual math performance. Instead, women who were trained to pair their gender group (females) with high math ability, thereby changing the broad stereotype at play, experienced increased working memory capacity which also led to higher performance (Forbes & Schmader, 2010). This work suggests that changing propositional (vs. associative) information, such as stereotypes about the group, might be more effective in relieving performance deficits in situations of stereotype threat. This supports my theoretical predictions that third-person (vs. first-person) imagery, which facilitates more broad propositional processing, might be best for protecting stigmatized individuals against the performance deficits that arise from situations of threat.

However, future research will be needed to disentangle which of these threat cues might be called upon more in associative or propositional processing in order to most effectively know how stereotype threat is operating as well as when the proposed intervention would work best to protect stigmatized individuals against stereotype threat.

Additional manipulations to explore the process at work for imagery perspective. The content of the imagery could also change whether this intervention works and shed light on the process behind these effects. Future research could manipulate whether people visualize past successes (as in the current work) or past failures.

Even the most successful STEM student might be inclined to remember their past failures, particularly when faced with stereotype threat-consistent cues and situations; could visualizing these failures from different perspectives have particularly helpful or detrimental effects? Imagining a failure from the third-person perspective could be even more detrimental to people than imagining a failure from the first-person perspective, since it allows for processing the event in terms of broader connections with the self, thereby potentially connecting the failure to abstract ideas about the self. In cases of stereotype threat, this broad sense of failure could be particularly harmful for performance under threat.

In contrast, first-person (vs. third-person) imagery of failures could actually be beneficial since it would allow people to highlight the concrete features of the one instance they failed, without broadly connecting such negativity to their overall sense of self. This prediction, along with the proposed model of imagery perspective, contradicts other models which suggest that first-person (vs. third-person) imagery will be more immersive and therefore more personally relevant or emotionally impactful (Pronin & Ross, 2006; Sanitioso, 2008; McIsaac & Eich, 2002; McIsaac & Eich, 2004). Particularly for negative events such as failures, other models predict that third-person (vs. first-person) imagery will always help distance the self from the negative experience (Kross & Ayduk, 2011; Kross & Grossman, 2012). In contrast, I predict that this effect will depend on the content of the broad propositional beliefs that people have about themselves and the event, such that negative events might be harmful when visualized from the third-person (vs. first-person) perspective if people are considering broader abstract information about themselves (as in my manipulations) instead of just distancing the event from themselves (as in some other perspective manipulations, see Kross & Ayduk, 2011).

In addition, the results from Study 2 suggest that third-person imagery might be more broadly helpful in situations that are less anxiety-provoking than stereotype threat, particularly since in these easier situations, people might already have some positive broad self-beliefs. Specifically, on average, participants who used third-person (vs. first-person) imagery performed better on the math test, and this effect did not depend on threat or gender. This effect of imagery perspective might have occurred because participants were not actually experiencing strong stereotype threat. Stereotype threat is more likely with difficult (vs. easy) tests (Spencer et al, 1999), and participants in Study 2 were recruited from a wider pool including more advanced math students who might have found the test less difficult than our participants in Study 1 (who were all in the same sophomore-level math class). Therefore, the results from these studies suggest that third-person (vs. first-person) imagery could be broadly helpful in situations that are not as difficult or do not provoke as much anxiety as strong stereotype threat. In these situations, third-person (vs. first-person) imagery of success might help all people integrate that success with their broader sense of self, which in turn would boost their performance in the present – so long as they were not impaired by other barriers of difficulty or threat. This interpretation is consistent with previous imagery perspective research showing that third-person (vs. first-person) imagery can positively impact behaviors such as goal pursuit (Libby et al, 2007; Vasquez & Buehler, 2007). However, the results from these two studies suggest that this broad positive effect of third-person imagery might depend on the perceived difficulty or anxiety in a situation, since this effect only emerges in Study 2 where participants might not have been as anxious about or challenged by the test.

Future research manipulating the specific content of the imagery (and whether it is negative or positive) and the difficulty of the test can explore the mechanism behind this potential broad effect, therefore adding evidence to how visual imagery perspective is actually operating for individuals in this situation.

The timing of the imagery and threat information is another important aspect of this intervention to further explore in order to clarify when it would work most effectively. Future research could manipulate the order in which participants receive the imagery and timing tasks in order to investigate whether different information gets incorporated into the processing of the visualized event.

Based on the model of imagery perspective outlined above, it is possible that different information might be available (and thus processed) if I change the timing of the perspective visualization task. I predict that telling students about the stereotype *before* the visualization task might actually make third-person imagery backfire since stereotypes would be more broad propositional information that could be called upon when using third-person imagery. Therefore, students who were using third-person imagery -- even to visualize a past success -- might incorporate the broad negative belief about their group with their own sense of self, thereby intensifying their own experience of stereotype threat and potentially impairing their ability to perform even more.

This timing manipulation highlights the importance of evaluating both the associative and propositional information available to influence processing at the moment of imagery. For example, some researchers have argued that a consistent sense of self can emerge at an implicit or associative level (Greenwald, Banaji, Rudman, Farnham, Nosek, & Mellott, 2002; Gawronski, Strack, & Bodenhausen, 2009). Therefore, if stigmatized individuals already held strong associations about themselves, their ability, or their identification with their group, these associations could be particularly influential when using first-person imagery, given that first-person imagery facilitates processing of an event in terms of its immediate and concrete associations. For example, a woman who has a strong negative association between herself and her math ability might activate these negative associations when using first-person imagery, even if the visualized event is positive. Further, if stigmatized individuals have a strong propositional belief that contradicts their strong associations, the two types of imagery would lead to different outcomes. For example, even if a woman has a propositional belief that contradicts her negative associations (e.g., she knows that she actually has performed relatively well in math), this belief might not be activated enough during first-person (vs. third-person) imagery to protect against the negative associations that would be highlighted in this type of imagery. In contrast, if a woman has a propositional belief that might be particularly harmful (e.g., she has been told that women are bad at math – as implied in the manipulations of threat in these two studies), this information would be particularly harmful to her performance if incorporated during third-person (vs. first-person) imagery.

Again, future research can explore these manipulations, potentially adding evidence to support my current theoretical predictions for how visual imagery perspective functions specifically in situations of stereotype threat as well as more generally in all situations.

Broader Implications

Broad theoretical implications for visual imagery perspective. In addition to specifically showing that visual perspective manipulations might be able to protect women against stereotype threat, this work broadly suggests supporting evidence for the current model of visual imagery perspective and its potential to change behavior. Although future research will be required to strengthen the argument, this work shows some initial evidence that third-person imagery is facilitating processing which allows individuals to incorporate a visualized success with their overall sense of self. In the context of these studies, this processing can be protective against stereotype threat if the imagery is positive and comes before the threat information. No such protective processing effect occurs with first-person imagery, suggesting that first-person imagery is facilitating more concrete, associative processing than propositional processing.

Broad theoretical implications for stereotype threat. These studies also shed light on the propositional information available in stereotype threat contexts, which could be potentially useful for future research on stereotype threat, the process by which it functions, and the interventions by which it can be interrupted. Specifically, these studies suggest that stereotype threat is occurring through the presence of links between self, ability, and ingroup, since I was able to strengthen the link between self and ability and thereby inhibit performance deficits. Given that this link was strengthened through third-person (vs. first-person) imagery, this lends support to the idea that propositional information is key to creating stereotype threat performance deficits, consistent with some previous research (Schmader et al, 2008; Forbes & Schmader, 2010).

Results from these two studies also support previous research exploring the mechanism behind stereotype threat, adding evidence to the model outlining the importance of the links between self, ability, and ingroup in creating stereotype threat (Schmader et al, 2008).

In addition, these studies add to that model by suggesting that if certain propositional information that is relevant to these links is given or changed before encountering threat, stereotype threat might not actually occur. Specifically, when women were provided with information suggesting that they were successful at math (through visualizing a past success), they did not experience the typical stereotype threat deficits -- as long as they were encouraged to integrate that information with their broad sense of self (i.e., by using third-person imagery vs. first-person imagery). Therefore, situations and interventions that clue people into more harmful or stereotypical broad propositional information, such as informing women that they might underperform in math or highlighting past times of difficulty with math, might actually exacerbate the consequences of stereotype threat. In addition, these results suggest that interventions that focus on people's associations, such as training women to feel more positively toward math, might not be as effective at preventing stereotype threat as interventions that focus on people's broader beliefs – at least without an additional aspect that integrates this information more broadly with the skill, the ingroup, or the self.

In addition, though future research will be required to fully explore these ideas, this work begins to further explore the question of whether stereotype threat is actually just broad social identity threat or something more specific. Though my predictions focus on women in a stereotype threat context, these results raise the possibility that a broader social identity threat might be at work for men. Specifically, men in our studies might have noticed "nontraditional" cues (whether from their classroom environment or our experimental environment) such as higher numbers of women in this STEM context. These cues might have indicated to men that their group was no longer at a secure advantage in math compared to women, thereby creating a sense of potential threat to their identity when they knew they were going to be compared to women (i.e., in the threat conditions). This identity threat could have then caused men to also experience performance deficits when they read threat information (vs. when they read no threat information), which they were then protected against after visualizing a past success from the third-person (vs. first-person) perspective – similar to our predictions for women. However, given that this pattern was not significantly consistent across studies, future research will be required to explore whether men are actually experiencing identity threat in these situations. In any case, it is unclear exactly what men are experiencing in my studies, and future research will be required to shed light on the processes that visual imagery perspective might be facilitating for these men.

Regardless of what is occurring with men, the results for women suggest that -- despite some arguments to the contrary (see Ceci, Ginther, Kahn, & Williams, 2014) -- unfortunately this stereotype about women's math ability is still active enough that it can impair the performance of women in STEM fields under stereotype threat.

Practical Applications

Although this work unfortunately adds evidence suggesting stereotypes still exist and can be harmful, it also provides some hope through evidence for a new intervention that protects against this stereotype. Past interventions have largely dealt with the nature of the test and how it is presented, but that focus puts the power to stop stereotype threat effect in the hands of administrators instead of the women themselves. My research instead focuses on a manipulation (i.e., visual imagery perspective) that each woman can use without waiting for the system to change.

In addition, my manipulation reaches across other typical boundaries to implementing change, requiring no extra equipment or technology, working across all languages, and being completely free and instantly accessible. This manipulation also has the added strength of being applicable to women of all ages, socioeconomic statuses, and geographical locations, so it could be used to the advantage of many (often understudied) groups of women both in the US and abroad. Therefore, this work could have important implications for women across the world in STEM fields.

Conclusion

Unfortunately, women in STEM today still have to fight against negative stereotypes about their group's ability; however, this work provides hope in the form of third-person success imagery. This work provides a new hope because many of the current interventions for women in STEM require long-term institutional changes, which are likely to encounter some administrative and financial hurdles. At the least, these interventions would take time and energy on the part of the administrators and potential mentors in the hierarchy above the stigmatized individuals themselves. The intervention explored in this research suffers from none of those problems, and instead it puts the power in the hands of the stigmatized individuals themselves.

The research presented here also broadly adds to work exploring the processing styles that visual imagery perspective invokes as well as the downstream consequences of visualizing events from first- and third-person perspective. In addition, this research adds to work exploring the consistencies behind stereotype threat and how it might operate, so that we can better understand how to protect against it.

Future research is still needed to clarify the mechanisms behind the effects in these studies as well as to add converging evidence to the results, but these two studies provide evidence toward a promising intervention for women in STEM today.

References

AAUW. (2008). *Where the girls are: The facts about gender equity in education*, by C. Corbett, C. Hill, & A. St. Rose. Washington, DC: Author.

AAUW . (2010). *Women in Science, Technology, Engineering, and Mathematics*, by C. Hill, C., Corbett, & A. St. Rose. Washington, DC: Author.

Beilock, S. L., Rydell, R. J., & McConnell, A.R. (2007). Stereotype threat and working memory: Mechanisms, alleviation, and spillover. *Journal of Experimental Psychology: General, 136,* 256–276.

Blascovich, J., Spencer, S. J., Quinn, D. M, & Steele, C. M. (2001). African-Americans and high blood pressure: The role of stereotype threat. *Psychological Science, 12,* 225-229.

Boucher, K.L., & Murphy, M.C. (in press). Why so few?: The role of social identity and situational cues in understanding the underrepresentation of women in STEM fields. In Mavor, K.I., Platow, M., & Bizumic, B. (Eds.). *Self, Social Identity, and Education*. Psychology Press: New York, NY.

Brainard, S. G., & Carlin, L. (1998). A six-year longitudinal study of undergraduate women in engineering and science. *Journal of Engineering Education, 87(4),* 369-375.

Brewer, W. F. (1988). Memory for randomly sampled autobiographical events. In U. Neisser & E. Winograd (Ed.), *Remembering reconsidered: Ecological and traditional approaches to the study of memory* (pp. 21-90). Cambridge: Cambridge University Press.

Brown, R. P. & Day, E.A. (2006). The difference isn't black and white: Stereotype threat and the race gap on Raven's Advanced Progressive matrices. *Journal of Applied Psychology, 91,* 979-985.

Brown, R. P. & Pinel, E. C. (2003). Stigma on my mind: Individual differences in the experience of stereotype threat. *Journal of Experimental Social Psychology, 39,* 626-633.

Ceci, S. J., Ginther, D. K., Kahn, S., & Williams, W. M. (2014). Women in academic science: A changing landscape. *Psychological Science in the Public Interest, 15(3),* 75-141.

Ceci, S. J., Williams, W. M., & Barnett, S. M. (2009). Women's underrepresentation in science: Sociocultural and biological considerations. *Psychological Bulletin, 135,* 218-261.

Conway, M. A. (1996). Autobiographical memories. In E. Bjork & R. Bjork (Eds.), *Handbook of perception and cognition: Vol. 10. Memory* (pp. 165-194) Orlando, EL: Academic Press.

Danaher, K., & Crandall, C. S. (2008). Streotype threat in applied settings re-examined. *Journal of Applied Social Psychology, 38(6),* 1639-1655.

Delgado, A. R. & Prieto, G. (2008). Stereotype threat as validity threat: The anxiety-sex-threat interaction. *Intelligence, 36,* 635-640.

Forbes, C. E. & Schmader, T. (2010). Retraining attitudes and stereotypes to affect motivation and cognitive capacity under stereotype threat. *Journal of Personality and Social Psychology, 99,* 740-754.

Fritz, M. S. & MacKinnon, D. P. (2007). Required sample size to detect the mediated effect. *Psychological Science, 18,* 233-239.

Gawronski, B., Strack, F., & Bodenhausen, G. V. (2009). Attitudes and cognitive consistency: The role of associative and propositional processes. In R. E. Petty, R. H. Fazio, & P. Briñol (Eds.), *Attitudes: Insights from the new wave of implicit measures* (pp.85-117). New York: Psychology Press.

Good, C., Aronson, J., & Harder, J. A. (2008). Problems in the pipeline: Stereotype threat and women's achievement in high-level math courses. *Journal of Applied Developmental Psychology, 29,* 17-28.

Greenwald, A. G., Banaji, M. R., Rudman, L. A., Farnham, S. D., Nosek, B. A., & Mellott, D. S. (2002). A unified theory of implicit attitudes, stereotypes, self-esteem, and self-concept. *Psychological Review, 109(1),* 3-25.

Grossmann, I., & Kross, E. (2014). Exploring 'Solomon's paradox": Self-distancing eliminates the self-other asymmetry in wise reasoning about close relations in younger and older adults. *Psychological Science, 1,* 1-10.

Halpern, D. F., Benbow, C. P., Geary, D. C., Gur, R. C., Hyde, J. S., & Gernsbacher, M. A. (2007). The science of sex differences in science and mathematics. *Psychological Science in the Public Interest, 8(1),* 1–51.

Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach.* New York, NY: The Guilford Press.

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

Johns, M., Inzlicht, M., & Schmader, T. (2008). Stereotype threat and executive resource depletion: Examining the influence of emotion regulation. *Journal of Experimental Psychology: General, 137,* 691–705.

Johns, M., Schmader, T., & Martens, A. (2005). Knowing is half the battle: Teaching stereotype threat as a means of improving women's math performance. *Psychological Science, 16,* 175–179.

Kawakami, K., Steele, J.R., Cifa, C., Phills, C.E., & Dovidio, J.F. (2008). Approaching math increases math = me and math = pleasant. *Journal of Experimental Social Psychology, 44,* 818–825.

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

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

Kross, E., & Ayduk, O. (2011). Making meaning out of negative experiences by self-distancing. *Current Directions in Psychological Science*, 20(3), 187-191.

Kross, E., & Grossmann, I. (2012). Boosting wisdom: Distance from the self enhances wise reasoning, attitudes, and behavior. *Journal of Experimental Psychology: General*, 141, 43–48.

Libby, L. K., & Eibach, R. P. (2011). Visual perspective in mental imagery: A representational tool that functions in judgment, emotion, and self-insight. In M.P. Zanna and J.M. Olson (Eds.), *Advances in Experimental Social Psychology* (Vol. 44, pp. 185–245). San Diego: Academic Press.

Libby, L. K., Shaeffer, E. M., & Eibach, R. P. (2009). Seeing meaning in action: A bidirectional link between visual perspective and action identification level. *Journal of Experimental Psychology: General, 138*, 503–516.

Libby, L. K., Shaeffer, E. M., Eibach, R. P, & Slemmer, J. A. (2007). Picture yourself at the polls: Visual perspective in mental imagery affects self-perception and behavior. *Psychological Science, 18,* 199-203.

Libby, L. K., Valenti, G., Hines, K. A., & Eibach, R. P. (2014). Using imagery perspective to access two distinct forms of self-knowledge: Associative evaluations versus propositional self-beliefs. *Journal of Experimental Psychology: General, 143,* 492–497.

Lubinski, D., & Benbow, C. P. (2006). Study of mathematically precocious youth after 35 years: Uncovering antecedents for the development of math-science expertise. *Perspectives on Psychological Science, 1(4),* 316–45.

Major, B., Spencer, S. J., Schmader, T., Wolfe, C. T., & Crocker, J. (1998). Coping with negative stereotypes about intellectual performance: The role of psychological disengagement. *Personality and Social Psychology Bulletin, 24,* 34-50.

Martens, A., Johns, M., Greenberg, J., & Schimel. (2006). Combating stereotype threat: The effect of self-affirmation on women's intellectual performance. *Journal of Experimental Social Psychology, 42,* 236-243.

Marx, D. M., & Goff, P. A. (2005). Clearing the air: The effect of experimenter race on target's test performance and subjective experience. *British Journal of Social Psychology, 44,* 645-657.

Marx, D. M., & Roman, J. S. (2002). Female role models: Protecting women's math test performance. *Personality and Social Psychology Bulletin, 28,* 1183-1193.

McIntyre, R. B., Paulson, R., & Lord, C. (2003). Alleviating women's mathematics stereotype threat through salience of group achievements. *Journal of Experimental Social Psychology, 39,* 83-90.

McIsaac, H. K., & Eich, E. (2002). Vantage point in episodic memory. *Psychonomic Bulletin & Review, 9,* 144–150.

McIssac, H.K., & Eich, E. (2004). Vantage point in traumatic memory. *Psychological Science*,15, 248-253.

Murphy, M.C. & Walton, G.M. (2013). From prejudiced people to prejudiced places: A social-contextual approach to prejudice. In Stangor, C. & Crandall, C. (Eds.).

Frontiers in Social Psychology Series: Stereotyping and Prejudice. Psychology Press: New York, NY.

Murphy, M.C. & Zirkel, S. (in press). Race and belonging in school: How anticipated and experienced belonging affect choice, persistence, and performance. *Teachers College Record*.

Murphy, M.C., & Taylor, V.J. (2011). The role of situational cues in signaling and maintaining stereotype threat. To appear in Inzlicht, M. & Schmader, T. (Eds.). *Stereotype Threat: Theory, Process, and Applications.* Oxford University Press: New York, NY.

Murphy, M. C. (2015). *The fragility of fit: Diverse environments shape the concerns, belonging, and performance of women and men in STEM settings*. Manuscript in preparation.

Nigro, G., & Neisser, U. (1983). Point of view in personal memories. *Cognitive Psychology, 15,* 467–482.

National Science Foundation. Division of Science Resources Statistics. (2009). Women, minorities, and persons with disabilities in science and engineering: 2009 (NSF 09-305). Arlington, VA: Author. Retrieved March 30, 2015, from www.nsf.gov/statistics/wmpd.

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

Pronin, E., & Ross, L. (2006). Temporal differences in trait self-ascription: When the self is seen as an other. *Journal of Personality and Social Psychology, 90(2),* 197-209.

Pronin, E., Steele, C., & Ross, L. (2004). Identity bifurcation in response to stereotype threat: Women and mathematics. *Journal of Experimental Social Psychology, 40,* 152-168.

Ripley, A. (2005). Who says a woman can't be Einstein? *Time, 165*, 51–60.

Rosenthal, H. E. S., Crisp, R. J., & Suen, M. W. (2007). Improving performance expectancies in stereotypic domains: Task relevance and the reduction of stereotype threat. *European Journal of Social Psychology, 37,* 586-597.

Rydell, R. J., McConnell, A. R., & Beilock, S. L. (2009). Multiple social identities and stereotype threat: Imbalance, accessibility, and working memory. *Journal of Personality and Social Psychology, 96(5),* 949-966.

Sanitioso, R. B. (2008). Motivated self and recall: Visual perspectives in remembering past behaviors. *European Journal of Social Psychology, 38(3),* 566-575.

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

Schmader, T., Forbes, C.E., Zhang, S., & Mendes, W.B. (2009). A meta-cognitive perspective on the cognitive deficits experienced in intellectually threatening environments. *Personality and Social Psychology Bulletin, 35,* 584–596.

Schmader, T. (2002). Gender identification moderates stereotype threat effects on women's math performance. *Journal of Experimental Social Psychology, 38,* 194-201.

Schmader, T. (2010). Stereotype threat deconstructed. *Current Directions in Psychological Science, 19,* 14-18.

Schmader, T., Johns, M., & Forbes, C. E. (2008). An integrated process model of stereotype threat effects on performance. *Psychological Review, 115,* 336–356.

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

Shaeffer, E. M., Libby, L. K., & Eibach, R. P. (2015). *Changing visual perspective changes processing style: A unique pathway by which imagery guides cognition.* Manuscript submitted for publication.

Shih, M., Pittinsky, T. L, & Ambady, N. (1999). Stereotype susceptibility: Identity salience and shifts in quantitative performance. *Psychological Science, 10,* 80-83.

Singer, J.A., & Salovey, P. (1993). *The remembered self: Emotion and memory in personality.* New York: Free Press.

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

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

Steele, C. M. (1997). A threat in the air: How stereotypes shape the intellectual identities and performance. *American Psychologist, 52*, 613–629.

Steele, J., James, J.B., & Barnett, R.C. (2002). Learning in a man's world: Examining the perceptions of undergraduate women in male-dominated academic areas. *Psychology of Women Quarterly, 2*, 46–50.

Steele, C. M., Spencer, S. J., & Aronson, J. (2002). Contending with images of one's group: The psychology of stereotype and social identity threat. In M. Zanna (Ed.), *Advances in Experimental Social Psychology.* San Diego: Academic Press.

Stricker, L. J., & Bejar, I. I. (2004). Test difficulty and stereotype threat on the GRE General test. *Journal of Applied Social Psychology, 34,* 563-597

Taylor, V. J., & Walton, G. M. (2011). Stereotype threat undermines academic learning. *Personality and Social Psychology Bulletin, 37(8),* 1055-1067.

O'Leary, M. (2012, March 7). Math gender gap theory faces skepticism from MU professor. *The Columbia Missourian.* Retrieved March 30, 2015 from http://www.columbiamissourian.com

U.S. Department of Commerce. Economics and Statistics Administration. (2011). *Women in STEM: A gender gap to innovation*, by D. N. Beede, T. A. Julian, D. Langon, G. McKittrick, B. Khan, & M. E. Doms. Washington, DC: Author.

U.S. Department of Education. National Center for Education Statistics. (2000). *Entry and persistence of women and minorities in college science and engineering education* (NCES 2000-601), by G. Huang, N. Taddese, & E. Walter. Washington, DC: Author.

U.S. Department of Education. Office for Civil Rights. (2012). *Gender equity in education: A data snapshot*. Washington, DC: Author. Retrieved March 30, 2015 from http://www2.ed.gov/about/offices/list/ocr/docs/gender-equity-in-education.pdf.

Valenti, G., Libby, L. K., & Eibach, R. P. (2011). Looking back with regret: Visual perspective in memory images differentially affects regret for actions and inactions. *Journal of Experimental Social Psychology, 47,* 730-737.

Vasquez, N. A., & Buehler, R. (2007). Seeing future success: Does imagery perspective influence achievement motivation? *Personality and Social Psychology Bulletin, 33*, 1392–1405.

Vogt, C. M., Hocevar, D., & Hagedorn, L. S. (2007). A social cognitive construct validation: Determining women's and men's success in engineering programs. *The Journal of Higher Education, 78(3),* 337–64.

Walton, G.M. & Cohen, G.L. (2003). Stereotype Lift. *Journal of Experimental Social Psychology, 39*, 456–467.

Walton, G. M., & Cohen, G. L. (2007). A question of belonging: Race, social fit, and achievement. *Journal of Personality and Social Psychology, 92,* 82-96.

Walton, G. M., Murphy, M. C., & Ryan, A. M. (2015). Stereotype threat in organizations: Implications for equity and performance. *Annual Review of Organizational Psychology and Organizational Behavior, 2,* 1-28.

Wout, D., Danso, H., Jackson, J., & Spencer, S. (2008). The many faces of stereotype threat: Group- and self-threat. *Journal of Experimental Social Psychology, 44,* 792-799.

Wout, D. A., Shih, M. J., Jackson, J. S., & Sellers, R. M. (2009). Targets as perceivers: How people determine when they will be negatively stereotyped. *Journal of Personality and Social Psychology, 96(2)*, 349-362.

Appendix: Items used for the math test in Studies 1 and 2

SECTION 1

11 Questions

Numbers: All numbers used are real numbers

Figures: Position of points, angles, regions, etc. can be assumed to be in the order shown; and angle measures can be assumed to be positive.
Lines shown as straight can be assumed to be straight.
Figures can be assumed to lie in a plane unless otherwise indicated.
Figures that accompany questions are intended to provide information useful in answering the questions. However, unless a note states that a figure is drawn to scale, you should solve these problems NOT by estimating sizes by sight or by measurement, but by using your knowledge of mathematics.

Directions: Each question has five answer choices. For each of these questions, select the best of the answer choices given.

1. The greatest number of diagonals that can be drawn from one vertex of a regular 6-sided polygon is

(A) 2
(B) 3
(C) 4
(D) 5
(E) 6

2. If $0 < st < 1$, then which of the following can be true?

(A) $s < -1$ and $t > 0$
(B) $s < -1$ and $t < -1$
(C) $s > -1$ and $t < -1$
(D) $s > 1$ and $t < -1$
(E) $s > 1$ and $t > 1$

3. On segment *WZ* below, if *WY* = 21, *XZ* = 26, and *YZ* is twice *WX*, what is the value of *XY* ?

```
|------------|------------|------------------------|
W            X            Y                        Z
```

(A) 5
(B) 10
(C) 11
(D) 16
(E) It cannot be determined from the information given.

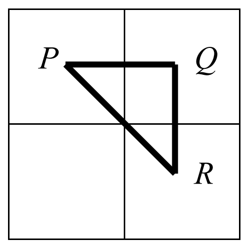
4. To reproduce an old photograph, a photographer charges x dollars to make a negative, $\frac{3x}{5}$ dollars for each of the first 10 prints, and $\frac{x}{5}$ dollars for each print in excess of 10 prints. If \$45 is the total charge to make a negative and 20 prints from a old photograph, what is the value of x ?

(A) 3
(B) 3.5
(C) 4
(D) 4.5
(E) 5

5. Which of the following is equal to $\frac{1}{4}$ of 0.01 percent?

(A) 0.000025
(B) 0.00025
(C) 0.0025
(D) 0.025
(E) 0.25

6. In the figure below, each of the four squares has sides of length x. If ΔPQR is formed by joining the centers of three of the squares, what is the perimeter of ΔPQR in terms of x ?



(A) $2x\sqrt{2}$
(B) $\frac{x\sqrt{2}}{x} + x$
(C) $2x + \sqrt{2}$
(D) $x\sqrt{2} + 2$
(E) $2x + x\sqrt{2}$

7. In a certain shop, notebooks that normally sell for 59 cents each are on sale at 2 for 99 cents. How much can be saved by purchasing 10 of these notebooks at the sale price?

(A) \$0.85
(B) \$0.95
(C) \$1.10
(D) \$1.15

(E) $2.00

8. Which of the following is a solution to $x + x^2 = 1$?

(A) -1
(B) 0
(C) $\frac{1}{2}$
(D) 1
(E) None of the above

9. If the average (arithmetic mean) of 5 consecutive integers is 12, what is the sum of the least and greatest of the 5 integers?

(A) 24
(B) 14
(C) 12
(D) 11
(E) 10

10. If $xy \neq 0, \frac{x-1}{xy} =$

(A) $\frac{1}{x} - \frac{1}{xy}$
(B) $\frac{x}{y} - \frac{1}{xy}$
(C) $\frac{1}{y} - x$
(D) $\frac{1}{y} - \frac{1}{xy}$
(E) $\frac{1}{xy} - \frac{1}{y}$

11. The cost, in dollars, of manufacturing x refrigerators is $9{,}000 + 400x$. The amount received when selling these x refrigerators is $500x$ dollars. What is the least number of refrigerators that must be manufactured and sold so that the amount received is at least equal to the manufacturing cost?

(A) 10
(B) 18
(C) 45
(D) 90
(E) 100