EXPLORING HOW PERCEIVED TRUE SELF-KNOWLEDGE INFLUENCES STRUCTURAL THREAT EFFECTS

by

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A thesis submitted in partial fulfillment
of the requirements for the degree

of

Master of Science

in

Psychological Science

MONTANA STATE UNIVERSITY
Bozeman, Montana

May 2015

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DEDICATION

This thesis is dedicated to two women. The first is the girl at the coffee shop who was never able to pass her last math class in college. The second is to my first math teacher who has always been my true motivator. Thanks, m'um.

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ABSTRACT

Despite no evidence of inherent ability differences between men and women, women continue to be underrepresented in Science, Technology, Engineering, and Math (STEM) fields. One (of several) factor that contributes to this underrepresentation is the negative effects that heightened concerns about being the target of stereotypes (i.e., stereotype threat) has on women's performance and motivation to persist in math-relevant fields. My thesis assessed whether perceived true self-knowledge – or the feeling of knowing who one really is - might buffer women from the negative effects of stereotype threat. Female participants (N = 133) were brought into the lab where they first completed a perceived true self-knowledge measure. Participants were then exposed to a math-relevant stereotype threat manipulation and subsequently completed primary outcome measures of math performance, interest in math, and the adoption of maladaptive goal orientations in math. I hypothesized that stereotype threat would decrease math performance, reduce interest in math, and increase the adoption of maladaptive goal orientations (i.e., performance avoidance goals), but only among participants low in perceived true self-knowledge. Participants high in true self-knowledge were expected to be buffered from these effects. The results did not support these predictions. However, the results may be inconclusive due to the ineffectiveness of the stereotype threat manipulation utilized. The discussion focuses on recommendations for future studies that might more effectively test the hypotheses under scrutiny.

INTRODUCTION

Evidence for the importance of workforce gender diversity is strong. Herring (2009), for example, found that a more gender diverse workforce is associated with higher revenue, a wider customer base, increases in the market share of a company, and greater profit margins relative to competitor companies. Similarly, Woolley et al. (2010) found that, as the proportion of women in a work group increases, so too does the performance of the group on tasks such as brainstorming, reasoning, and goal planning. Despite these benefits, women's representation in organizational contexts is lacking, particularly in the fields of science, technology, engineering, and mathematics (STEM). Indeed, recent research has found that women only occupy 26% of jobs in STEM fields (National Science Foundation, 2013). Related to and perhaps contributing to this problem are the significant achievement gaps that exist between men and women in mathematics and mathematics related fields (Nelson & Brammer, 2010). Math is a critical area in all STEM fields and is important as people climb the STEM career ladder (Culotta & Gibbons, 1992). Yet, research shows that women are not only underrepresented in math majors (Bressoud, 2009), they also tend to perform worse on math achievement tests (i.e., the SAT; College Board, 2013), despite showing no inherent differences in overall math ability (Hyde et al., 1990). Given the centrality of math in STEM, the purpose of the proposed experiment is to investigate a previously unrecognized factor that might protect women from factors that contribute to these math performance deficits. I will integrate research on stereotype threat and perceived true self-knowledge (i.e., who one thinks they really are) to do so.

Stereotype Threat and Its Impact on Women in STEM

I approach the issue of female underrepresentation in STEM through the social psychological perspective of stereotype threat (ST). ST occurs when one feels at risk of "being negatively stereotyped," "judged or treated stereotypically," or "confirming to the stereotype" (Steele, 1998, p. 614). For example, there is a common stereotype that women are worse at math than men. Previous research indicates that when women feel at risk of confirming to this stereotype, their performance and commitment to math-relevant domains can suffer (e.g., Smith & White, 2002; Good, Aronson, & Harder, 2008). One prototypical study (Spencer, Steele, & Quinn, 1999), for example, informed a group of high achieving male and female math students that they would be taking two tests. For half the students, the first test was reported to have shown gender differences in performance and the second test was not. The other half of students were told that the first test was not reported to show gender differences, where as the second test was reported to show gender differences in performance. As predicted, when women received the instruction that there was a gender difference in performance on a test, they performed significantly worse than their male counterparts. However, when women were told that there was no difference in performance on the math test, this difference in performance disappeared. Thus, highlighting gender differences placed women under heightened threat of confirming the active stereotype and decreased performance relative to men.

Similar research has found that these "stereotype threat" effects can be elicited in a number of other subtle ways. For example, having women merely read the words

"Quantitative Examination" before a math task is sufficient to elicit ST effects that hinder math performance (Schimel et al., 2004), as does simply being a minority in a stigmatized domain (e.g., being a woman in a male-dominated math-relevant context; Inzlicht & Ben- Zeev, 2000). The ST effect is important because it serves as one social psychological explanation as to why women perform worse than men in math relevant-fields, even when no evidence of inherent differences in math ability between men and women exists. More broadly, though, the threat of confirming a negative stereotype represents a contextual factor that can not only impair performance, but a wide variety of other outcomes. These outcomes have implications for women's persistence in STEM fields.

Indeed, while the performance consequences of ST are important for women's interest in math, they do not fully explain the underrepresentation of women in STEM. Research indicates that motivation, goals, identification with STEM, and a sense of belonging within STEM fields can also play important roles in addressing this underrepresentation issue. The Motivational Experiences Model of Stereotype Threat (MEMST; Thoman et al., 2013) was developed to explain how ST affects STEM participation in ways beyond performance deficits. Specifically, the model provides a framework whereby a stigmatized student's motivation to persist in STEM can be understood through the type of goal orientation a student adopts (i.e. avoidance or approach), a student's sense of belonging in a domain, and a student's strength of identification with a domain.

Domain Identification

Identifying with a domain is a very prominent predictor of future choices and level of engagement in a chosen area (e.g., Smith & White, 2001; Osborne & Jones, 2011). Domain identification is the extent to which an individual defines the self through a role or their performance in a particular domain (Osborne & Walker, 2006). Disidentification occurs when an individual lacks a commitment to and begins to actively distance him or herself from a domain (Kreiner & Ashforth, 2004). Domain identification is a critical factor in people's persistence within a particular field and research indicates that ST can lead stereotyped individuals to disidentify with STEM. Longitudinal research, in particular, has provided strong evidence for this process. Woodcock et al. (2012) assessed stereotype vulnerability in 1420 minority students over a three-year period using the stereotype vulnerability scale (Spencer, 1994). Each fall, students completed the stereotype vulnerability scale, which measures the impact of stereotype threat on students' math performance. Along with the stereotype vulnerability measure, participants completed a five-item subscale from the scientific identity scale (Chemers, 2006). These five items measure the level of identification a student has in science. For male and female Hispanic students, stereotype-vulnerability positively predicted scientific disidentification. Further, this disidentification was a negative predictor of intention to pursue a scientific research career. Therefore, the consequences of ST go beyond performance decrements for women in STEM fields. ST can lead to women's disidentification in STEM fields, which in turn negatively predicts STEM dropout.

Interest

According to Thoman et al. (2013), interest refers to a "student's feelings toward and engagement in a task" (p. 225) and is conceptually similar to the construct of intrinsic motivation in that both terms are used to capture the process by which a student focuses their attention and harnesses the resources needed for long-term engagement (Thoman et al., 2013). Interest is important for understanding persistence in STEM because interest positively predicts persistence on tasks and activities (Sansone, Wiebe, & Morgan, 1999). Research indicates that being under ST can negatively impact interest. For example, Smith et al. (2007; Study 1) found that female participants high in achievement motivation were less interested in a computer science task if they were first told that men were better than women at math (i.e., they were placed under ST) and were induced to adopt a goal orientation focused on avoiding the appearance of incompetence (i.e., a performance-avoidance goal orientation; Elliott, 1999) relative to a more adaptive goal orientation. Somewhat similarly, Davies, Spencer, Quinn, and Gerhardstein (2002) found that, when women were exposed to gender stereotypic commercials that activated gender stereotypes, they reported less interest in quantitative careers than women not exposed to stereotypic commercials. These same commercials also undermined women's performance on a math exam in a separate study, suggesting that they do arouse ST. Thus, studies such as these and others (e.g., Forbes & Schmader, 2010; Shapiro et al., 2013) indicate that ST can negatively impact interest in STEM relevant tasks and careers and potentially contribute to the retention of women in STEM.

Goal Adoption

The MEMST also emphasizes that ST can affect the ways that women orient themselves towards their goals (Senko et al., 2008). The model specifically emphasizes the distinction between performance approach and performance avoidance goals (Elliot, 1999). Performance-approach goals are directed to achieve a desirable possible outcome that provides proof of competence to others. Performance-avoidance goals are initiated and directed to avoid negative outcomes that provide proof that one is not *incompetent* to others. Adopting an avoidant goal orientation can be harmful and lead to outcomes such as poor test performance and low levels of interest (Huang, 2011), and research indicates that ST can increase the adoption of performance avoidant goal orientation. Specifically, when female participants are told that women perform poorly compared to men on a upcoming math task, they are more likely to report that they would endorse performance-avoidance goals on a future math task than women who are told that men and women perform equally well on the math task (Smith, 2006). There is also evidence that this heightened endorsement of performance avoidance goals under stereotype threat is especially high for women high in achievement motivation (Smith et al., 2007). The adoption of performance avoidance goals in the presence of ST is important to address because overtime performance avoidance goal adoption, along with a decline in interest (Smith et al., 2007), is associated with the dropout of women in STEM fields (Hernandez et al., 2013).

Belongingness

How certain one feels about their social belonging within a stereotyped domain is

also critical for understanding retention in STEM disciplines (Walton & Cohen, 2007). For example, Cheryan and Plaut (2010) reported that women's consideration of majoring in a STEM field was much lower when they perceived a lack of similarity between themselves and others in the field. Similar research has shown that experimentally inducing belonging uncertainty in a STEM domain can decrease the willingness to continue in that domain (Walton & Cohen, 2007). ST can also directly decrease these feelings of belonging (Murphy, Steele, & Gross, 2007). For example, informing women that an academic field is male-dominated (ST condition) verse gender-equal (control condition) leads to women feeling as though they would need to exert more effort in a field to succeed. These same women also reported feeling less belonging in the stereotyped field, and this low feeling of belonging mediated the relationship between success and low motivation to persist in the stereotyped field (Smith et al., 2013). Therefore, belonging seems to be a critical factor in women's decision to stay in a field they believe they might be stereotyped in.

In summary, negative stereotypes persist for women in STEM fields (Smith & White, 2002), rendering them vulnerable to heightened concerns about being stereotyped and confirming the stereotypes (i.e., stereotype threat). ST helps partially explains why we see unequal representation between men and women in STEM fields, even though evidence for inherent differences in the skills needed for success in STEM fields is non-existent. Experimental research indicates that ST can negatively affect performance (e.g., Aronson et al., 1999), domain identification (e.g., Woodcock et al., 2012), interest in STEM relevant tasks and careers (e.g., Smith et al., 2007), performance goal adoption (e.g., Smith, 2006), and belongingness (e.g., Smith et al., 2013), all of which are

important predictors of persistence in STEM disciplines. Thus, the literature on ST has revealed the importance of alleviating ST threat effects in order to improve STEM participation among women.

Attenuating the Effects of Stereotype Threat

Given the array of ST consequences that may contribute to persistence in STEM among stereotyped groups, the identification of factors and interventions that mitigate ST effects has been a prominent priority (e.g. Fryer, Levitt, & List, 2008; Walton & Cohen, 2007; Cohen & Garcia, 2005). Such factors and interventions are varied; some consist of target specific variables that are affected by ST (e.g., belongingness), while others target the more general integrity of the self-concept (e.g., self-affirmation; Steele, 1988). Regardless of the specific variable targeted, one imperative finding in psychological research is that brief interventions can have substantial and beneficial impacts (Wilson, 2006). For example, having students simply spend 15 minutes writing about their values at the beginning of an academic semester improved stereotyped individuals' GPA by the end of the semester (Cohen et al., 2006). In what follows, I will briefly review research on some of the more common and better-established ST interventions.

Increasing Belongingness

As mentioned above, ST can disrupt a student's sense of belonging in math by eliciting uncertainty about their social connectedness to others in that domain. These feelings of belongingness uncertainty have been linked to a number of consequences for stereotyped individuals, including achievement and motivation (Walton & Cohen, 2007).

In light of these important consequences, researchers have explored whether bolstering a sense of belongingness in stereotyped individuals can eliminate some of the harmful consequences of ST. The evidence suggests that it can. For example, Walton and Cohen (2007) implemented a brief, but effective belongingness intervention. Here, the experimenters targeted doubts of social belonging by informing Black students that these doubts were common across racial groups, and that these doubts are temporary rather than stable. Participants in the control condition were informed that student's social-political views grew to be more sophisticated with time (not addressing social belonging). For those students in the treatment group, this brief intervention increased Black students' engagement in achievement behavior and lead to an improved GPA. In a similar manner, a brief belongingness intervention improved women's GPA in engineering (Walton et al., 2014). In this study, incoming female students to an engineering program read material that emphasized how both men and women are concerned with their social belonging when coming into the engineering program. The material also emphasized that these concerns dissipate with time and eventually most students come to feel at home. This single intervention not only raised women's GPA throughout the course of the year, but it also allowed them to frame daily adversities as challenges they could manage, and led to greater confidence that they could succeed in engineering by their second semester. Thus, interventions that mitigate belongingness uncertainty can be effective at reducing the negative effects of ST.

Providing Role Models

Providing successful role models that face the same ST as stereotyped students

can also successfully buffer against ST. In fact, research has shown that providing this role model can mitigate or even eliminate the effects associated with ST (Blanton, Crocker, & Miller, 2000). Being made aware of an individual who is subject to the same stereotype (e.g., women being worse at math) and is successful in the stereotyped domain (e.g., math) challenges the stereotype about one's group and can protect people from the negative effects of ST. Evidence for the effectiveness of role model interventions is encouraging. For example, Marx and Roman (2002) compared two groups of women, both under ST and both taking a math test. In one condition, a female role model was present during the math test. In the other condition, no female role model was present during the test. Women who took the test in the presence of a successful role model performed significantly better than women who took the test with the presence of a role model. These findings demonstrate that simply being around successful role models can mitigate the negative effects of ST.

Reducing Stereotype Relevance of Task

Another method for protecting people from ST effects is to simply reduce the stereotype relevance of the particular task. For example, simply informing participants that "men and women perform equally well on these math problems" eliminates ST performance effects on math exams among women (Quinn & Spencer, 2001; Smith & White, 2002; Smith et al., 2007). Likewise, eliminating the salience of gender in testing contexts can mitigate ST effects. For example, having men and women report their gender after taking a math exam as opposed to before taking the exam, reduced the performance gap between men and women in a real-world setting by 33% on an AP

calculus final exam with a sample of 2000 students (Danaher & Crandall, 2008). Other research suggests that this approach may be especially important for women who strongly identify with their gender, as it is primarily these individuals who are threatened by the potential implications of performance on a gender-stereotyped task (e.g., a math test; Schmader, 2002). Regardless, a number of studies indicate that reducing the stereotype relevance of the task can mitigate ST consequences.

Affirming the Integrity of the Self

While the above approaches (and others) have yielded positive results, arguably the most widely utilized intervention developed out of Self-Affirmation Theory (Steele, 1988). Self-affirmation theory posits that the threat of confirming a negative stereotype about one's group is but one of many threats that directly attack self-integrity, or the desired belief that one is "good, virtuous, successful, and able to control important life outcomes" (Sherman & Cohen, 2006, p. 183). The theory posits that people are motivated to maintain self-integrity, that being part of a group is important to self-integrity, and that negative group characterizations (e.g. stereotypes) can threaten self-integrity. Thus, "self-affirmation" interventions have been developed to affirm (or bolster) the integrity of the self-system and consequently protect people from the harmful consequences of many self-relevant threats, including stereotype threat.

From this perspective, those individuals who hold a certain skill or trait close as self-relevant should experience the most deleterious effects of ST domains where these skills were utilized. Indeed, one key finding in the domain identification literature is that those students who most strongly identify with the math domain are the most susceptible

ST effects (e.g., Keller, 2007; Spencer, Steele, & Quinn, 1999). For example, Keller (2007) had male and female participants complete a measure of the extent to which math is important to their self-concepts (i.e., math identification). These participants were then randomly assigned to a ST or no ST condition prior to completing a mat test. Results indicated that there was no difference in performance for men across conditions. However, women who highly identified with the math domain performed significantly worse under ST than those who were highly identified in the no ST condition. Further, in the no ST condition, those who highly identified with math outperformed those who did not highly identify with math. These findings support the idea that ST effects can attack the self-system, particularly amongst those who link the self to the stereotyped domain. Thus, the logic of self-affirmation theory is that affirming the integrity self should protect people from the effects of ST.

Empirical research provides support for self-affirmation theory and for the effectiveness of self-affirmation interventions. Martens et al. (2006), for example, tested whether self-affirmations buffer against the negative consequences of ST on women's math performance. First, participants were told that a math test they would be taking was as a direct measure of math intelligence (ST condition) or reasoning problems (no ST condition). Next, the experimenters had half of the women write about a characteristic or value of their self that was not under attack in the stereotype threatened math domain (e.g. I am a great friend). This process was expected to bolster, or affirm, the integrity of the self. The other half of women did not take part in this self-affirmation task. The results showed that women under ST who self-affirmed outperformed women in the ST condition that did not self-affirm.

Self-affirmations are effective in "real-life" situations as well. Cohen et al. (2006) provides a prototypical example of this self-affirmation intervention with minority students in the seventh grade. In this study, participants in the self-affirmation group were presented with a list of values (e.g. specific relationships or talents) and were told to identify and write about the value that was most important to them. Control participants identified and wrote about their least important value. Self-affirmations were found to buffer minority students from an early decline in general performance (i.e. overall GPA) in a middle school setting. In otherwords, the self-affirmation intervention reduced the achievement gap between minority and majority students. These findings thus provide strong evidence that self-affirmations help prevent ST from negatively affecting performance over time.

In summary, multiple psychological interventions have been created to help curtail the harmful consequences of ST and help improve stereotyped individuals' outcomes in stereotyped domains. These include increasing a sense of belonging, providing role models, restructuring testing contexts to diminish their stereotype relevance, and bolstering self-integrity through self-affirmations. However, it remains important to continue exploring and identifying factors that might enhance the effectiveness of existing approaches or provide new ways for reducing the effects of ST. In particular, while self-affirmations are effective (e.g., Martens et al., 2006; Stone et al., 2011; Shapiro et al., 2013), a currently underdeveloped area of research suggests that affirming certain aspects of the self may be more effective than others at curtailing the effects of ST (Schimel et al., 2004). Specifically, research indicates that aspects of the self that reflect who a person believes she truly is (i.e. true self-concept) and the feeling

of knowing who one truly is substantially contributes to psychological health and psychological security in the face of threat. More deeply integrating this research with the literature on ST could thus enhance existing approaches to ST interventions by highlighting a potentially more impactful aspect of the self to target.

The True Self, Psychological Security, and Protection Against Stereotype Threat

The literature on "who one thinks they truly are" follows from a long history of theoretical interest in the true self-concept, which is defined as the beliefs about " who one really is, regardless of his or her outward behavior" (Schlegel et al., 2011, p. 745). Classic theorists like Winnicott (1965) and Rogers (1959), for example, emphasized that understanding and freely expressing one's true self-concept was an essential aspect of psychological well-being. More recently, psychological research has emphasized the ways in which the true self-concept contributes to well-being and psychological security.

Much of this work has come from considerations of individual differences in authenticity. Authenticity is the subjective experience of the "unobstructed operation of one's true- or core-self in one's daily enterprise" (Kernis & Goldman, 2006, p. 294). Kernis and Goldmann (2006) developed a self-report measure of authenticity to explore how individual differences in authenticity might relate to multiple aspects of psychological health. They found, across a number of studies, that authenticity is positively related to aspects of well-being, ranging from life satisfaction, to self-esteem, to security in romantic relationships. In addition, Lakey et al. (2008) found that individual differences in authenticity were inversely correlated with psychological defensiveness.

In this study, participants completed the authenticity measure and then completed a defensive verbal behavior assessment (Barrett, Williams, & Fong, 2002). During the verbal behavior assessment, participants were asked questions that assessed instances where individuals acted incongruent to their desired or held personal views [e.g., "*Tell me about a time when you've done something unethical on an assignment?"* (p. 234)]. A defensive response to these questions was indexed by vague and evasive details that externalize responsibility for the behavior (e.g., blaming someone else); where as a non-defensive response was indexed by open and honest answers that recount unpleasant feelings of the detailed experience. The findings indicated that the greater levels of authenticity were associated with less verbal defensiveness. Thus, this finding supports the idea that the extent to which people feel that they live in accord with their true self-concept experience benefits to their well-being and are more psychologically secure.

Notably, experimental research has also provided evidence for a causal connection between the true self-concept and psychological security. For example, Schimel et al. (2001) found that people are less defensive when they feel accepted for who they really are (the true self), relative to when they are accepted for their achievements. In this study, participants were asked to think about and write down a person that either represented a contingent relationship (i.e., someone who is evaluative and only accepting when you live up to certain standards), a non-contingent relationship (i.e., someone who is accepting and non-evaluative, accepts you for who you are), or a neutral relationship (i.e., someone like a classmate or a professor who you interact with for business or academics, but not socially). Next, participants received information on how well they performed on a bogus test that they had partaken in earlier. All

participants were told that they scored 12 out of 20 and were told that this was not great, but not bad either. Then, during an information session participants learned how well they did compared to others in the experiment by reviewing fake score sheets presumably from previous participants. Half of the participants reviewed six score sheets with high scores (all scores were above 12), while the other half of participants reviewed six score sheet with low scores (all scores were below 12). Participants were then asked if and how many more score sheets they would like to review. The additional number of requested score sheets was the dependent measure of defensive responding. That is, a desire to review a greater number of score sheets when people expected that others performed worse (relative to better) is indicative of a defensive form of downward social comparison (desire to compare one's self only to people who are worse). Participants in the "true-self" acceptance condition did not show an enhanced interest in downward social comparison information, whereas participants in the other conditions did. These results indicate that activating the true self-concept prior to a possible defensive response situation reduces defensiveness.

Other research is also consistent with this idea. Arndt et al. (2002) randomly assigned participants to visualize an individual who accepted them for who they truly are, an individual who only liked them when they met certain standards, or a neutral acquaintance. After this visualization exercise, participants were asked to rate how much their performance on an upcoming task would be due to their level of effort, ability, difficulty of the task, their current mood, luck, the current testing conditions, and how reliable a test of math ability they expected it to be. Those who visualized a non-contingent relationship reported that their performance outcomes would depend less on

external factors than those in the contingent relationship condition. Because external attributions are associated with defensiveness, these findings further support the hypothesis that true self-activation enhances psychological security. Similarly, Vess et al. (2014) had people write about who they truly are, an achievement, or an ordinary event and then gave them negative or positive performance feedback. They found that, following negative performance feedback, focusing people on who they truly are led to shame-free guilt, a more secure self-relevant emotion than guilt-free shame. Collectively, research on the activation of true self-conceptions indicate that the true self –concept plays an important role in psychological health and increases psychological security in the face of threat. This raises the possibility that true self-conceptions may be particularly effective at protecting people from the negative effects of stereotype threat.

One existing study supports this possibility. Schimel et al. (2004) hypothesized that the security enhancing benefits of true self-conceptions would protect women from the harmful math performance consequences of ST. Female participants who self-reported themselves as invested in academics (i.e., high in identification) and could identify the stereotype of women in math were first randomly assigned to conditions that either aroused or did not arouse stereotype threat. Specifically, women in the stereotype threat condition were given instructions for a test that was described to them as "indicative of their mathematical intelligence" and were asked to indicate their gender on an initial demographics sheet (thus making gender salient and enhancing the likelihood of ST). Participants in the control condition were given instructions for a test described to them as "problems for future research" and were not asked to indicate their gender. Next, participants were randomly assigned to the conditions of a "self-description task"

developed to activate true-self conceptions or not. The true-self condition asked participants to complete sentence stems designed to focus participants on their most valued self-definitions that were unconnected to social standards, while the comparison condition asked participants to complete sentence stems that focused them on the contingent nature of their valued self-definitions. All participants then completed the (math) test that was described to them earlier in the study and performance was recorded as the critical dependent variable. For participants in the non-true self-condition, math performance was significantly worse in the ST condition compared to the no ST condition. In contrast, those in the true self-condition actually showed an increase in performance under ST relative to the no ST condition. This reversal of the ST effect was not predicted, but the results do nevertheless support the idea that true self-conceptions can protect people from the consequences of ST.

While the above literature suggests that focusing people on the true self-concept can alleviate defensiveness and attenuate the performance consequences of stereotype threat, there is an important gap that needs to be addressed. Specifically, an emerging literature has indicated that focusing on the true self-concept may not be consequential for everyone or in all contexts. Schlegel and colleagues' work has indicated that how well an individual feels they know who they truly are (i.e., perceived true self-knowledge; PTSK) affects some of the consequences of focusing people on the true self-concept. For example, Schlegel et al. (2011) hypothesized that the true self-concept would only enhance meaning in life when people felt that they knew who they truly are. Here, Schlegel et al. (2011) presented a writing prompt to students, half of students received a prompt to list characteristics of their true self and the other half received a prompt to list

characteristics of their actual self (i.e., "who you are around most people, even if this isn't who you really are" (p. 747). Within these two self-conditions, participants were either asked to list 5 self-descriptors or 18 self-descriptors of their designated self (i.e., true or actual self). This manipulation of listing 5 versus 18 descriptors affects the subjective ease at which that information is brought to mind (5 feels easier than 18). Research indicates that this "ease" is a cue by which individuals identify how well they know a particular topic, with greater ease indicating a high level of knowledge and greater difficulty indicating a low level of knowledge (e.g., Alter & Oppenheimer, 2009). As was predicted in the Schlegel et al. (2011) study, across the self-conditions, those in the 5 self-descriptor list condition found it significantly easier to describe their assigned self as compared to those in the 18 self-descriptor list condition. More importantly, participants in the true self-condition who experienced relative ease generating descriptors (i.e., those high PTSK) reported greater, meaning in life relative to those who experienced difficulty. There was no effect of ease in the actual self-condition.

The research on PTSK also indicates that people can naturally vary on how well they feel they know themselves, meaning that PTSK can be both an experimentally altered experience and a naturally occurring individual difference variable. For example, several studies have simply measured PTSK to examine its predictive qualities. A study in Schlegel et al. (2011) had participants list six words that described their true self and six words that described their actual self. Then participants were asked how easy it was for them to come up with these words. The ease at which participants generated true-self descriptors positively predicted meaning in life, while the felt ease of coming up with actual-self characteristics was unrelated to meaning in life. These studies indicate that

PTSK is important for understanding the functionality of the true self-concept; activating knowledge of the true self-concept only seems to be beneficial when people fell that they know who they truly are. It thus seems plausible that focusing on the true self-concept will only offer protection from ST for people who feel like they really know who they truly are (i.e., those high in PTSK). The purpose of this project is to initially test this possibility.

The Present Study

The underrepresentation of women in STEM continues to be a problem (National Science Foundation, 2013) and the stereotype threat perspective suggests that these disparities may result, in part, from the negative consequences being the target of a stereotype. Indeed, stereotype threat negatively affects outcomes important for STEM retention and persistence, such as women's performance (Spencer, Steele, & Quinn, 1999), intrinsic motivation (Smith & White, 2002), and the adoption of adaptive goal orientations (Senko et al., 2008). These negative effects have led to the development of numerous interventions designed to eliminate the harmful consequences of ST, but the need for continued efforts to develop effective interventions remains. For example, while self-affirmation interventions have been shown to be especially effective at reducing some of the negative effects of ST, some research suggests that affirming certain aspects of the self may be even more impactful than just any aspect of the self. Research showing that focusing people on their true self-concepts increases psychological security (e.g., Arndt et al., 2002) and that the true self-concept can counteract the negative consequences of ST on women's math performance suggests that affirmations of the true

self-concept may be particularly effective. However, based on emerging findings (Schlegel et al., 2011), the true self-concept may only be functional for people who feel like they know who they truly are. This study will provide an initial test of this possibility by focusing on naturally occurring individual differences in perceived true self-knowledge. The goal is to understand whether being high in PTSK will protect women from some of the negative effects of ST.

In this study, female participants who self-reported high identification with science completed a measure of PTSK (Schlegel et al., 2013) before exposure to a ST eliciting task or a non-ST eliciting task (Dar-Nimrod & Heine, 2006). Only women high in science identity were included because previous research has indicated that women with high identification in a stereotyped domain are the most susceptible to the effects of ST (Smith & White, 2001). After the ST task, participants completed a math test (Marx et al., 2005), a measure of interest (intrinsic motivation) in math (Deemer et al., 2010), and a goal adoption measure (Elliot & Murayama, 2008). I predicted that individuals with high PTSK should be protected from the negative effects of ST on performance, avoidance goal adoption, and interest in math. In contrast, I predicted that ST would negatively impact those low in PTSK.

METHODS

Participants

One hundred and thirty-three female students (85% Caucasian, 4.5% Hispanic, 2.3% Black, 2.3% Native American) were recruited from the PSYX101 subject pool via SONA SYSTEMS (a subject pool management software program) at Montana State University in the Fall of 2014 and Spring of 2015. The advertisement described the study as including standard personality measures, a self-identification measure, and several performance tasks. The mean age of participants was 20.07 (*SD* = 3.47). Participants received partial course credit for their participation. Because the study focused on women in STEM disciplines, only women who self-reported high identification (i.e., above the midpoint) with science in a prescreen survey were included. The prescreen survey was administered online during the first two weeks of the semester and only women who above the midpoint on the science identification measure were able to sign up for my experiment. Because my study focused on performance in math, a more specific measure of math identification would have been preferable to screen participants. Unfortunately, the prescreen survey only contained a measure of science identity. However, given the centrality of math for most science disciplines, I reasoned that selecting individuals high in science identity was appropriate for this study.

Procedures and Materials

After participants arrived for the experimental session, an experimenter informed them that the study was investigating different aspects of academic performance and asked them to sign an informed consent document. The experimenter, who was blind to conditions, then escorted the participants to a separate laboratory room where they completed all materials on a computer in private cubicles. The experimental materials are described below.

Perceived True Self-Knowledge

First, embedded within a battery of filler measures, participants completed a "Self-Description Task" that has been utilized in previous research to assess individual differences in perceived true self-knowledge (e.g., Schlegel et al., 2013). Specifically, all participants listed the 10 words that described their true selves. The instructions for this task read:

> "Specifically, we'd like you to think about the characteristics, roles or attributes that define who you really are—even if those characteristics are different than how you sometimes act in your daily life. For example, think about the following song lyric: 'Can you see the real me?' Imagine this is a song about you—how would you describe the real you?" (Schlegel et al., 2013, p. 546)

Some example descriptors that participants provided are "funny," "student," and "friend." After participants generated their list, they responded to three questions: "It is easy for me to think of who I really am," "How well do you think you know your true self?," and "How easy is it for you to think of your true self?" Participants responded on a 10-point scale with anchors appropriate for the question (e.g., 1 = *extremely difficult* to 10

= *extremely easy*; R. Schlegel, personal communication, September 1, 2014). This assessment is considered a measure of perceived true self-knowledge based on research indicating that people use the ease of generating knowledge as a gauge of how well they know a particular topic (e.g., Alter & Oppenheimer, 2009). Responses were averaged into a single PTSK composite.

Stereotype Threat Manipulation

Participants then completed additional filler personality measures prior to being informed by the computer that they would complete a verbal task and a math task during the experiment. In the verbal task, participants were presented with an article to read. Participants were specifically told that this article is a measure of their verbal ability. These chosen articles created the manipulation for ST by informing participants that gender differences in math ability are due to biological factors (ST condition) or situational factors (no ST condition; Schmader et al., 2013). Though no true control group was included in this study, previous research has included one and has found that the biological essay leads to significantly worse performance on a math test as compared to a control condition (i.e., a condition where women are told that no differences in math performance between men and women exist; Dar-Nimrod & Heine, 2006). Consistent with traditional ST inductions, findings indicate that women who read the biological factors paper perform significantly worse on a post-reading math test than those who read the situational factors paper (Dar-Nimrod & Heine, 2006).

Math Performance

Following the verbal task (i.e. ST manipulation), all participants took a math

exam. Participants had 20 minutes to complete 16 difficult quantitative math questions utilized in previous ST research. The utilization of difficult math questions as an assessment of math performance is consistent with previous ST research (see Marx et al., 2005). The number of correct answers on the exam served as the critical assessment of math performance.

Performance and Mastery Goal Adoption

A measure for goal adoption immediately followed the math exam. First, participants completed a modified version of the *Achievement Goal Questionnaire -- Revised* (Elliot & Murayama, 2008), which measured the adoption of performance-approach, performance-avoidance, mastery-approach, and mastery-avoidance goals. This measure assesses academic goal adoption (e.g. Pekrun et al., 2010) and has been used in previous ST research focused on the adoption of different types of goals (e.g. Deemer et al., 2014). The measure was originally developed to assess goal adoption in a generic classroom setting. However, for the current study, the items were modified to reflect goal adoption in the domain of mathematics. Example items included, "My goal on the math test I just completed was to avoid being outperformed by my peers" (performance-avoidance), "My goal on the math test I just completed was to be better at math than my peers" (performance-approach), "My goal on the math test I just completed was to learn as much as possible" (mastery-approach), and "My goal on the math test I just completed was to avoid learning less than I possibly could" (mastery-avoidance). Responses to each item were made on a 7-point scale from 1 (*strongly disagree*) to 7 (*strongly agree*) and were averaged to create the four distinct sub-scales that the measure was designed to

assess. Although the entire measure of performance and mastery goals were administered, I only focus on performance avoidance goals because previous research has identified performance avoidance goal adoption as a particularly important consequence of ST (Smith, 2006).

Interest/Intrinsic Motivation

In addition to the goal adoption measure, participants completed the interest subscale of the *Research Motivation Scale* (Deemer et al., 2010). The original scale was designed to measure interest to work in a generic research lab. However, in the current study, the items were modified to assess interest to pursue math. Example items include, "I work on math for the joy of it", "I love to learn new things through math". This subscale includes 9-items. Responses were made on a 7-point scale from 1 (*strongly disagree*) to 7 (*strongly agree*) and averaged to form a single interest composite.

ST Manipulation Check

Next, directly following previous research (Schmader et al., 2013), participants completed 2 questions designed to assess the effectiveness of the ST manipulation. These 2-items assessed whether participants adopted the perspective that the ST articles (gender differences being based on biological versus situational factors) were intended to induce. The two questions asked participants, "Based on what you learned in this study, to what extent do you think gender differences in math are due to biological factors?" and "Based on what you learned in this study, to what extent do you think gender differences in math are due to situational factors?" Responses were made on a 7-point likert-scale from 1(*not*

at all due to biological factors or *situational factors*) to 7 (*entirely due to biological factors* or *situational factors*).

Math Identification

Participants then completed a domain identification measure (Smith & White, 2001), which assessed how strongly participants identified with the math domain. The measure was included for exploratory purposes and was not a primary outcome in the study. The measure includes 8 math-related items (e.g., "I have always done well in Math"). Responses for seven of the items were made on a 7-point likert-scale from 1 (*Strongly Disagree*) to 7 (*Strongly Agree*); responses to the remaining item were made on a 5-point likert-scale from 1 (*Very Poor*) to 5 (*Excellent*). Scores on this measure were summed to create single math identification composite. Participants completed a brief demographics survey immediately after the identification task. At the end of the study, an experimenter debriefed participants, thanked them for their participation, and dismissed them.

RESULTS

Preliminary Analyses

Descriptive Statistics

The descriptive statistics, bivariate correlations, and reliability coefficients of all study variables are provided in Table 1. Scores for each variable were calculated consistent with previous research and each of the measures have been validated previously. Based on this, I didn't conduct a factor analysis on the scales in my sample. As can be seen in the table, all measures had acceptable reliability. The table also demonstrates that PTSK was not significantly correlated with any of the other measures in the study at the bivariate level. However, other correlations consistent with what would be expected from previous research emerged (e.g., Elliot et al., 1999, Elliot & Murayama, 2008), with one exception. Previous research indicates that the adoption of performance avoidance goals is negatively associated with interest for women with high achievement motivation (Smith et al., 2007), but my study detected a positive correlation between interest and performance-avoidance goals for women with high science identification. Though this study was not a replication of Smith et al., (2007), one possible explanation for this discrepancy might have to do with the way I measured performance avoidance goals and interest. Interest captured a general interest in math, while the performance goal measure captured goals about the specific math task that participants completed. Previous research has tended to focus on measuring both constructs in terms of a specific task. Nevertheless, this explanation is speculative and the

relationship between interest and performance avoidance goals detected in my study is not easily reconciled with previous research.

Table 1. Summary of Correlations and Descriptive Statistics for Key Study Variables

Measure	1	2	3	4	*M*	*SD*	α
1. PTSK	-				6.72	1.78	.70
2.Math ID	.068	-			30.45	11.15	.90
3. INT	.040	.791**	-		2.49	1.06	.96
4.Perf. Avoid.	-.020	.257**	.226**	-	3.23	1.05	.94

Note. $N = 133$; $*p < .05$, $**p < .01$, $***p < .001$. *PTSK = perceived true self-knowledge; Math ID = math identification; INT = interest; Perf. Avoid. = performance avoidance goal adoption.*

ST Manipulation Check

Responses to each of the two manipulation check questions were submitted to independent samples *t*-tests. The results indicated that participants who read that gender differences in math are due to situational factors were more likely ($M = 4.90$, $SD = 1.29$) to attribute gender differences to social factors compared to participants who read that gender differences in math are due to biological factors ($M = 4.14$, $SD = 1.52$), $t(133) = -3.112$, $p < .01$. However, those who read that gender differences in math performance are due to biological factors ($M = 3.14$, $SD = 1.62$) were not more likely to attribute gender differences to biological factors compared to those in the situational factors condition ($M = 2.93$, $SD = 1.67$), $t(133) = .745$, $p = .46$. In fact, looking at the mean response to the manipulation check assessing biological attributions for math gender differences, it doesn't appear that many participants believed that gender differences in math are

biologically based. This is counter to previous research that found that the essay containing the explanation for gender differences in math performance as a biological difference between men and women lead to significantly stronger belief in biological reasoning (ST inducing) for math performance as compared to those who read the situational factors essay explaining gender differences in math as a function of being told by parents and teachers that men are better than women at math (Schmader et al., 2013). I address this issue in the general discussion.

Primary Analyses

Math Performance

Although the ST manipulation did not appear to be effective (as measured by manipulation check items), I nevertheless ran analyses to test the primary hypothesis that PTSK would moderate the negative effects of ST. Math performance was submitted to a regression analysis by entering the main effects of ST (dummy-coded; ST=1, No ST = 0) and PTSK (mean-centered) in Step 1, and the ST x PTSK interaction in Step 2. As seen in Table 2, the main effects of ST (β = -.03, p = .730) and PTSK (β = -.09, p = .308) were not significant. Likewise, and inconsistent with the hypotheses, the ST x PTSK interaction was not significant (β = -.069, p = .545).

Table 2. Effects of PTSK and ST on Math Performance

Variable	*b*	*S.E.*	*β*	*t*	*p*	ΔR^2
Step 1						-.007
ST	-.162	.468	-.030	-.346	.730	
PTSK	-.133	.130	-.090	-1.025	.308	
Step 2						-.012
ST x PTSK	-.156	.263	-.069	-.593	.545	

Note. $N = 133$; $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

Interest

Interest was submitted to the same regression model as math performance. As seen in table 3, the main effects of ST ($\beta = -.078$, $p = .373$) and PTSK ($\beta = .034$, $p = .701$), and the ST x PTSK interaction were not significant ($\beta = .029$, $p = .808$).

Table 3. *Effects of PTSK and ST on Interest*

Variable	*b*	*S.E.*	*β*	*t*	*p*	ΔR^2
Step 1						-.008
ST	-.166	.186	-.078	-.894	.373	
PTSK	.020	.052	.034	.385	.701	
Step 2						-.015
ST x PTSK	.025	.104	.029	.244	.808	

Note. $N = 133$; $^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

Performance Avoidance Goal Adoption

Performance avoidance goal adoption was submitted to the same regression analysis as the preceding dependent variables. Table 5 displays that the main effects of ST (β = -.015, p = .868) and PTSK (β = -.019, p = .826), and the ST x PTSK interaction were not significant (β = -.067, p = .568).

Table 4. *Effects of PTSK and ST on Performance Avoidance Goals*

Variable	*b*	*S.E.*	*β*	*t*	*p*	ΔR^2
Step 1						-.015
ST	-.031	.185	-.015	-.168	.868	
PTSK	-.011	.051	-.019	-.221	.826	
Step 2						-.020
ST x PTSK	-.059	.104	-.067	-.572	.568	

Note. N = 133; *p < .05, **p < .01, ***p < .001

Ancillary Analyses

In addition to the primary analyses above, a series of exploratory ancillary analyses were also conducted. I first assessed whether math identification might interact with ST and PTSK to affect the primary outcomes of interest. No significant three-way interactions emerged. However significant two-way interactions involving math identification did emerge. It is, of course, important to note that examining the role of math identification when I had already selected participants for being high in science identity could be perceived as inappropriate. I explored math identification as a

moderator in order to fully actualize the data. Indeed, previous research has indicated identification in the specific stereotyped domain can buffer against the negative effects of ST (e.g., Osborne & Jones, 2011; Aronson et al., 1999). The exploratory analyses presented below, while consistent with the approaches of previous research, should nevertheless be interpreted with caution given the selection criteria utilized to recruit participants. Additional ancillary analyses can be found in Appendix A.

ST x Math Identification

Effect on Math Performance

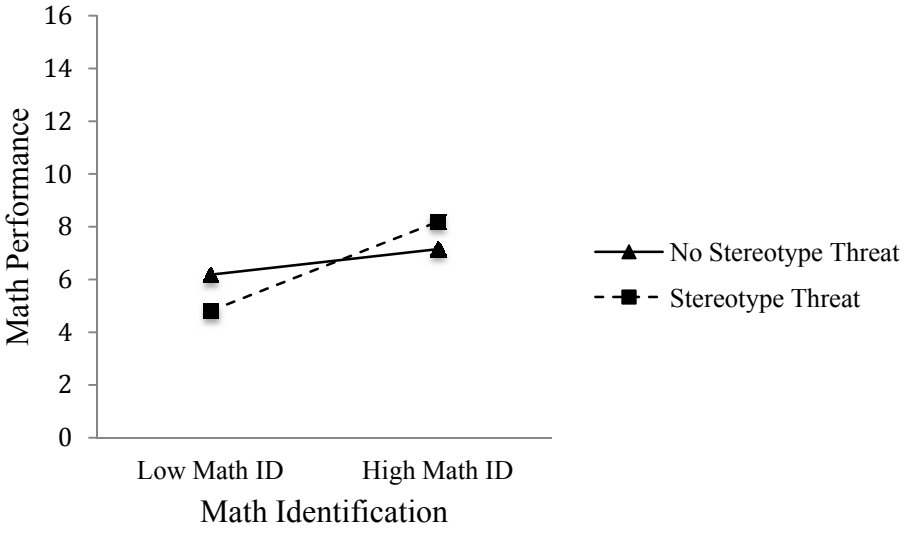
Again, although the ST manipulation was not effective (as measured by manipulation check items), I nevertheless ran exploratory analyses to test for potential main and interactive effects involving math identification. Math performance was submitted to a regression analysis by entering the main effects of ST (dummy-coded; ST = 1, No ST = 0) and math identification (mean-centered) in Step 1, and the ST x MATH ID interaction in Step 2. As seen in Table 15, the main effect of math identification (β = .365, p = .000) was significant. The effect indicates that math identification positively predicted math performance. Further, the interaction in Step 2 for ST x MATH ID (β = .288, p = .003) was significant. As shown in Figure 1, predicted means tests indicated that women low in math identification performed significantly worse under ST than when not under stereotype threat (β = -1.372, p = .024). In contrast, women high in math identification did not significantly differ in math performance between the ST and no ST conditions (β = 1.039, p = .13).

Table 5. Effects of ST and Math ID on Math Performance

Variable	*b*	*S.E.*	*β*	*t*	*p*	ΔR^2
Step 1						.121
ST	-.161	.436	-.030	-.369	.714	
Math ID	1.256	.281	.365	4.475***	.000	
Step 2						.164
ST x Math ID	1.548	.557	.288	2.782**	.006	

Note. $N = 133$; $^*p < .05$, $^{**}p < .01$, $^{***}p < .001$

Figure 1. Interaction between ST and Math ID predicting Math Performance



Interest

Interest was submitted to a parallel regression analysis as math performance for the investigation of ST x MATH ID effects. As seen in Table 16, the main effect of math identification ($\beta = .793$, $p = .000$) was significant, such that math identification positively

predicted interest. There was also a marginal effect of ST, such that participants in the ST condition reported marginally less interest in math than non-ST participants (after controlling for math identification).

Table 6. Effects of ST and Math ID on Interest

Variable	*b*	*S.E.*	*β*	*t*	*p*	ΔR^2
Step 1						.630
ST	-.206	.112	-.097	-1.840	.068	
Math ID	1.081	.072	.793	14.977***	.000	
Step 2						.627
ST x Math ID	.018	.147	.009	.124	.902	

Note. $N = 133$; *$p < .05$, **$p < .01$, ***$p < .001$

Performance Avoidance Goal Adoption

Performance avoidance goal adoption was submitted to the same regression model described above. As seen in Table 18, the main effect of math identification ($\beta = .257$, $p = .003$) was significant such that math identification positively predicted performance avoidance goal adoption.

Table 7. Effects of ST and Math ID on Performance Avoidance Goals

Variable	*b*	*S.E.*	*β*	*t*	*p*	ΔR^2
Step 1						.112
ST	-.039	.178	-.018	-.217	.828	
Math ID	.348	.115	.257	3.035**	.003	
Step 2						.107
ST x Math ID	-.106	.206	-.055	-.515	.780	

Note. $N = 133$; *$p < .05$, **$p < .01$, ***$p < .001$

DISCUSSION

This study investigated whether perceived true self-knowledge buffers three important negative outcomes (i.e., decrement in performance, motivation, and performance avoidance goal orientation) associated with stereotype threat. The primary hypothesis proposed that for individuals with high PTSK, ST would have no detrimental effect on math performance, interest, and performance avoidance goal adoption. In contrast, I hypothesized that ST would negatively affect performance, intrinsic motivation, and performance avoidance goal adoption for people low in PTSK. The results of this study did not support these predictions. No significant effects involving PTSK emerged. Exploratory analyses did reveal that math identification interacted with ST to affect math performance. Individuals with low math identification performed significantly worse under ST (vs. no ST), whereas individuals high in math identification were not significantly affected by the ST manipulation. This interaction effect was opposite of many previous findings in the literature (e.g., Keller, 2007). A discussion of these results and the issues that may have led to the primary hypotheses not being supported is provided below.

Lack of Support for the Primary Hypotheses

The purpose of the present study was to test an extension of Schimel et al.'s (2004) findings. Specifically, Schimel et al. (2004) found that when people are focused on their true self, they are protected against the negative effects of ST on math performance. In the present study, I examined whether the degree to which people feel

they know their true selves plays a role in protecting people from ST. This is an important question because previous research suggests that making the true self salient might only offer benefits when people feel they know who they are. I predicted that people with high PTSK would experience the buffering effects of the true self on ST for math performance, interest, and goal adoption. The results did not support this prediction. PTSK did not moderate the effects of ST on any of the measured outcomes.

Of course, one main and very important concern with interpreting these findings is the lack of evidence for the effectiveness of the ST manipulation. The results actually suggest that the ST induction was not effective. I selected this manipulation based on previous research indicating that it reliably induces ST effects. For example, Dar-Nimrod and Heine (2006) hypothesized that people would perform worse on a math task if performance differences were attributed to genetic differences (biological factors condition) as opposed to situational experiences (situational factors condition). In the aforementioned study, female participants came into the lab and completed two math tests, which were separated by a verbal section that contained the ST manipulation. The ST manipulation was contained in one of four essays (i.e., four conditions). Two of the essays included were the genetic differences essay (ST condition) or the situational factors essay (no ST condition) that were featured in the present research. As a control, two more traditional approaches to ST inductions were included. One condition featured an essay that explained that there were no differences in math performance across gender (traditional no ST condition), while the other condition primed sex without addressing the math stereotype (traditional ST condition). Participants completed a second math test after this manipulation. Results indicated that when controlling for the first math test,

women in the biological factors essay condition performed worse than those in the situational factors condition, worse than those in the traditional no ST condition, and equivalent to those in the traditional ST condition. This finding indicates that the essays used in the present experiment have reliably induced theoretically predicted performance effects in past research.

The validity of the ST manipulation used in the present research is also supported by manipulation check evidence in previous research. Schmader et al. (2014) utilized the same essays and same manipulation check questions (e.g., "Based on what you learned in this study, to what extent do you think gender differences in math are due to biological factors?") featured in my study and found support for the effectiveness of the manipulation. Specifically, the biological factors essay group was more likely to endorse a biological interpretation of gender differences (ST condition) in math performance than the situational factors essay group (no ST condition). In contrast, the situational factors group was more likely to endorse the situational factors interpretation of gender differences (no ST condition) in math performance relative to the biological factors group. These differences in beliefs about the origins of math performance differences were not replicated in the present study. I specifically found that belief in a biological cause for gender differences in math performance (ST condition) did not differ between the biological factors essay group and the situational factors essay group. Yet, those who read the situational factors essay endorsed the belief in the situational factors interpretation for gender differences in math performance (no ST condition) more than the biological factors group. However, it is the biological factors essay that triggers the ST. Yet, in both conditions endorsement of situational explanations for math performance

differences were higher. Since the group that was presented with this explanation did not believe that gender differences are due to biological differences as reported in the ST manipulation check, it seems unlikely that ST was triggered.

What may have limited the manipulations effectiveness? It is possible that they may be at least be partially driven by context. Women in college in 2015, relative to women in 2006 when the original Dar-Nimrod and Heine study was conducted, may simply be more resilient to the messages contained in the essays. Indeed, it seems reasonable to think that the women in my sample may have been exposed to information about the lack of differences between men and women in math ability at some point in their educational careers. Another methodological possibility is that the manipulation was simply too blatant to be effective. In fact, a recent meta-analysis found that explicit manipulations of ST produce smaller ST effects than more subtle manipulations (e.g., including a gender inquiry before the math test; Nguyen & Ryan, 2008). For example, blatant manipulations highlighting explicit gender differences in math ability (e.g., an essay stating that gender differences in math are biologically driven) are less effective than more subtle manipulations that do not mention gender differences explicitly (e.g., describing a test as a measure of women's natural math ability; Shapiro et al., 2013). Therefore, a follow up study may benefit from the use of a more subtle manipulation of ST to address the ineffectiveness of the manipulation featured in my study.

A future study might also benefit from the use of a ST manipulation that specifically threatens the self. Shapiro and Neuberg (2007) described ST as having the potential to elicit a variety of threats, including personal self-concept threat, group concept threat, and a threat to one's own reputation in the eyes of an out-group member.

One might argue that the ST manipulation used in the present research primarily threatened one's group, rather than one's self-concept, which could be relevant for studying the effects of PTSK. Its possible that PTSK might have the potential to buffer against questions triggered by ST inductions that target the self-concept (e.g., "What if the stereotype is true of me?"), whereas PTSK might be less effective against the questions triggered by ST inductions that target one's group (e.g., "What if this stereotype is true of my group?"). Thus, a study utilizing a ST induction that threatens the self-concept or self-integrity (e.g., Shapiro, Williams, & Hambarchyan, 2013) might be wise for future studies.

For example, Shapiro, Williams, & Hambarchyan (2013) exposed half of their participants to a self-affirmation exercise where they ranked characteristics and values (Martens et al., 2006) in terms of importance to their self. The other half of participants received no self-affirmation. Then students were either given a self-as-target ST manipulation (e.g., students told math test would be a measure of their mathematic ability), or a group-as-target ST manipulation (e.g., students were told math test would measure mathematic ability between Black and White students). Finally, students were given a GRE-like math test. Self-affirmation buffered the effects of ST when the ST manipulation targeted the self, but had no effect when the ST manipulation targeted one's group. This supports the idea that PTSK might be most effective at combating ST primarily when the self is at risk.

To summarize, a number of factors may have contributed to the null results observed. A future study remedying these issues is thus needed. To conduct this study, I would target participants who may have less experience with ideas about the differences

in math performance between men and women. This could be accomplished by targeting female students at earlier stages of education (e.g., middle school) and would potentially reduce some of the concerns noted above regarding people's prior exposure to ST ideas. I would also specifically recruit women high in math identity to be more consistent with previous research (e.g., Smith, Morgan, & White, 2005) and to maximize the impact of the math-relevant ST manipulation. Finally, I would utilize a less blatant ST manipulation that targets the self – rather than one's group (e.g., Shapiro et al., 2013) – given that PTSK is clearly a self-relevant factor. These modifications should increase my ability to meaningfully test the hypotheses that guided this project.

Exploratory Analyses Focused on the Role of Math Identification

Although the primary hypotheses and effectiveness of the ST manipulation were not supported, exploratory analyses did reveal a significant pattern of results involving math identification. In particular, there were significant interaction effects between ST and math identification on math performance. Many studies report that ST effects are most pronounced for people who highly identify with the stereotyped domain. For example, Keller (2007) had female students complete a math identification measure two weeks prior to coming in for the experimental session. Upon arriving at the experimental session, participants were told that they would be completing a difficult math task. Half of the participants were told that the math task tends to produce gender differences in performance (ST condition), while the other half were told that there were no gender differences in performance for the task (no ST condition). Women who had

high identification with math performed significantly worse than women that reported low identification with math. However, the present findings indicate a different pattern of results. Those who were low in math identification performed worse under ST than when not under ST, whereas those high in math identification displayed a non-significant trend towards improvement under ST. This pattern of results is difficult to reconcile with earlier ST research and was not predicted a priori.

Schimel et al. (2004), however, does report a finding that might offer some insight. In this study, only female participants who were highly identified with academics (i.e., above the midpoint on a 9-point scale for academic identification) and who were aware of the stereotype that women are worse at math then men were included. These participants were randomly assigned to a ST or non-ST condition and, prior to completing the math test DV (where ST effects should emerge), thought about aspects of themselves that were linked to who they truly are, other people's standards, or a neutral topic. For people in the "other determined" self-aspect condition and the neutral condition, ST elicited the classic decrease in performance. However, participants in the true self-condition actually performed significantly better under ST than the true self-affirmed individuals not under ST. Thus, women were who highly identified with academia and who were focused on their true selves performed better on math test under ST. These results are similar to those found in the current study in that all participants in the current study thought about their true selves in the PTSK measure. Therefore, though my finding for highly identified individuals was not significant, it does trend in a direction similar to that found in Schimel et al. (2004). Unfortunately, no study has examined how true self-affirmations affect math performance for individuals low in math identification, making its

interpretation difficult. Again, though, any interpretation of these findings should be taken with extreme caution given that the ST manipulation was not effective.

Conclusion

The primary purpose of the present study was to investigate whether high PTSK buffers against the negative consequences of ST on performance, interest, and performance avoidance goal adoption. Unfortunately, high PTSK did not buffer against consequences of ST. One major limitation of these findings, however, was the ineffectiveness of the ST manipulation. In hindsight, there appears to be at least two problems with the current design that should be remedied in future studies. The first problem was the utilization of a blatant ST manipulation when existing research suggests that more subtle manipulations are more effective (Nguyen & Ryan, 2008). The second problem may have been the selection of a ST manipulation that threatens one's group (i.e., women are worse at math than men) rather than one's self-concept (Shapiro, Williams, & Hambarchyan, 2013). Nevertheless, despite the inconclusiveness of the results, the finding that ST may not have been effectively manipulated indicates that it may be too early to say if true self-knowledge is important in buffering the negative consequences of ST. Future research should test this further. Doing so could provide more information about unique factors that can mitigate the negative consequences of ST on outcomes (e.g., Math performance) that may be critical to STEM retention.

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APPENDICES

APPENDIX A

EXPLORATORY ANALYSES INVOLVING ST, PTSK, AND MATH IDENTIFICATION ON CRITICAL DVS

Math Performance

Math performance was submitted to a regression analysis by entering the main effects of ST (dummy-coded; ST =1, No ST = 0), PTSK (mean-centered), and Math Identification (mean-centered) in Step 1, the two-way interactions of ST x PTSK, ST x MATH ID, and PTSK x MATH ID interactions in Step 2, and the three-way ST x PTSK x MATH ID interaction in Step 3. As seen in Table 9, the main effect of math identification was significant ($\beta = .373$, $p < .001$), indicating that math identity positively predicted math performance. The analysis also revealed a significant ST x MATH ID interaction ($\beta = .293$, $p = .006$). Simple slopes analyses were conducted to unpack this interaction. As can be seen in Figure 1, when women had low identification with math, they performed worse under ST than when not under ST ($\beta = -1.481$, $p = .04$). In contrast, for women high in math identification there was no difference in math performance between ST conditions ($\beta = 1.056$, $p = .13$).

Table 8. Effects of ST, PTSK, and Math ID on Math Performance

Variable	*b*	*S.E.*	*β*	*t*	*p*	ΔR^2
Step 1						.127
ST	-.215	.436	-.040	-.492	.623	
PTSK	-.172	.121	-.116	-1.418	.159	
MATH ID	1.284	.280	.373	4.580***	.000	
Step 2						.162
ST x PTSK	-.161	.241	-.072	-.669	.505	
ST x Math ID	1.573	.559	.293	2.812**	.006	
PTSK x Math ID	-.068	.150	-.038	-.455	.650	
Step 3						.160
ST x PTSK x Math ID	-.261	.319	-.083	-.817	.416	

Note. $N = 133$; *$p < .05$, **$p < .01$, ***$p < .001$

Interest

Interest was submitted to the same 3-step regression model as math performance. As seen in Table 10, the main effect of math identification ($\beta = .795$, $p = .000$) was significant, indicating that higher identification with math predicted greater math performance. The main effect of ST ($\beta = -1.862$, $p = .068$) was marginally significant, this trend represents that women under ST were less interested in math as opposed to those women in the no ST condition.

Table 9. Effects of ST, PTSK, and Math ID on Interest

Variable	*b*	*S.E.*	*β*	*t*	*p*	ΔR^2
Step 1						.628
ST	-.210	.113	-.099	-1.862	.068	
PTSK	-.013	.031	-.022	-.409	.682	
Math ID	1.084	.073	.795	14.921***	.000	
Step 2						.620
ST x PTSK	.047	.064	.052	.725	.470	
ST x Math ID	.010	.149	.004	.064	.950	
PTSK x Math ID	.003	.040	.004	.072	.944	
Step 3						.617
ST x PTSK x Math ID	-.005	.085	-.004	-.055	.956	

Note. $N = 133$; *$p < .05$, **$p < .01$, ***$p < .001$

Avoidance Goal Adoption

Performance avoidance goal adoption was submitted to a parallel 3-step regression analysis. As seen in Table 12, the main effect of math identification ($\beta = .260$, $p = .004$) was significant; indicating that math identification positively predicts performance avoidance goal adoption.

Table 10. Effects of ST, PTSK, and Math ID on Performance Avoidance Goals

Variable	*b*	*S.E.*	*β*	*t*	*p*	ΔR^2
Step 1						.046
ST	-.046	.179	-.022	-.254	.800	
PTSK	-.022	.050	-.038	-.440	.662	
Math ID	.352	.115	.260	3.049**	.004	
Step 2						.036
ST x PTSK	-.066	.102	-.075	-.649	.518	
ST x Math ID	.056	.236	.027	.239	.812	
PTSK x Math ID	.072	.063	.102	1.137	.258	
Step 3						.032
ST x PTSK x Math ID	.090	.135	.072	.665	.508	

Note. $N = 133$; *$p < .05$, **$p < .01$, ***$p < .001$

APPENDIX B

STEREOTYPE THREAT MANIPULATION

Verbal Reasoning Test (Stereotype Threat Manipulation)

SECTION 1: SENTENCE COMPLETION

Directions: Each sentence below has one or two blanks, each blank indicating that something has been omitted. Beneath the sentence are five lettered words or sets of words. Choose the word or set of words for each blank that best fits the meaning of the sentence as a whole.

1. French folktales almost always take place within the basic ------- that correspond to the ------- setting of peasant life: on the one hand, the household and village and on the other, the open road.
    a. contexts. .hierarchical
    b. structures. .personal
    c. frameworks. .dual
    d. chronologies. .generic
    e. narratives. .ambivalent

2. Inspired interim responses to hitherto unknown problems, New Deal economic stratagems became ------- as a result of bureaucratization, their flexibility and adaptability destroyed by their transformation into rigid policies.
    a. politicized
    b. consolidated
    c. ossified
    d. ungovernable
    e. streamlined

SECTION II: ANTONYMS

Directions: Each question below consists of a word in printed capital letters, followed by five lettered words or phrases. Choose the lettered word or phrase that is most nearly opposite in meaning to the word in capital letters.

3. ANOMALOUS:
    a. veracious
    b. precise
    c. essential
    d. conforming to an established rule
    e. proceeding in a timely fashion

4. PROXILITY
    a. intense devotion
    b. vehement protest
    c. serious offense
    d. exact measurement
    e. extreme brevity

SECTION III: READING COMPREHENSION

Directions: Each passage in this group is followed by questions based on its content. After reading a passage, choose the best answer to each question. Answer all questions following a passage on the basis of what is stated or implied in that passage.

To IRB: Participants will be randomly assigned to read and answer questions about one of the essays below. The essays describe gender differences in math as being due to biological/genetic (stereotype threat condition) or situational (non-stereotype threat condition) factors.

Non-Stereotype Threat Essay

Expectations are responsible for gender differences in mathematical abilities, Researchers Say

By DR. ERIN A. GOODEY

The environmental camp in a longstanding controversial issue, which has drawn a lot of attention over the past few decades, has received the most convincing support to date in results released today from an international group of psychology researchers. The researchers claim to find reasons for well-documented gender differences in mathematical reasoning abilities. The results show that there are no innate differences between males and females in mathematical reasoning.

The new research is the largest published study of differences among males and females in mathematical reasoning. The research was conducted over 8 years in which the participants were followed and their performance closely observed. Unlike previous research in the field, the present study followed both a genetic research design (to look for internal factors to explain the difference) and a cognitive research design (to look for external factors to explain the difference). In the genetic paradigm, using top of the line instruments (F-MRI, DNA analyzers, and messenger RNA blockers), the researchers failed to find any gender differences on mathematical tasks.

Using an ingenious cognitive paradigm, the researchers manipulated the teachers' expectations of students in 64 elementary school classes in 18 cities and towns around the country. In the experimental condition, the researchers visited schools as educational psychologists and gave students a bogus mathematical test at the beginning of the year. Afterwards, they provided the teachers with fake reports that illustrated that the girls in the class were better in mathematics. Observing the teachers through a video camera in the class, it became apparent that teachers were paying more attention to the girls, were more praising towards them and were more dismissive of the boys. In the control condition, where no manipulations of teachers' expectations had taken place, the opposite pattern was observed. Teachers were more attentive towards boys, were praising them more and were more dismissive of girls. The findings showed that the girls in the experimental condition were superior to the boys if the teachers' expectations were manipulated in one of the first three years of elementary school followed by two more years. Manipulation of teachers' expectations after the third year seems to mitigate the effects of teacher's expectations in the first years of school, but not to enough to turn them around as in the case of a manipulation during the first three years. In the control conditions, boys showed superior performance by having on average a grade 5 percentile points higher than the girls throughout the 8 years of the

experiment, providing more support to the general stereotype. The critical period for the students' self-expectations construct seems to be in the beginning of the formal education.

The research was supported by the National Institute of Health (NIH), which provided the international team of researchers, led by Dr. Mark Goldstein from the Harvard Gender Research Institute, with a grant of an unprecedented 35 million dollars to fund a 6-year study of gender differences in education. The results that appeared today in Child Development, one of the leading journals of the American Psychology Association, are only the start of many that will follow in the coming years from this prolific team.

Dr. Thomas Schmidt, speaking for the team, concluded that "manipulating teachers' expectations in the same way that the stereotype does, shows that the construct of mathematical abilities that is apparent in teachers' minds and behavior may as well be the factor that explains gender differences in math". The current research joins a long line of research showing the effect of teachers' expectations on students' performance.

"This study is both statistically and clinically significant," said the lead author, Dr. Karen Dinear, director of child and adolescent psychiatry at the University of Wisconsin Medical Branch. "Its magnitude sheds new light on a long discourse concerning the role that genes and the environment play in the finding that, in general, males have higher mathematical reasoning abilities than females."

Dr. Laura Wehr, from the University of North Dakota Microbiology and Genes Unit, suggested that the results are not as sound as other may claim due to the size of the sample used in the genetic conditions of the study (950 females and 875 males). Other experts predicted more criticism in the coming weeks and months once more researchers in the field have a chance to review the findings.

5. What is the main argument of this article?

a. Mathematics should not be taught in co-ed classes
b. Gender differences cannot be accounted for by innate qualities
c. No reasonable explanations can account for differences in mathematical abilities
d. Teachers should be aware of gender differences
e. Girls are not putting enough effort into their math studies

6. Why is this research the most convincing evidence to date?

a. A large population tested and the time spent on observation
b. Use of advanced technological equipments is more reliable now
c. Both innate and cognitive factors were tested
d. Teachers opinions are more valued than others
e. Children were unaware of the manipulation

7. According the article, how do math differences occur amongst boys & girls?

a. Teachers' high expectations led girls to be more anxious and boys to be more determined

b. Boys were disruptive affecting girls' concentration
c. Girls did not show as much interest in math as boys
d. Teachers were much more likely to help and praise boys than girls
e. Boys played with toys that involved more mathematical reasoning

8. In the future, how can females improve their math skills?

a. Take herbal supplements
b. Ask more questions during math class
c. Find teachers who praise them more
d. Teachers should be aware of their own interactions with students
e. Believe in their abilities

Stereotype Threat Condition

Genes are involved in mathematical abilities, Researchers Say

By DR. ERIN A. GOODEY

The biological camp in a longstanding controversial issue, which has drawn a lot of attention over the past few decades, has received the most convincing support to date in results released today from an international group of genetic researchers. The researchers claim to find genetic bases for well-documented gender differences in mathematical reasoning abilities. The study shows that innate differences exist between males and females in mathematical reasoning.

The new research is the largest published study of polygenetic effects to test the interaction between different genes and higher cognitive functions. One of the main findings demonstrates an interaction of 2 genes located on the Y chromosome (which is found only in males) with genes on chromosome 5 and chromosome 7. This interaction produces hormonal changes guided by the hypothalamus. The onset of the hormonal release is guided by activation of the Brotically area in the frontal lobe. This area is activated when processing mathematical oriented problems. F-MRI scans show these hormonal changes create an increase in the amount of ATP (the body's currency of energy) molecules directed to the hippocampus when a person is engaged in higher mathematical reasoning tasks. The increased energy to this area of the brain, considered the "working memory organ", enables the person to retain more accessible short term memory information while concentrating, a critical element in mathematical reasoning capabilities. This genetic difference seems to explain the findings that boys show superior performance by having on average a grade 5 percentile points higher than girls.

The research was supported by the National Institute of Health (NIH), which provided the international team of researchers, led by Dr. Mark Goldstein from the Harvard Microbiology Research Institute, with a grant of an unprecedented 35 million dollars to fund a 6-year study of polygenetic effects on brain capacities. The results that appeared today in the Journal of American Medical Association are only the start of many that will follow in the coming years from this prolific team.

Dr. Thomas Schmidt, speaking for the team, concluded that "manipulating hormonal state in the same way that the polygenetic effect does, may enable us in the future to elevate females' mathematical reasoning abilities to be in-line with those of males".

"This study is both statistically and clinically significant," said the leading author, Dr. Karen Dinear, director of child and adolescent psychiatry at the University of Wisconsin Medical Branch. "Its magnitude sheds new light on a long discourse concerning the role that genes and the environment play in the finding that, in general, males have higher mathematical reasoning abilities than females."

Other experts said the study was important in adding to the limited knowledge about the effects of different hormones on brain functions.

Dr. Laura Wehr, from the University of Aiwa Microbiology and Genes Unit, suggested that the results are not as sound as other may claim due to the size of the sample used in the study (63 females and 58 males). Other experts predicted more criticism in the coming weeks and months once more researchers in the field have a chance to review the findings.

5. What is the main argument of this article?

a. Males are better at math than females

b. Females are better at math than males

c. Males have a genetic math disadvantage over females

d. Males have a genetic math advantage over females

e. Males and Females both are genetically equipped for math

6. How does the "math gene" work?

a. Through clearer visual representations

b. Flow of energy allows longer short term memory retention

c. Higher levels of cognitive thinking are encoded differently

d. Hormones alter the structure of the brain

e. More areas of the brain are triggered for enhanced mathematical attention

7. According to the article, what is not the cause of math differences between the sexes?

a. Pituitary Gland

b. Hormones

c. Genes

d. Hypothalamus

e. Frontal lobe

8. According to this article, in the future how can females improve their math skills?

a. Taking herbal supplements

b. Asking more questions during math class

c. It is not possible for females to improve their math skills

d. Spending more time on their math homework

e. Altering hormone secretions

Questioning Classical Empiricism

By: DR. STEVEN TRUST

Historically, a cornerstone of classical empiricism has been the notion that every true generalization must be confirmable by specific observations. In classical empiricism, the truth of "All balls are red," for example, is assessed by inspecting balls; any observation of a *non* red ball refutes unequivocally the proposed generalization.

For W.V.O. Quine, however, this constitutes an overly "narrow" conception of empiricism. "All balls are red," he maintains, forms one strand within an entire web of statements (our knowledge); individual observations can be referred only to this web as a whole. As new observations are collected, he explains, they must be integrated into the web. Problems occur only if a contradiction develops between a new observation, say, "That ball is blue," and the preexisting statements. In that case, he argues, *any* statement or combination of statements (not merely the "offending" generalization, as in classical empiricism) can be altered to achieve the fundamental requirement, a system free of contradictions, even if, in some cases, the alteration consists of labeling the new observation a "hallucination."

9. The author of the passage is primarily concerned with presenting

    a. criticisms of Quine's views on the proper conceptualization of empiricism

    b. evidence to support Quine's claims about the problems inherent in classical empiricism

    c. an account of Quine's counterproposal to one of the traditional assumptions of classical empiricism

    d. an overview of classical empiricism and its contributions to Quine's alternate understanding of empiricism

    e. a history of classical empiricism and Quine's reservations about it

10. According to Quine's conception of empiricism, if a new observation were to contradict some statement already within our system of knowledge, which of the following would be true?

    a. The new observation would be rejected as untrue.

b. Both the observation and the statement in our system that it had contradicted would be discarded.

c. New observations would be added to our web of statements in order to expand our system of knowledge.

d. The observation or some part of our web of statements would need to be adjusted to resolve the contradiction.

e. An entirely new field of knowledge would be created.