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The impact of stereotype threat on high school females' math performance: Moderators and an intervention

Jacqueline Hebert Ball
Louisiana Tech University

THE IMPACT OF STEREOTYPE THREAT ON HIGH SCHOOL FEMALES' MATH PERFORMANCE: MODERATORS AND AN INTERVENTION

by

Jacqueline Hebert Ball, M.S., M.A.

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Walter Buboltz, PhD

Supervisor of Dissertation Research

Donna Thomas

Head of Department

Department of Psychology

Department

Recommendation concurred in:

Advisory Committee

Approved:

Director of Graduate Studies

Dean of the College

Approved:

Sheryl S. Shoemaker

Dean of the Graduate School

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ABSTRACT

Historically, there has been a significant gender gap in science, technology, engineering, and mathematics (STEM) careers (Beede et al., 2011; National Science Foundation, 2009), which has been attributed to females' lack of interest and pursuit of careers in these fields (Singletary et al., 2009). In the past, the lack of female participation in these careers was explained by a difference in natural abilities in these areas, especially in mathematics (Benbow & Stanley, 1983); however, research has shown that females are capable of performing just as well as males in the same age group in math (Smith & White, 2002; Spencer et al., 1999). In recent decades another explanation for this gender gap has arisen, *stereotype threat* (Steele & Aronson, 1995).

Stereotype threat occurs when an individual is placed in a situation in which he or she is at risk for confirming a negative stereotype about his or her group (Steele & Aronson, 1995). It has been proposed that females experience stereotype threat when taking a math test due to the concern of confirming the negative stereotype that females are not as capable as males in math, which hinders their performance due to increased anxiety and self-evaluation (Spencer et al., 1999; Steele & Aronson, 1995).

This study sought to extend the research in the area of stereotype-threat effects on females' math performance by examining the effects of proposed moderators (i.e., domain identification, gender identification, and stigma consciousness), a proposed protective factor (i.e., math self-efficacy), and an intervention to reduce threat with a high school student sample of 100 participants. The results of the present study replicated the

findings previously produced in studies with college student samples, specifically that females perform lower than males in a stereotype-threat condition and that they perform comparable to males when an intervention of reframing the math test as gender fair is employed (Quinn & Spencer, 2001; Smith & White, 2002; Spencer et al., 1999). There was no significant moderation found in the present study; however, math identification and math self-efficacy were indicated to be positively correlated to math performance. This finding can have great implications in the classroom setting and in increasing females' interest and pursuit of math and other STEM careers. Future research should continue to examine the potential benefits of employing a reframing the task as gender fair intervention, specifically examining its long-term effectiveness. Additionally, future studies could examine ways to develop and increase females' math self-efficacy and math identification.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

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CHAPTER ONE

INTRODUCTION

In an economic time where job uncertainty and competition are at the forefront of many Americans' minds (Jacobe, 2011), it is important that the youth of America not limit themselves in their career aspirations and that they are given the opportunities to reach their fullest potential. Historically, there has been a significant gender gap in science, technology, engineering, and mathematics (STEM) careers because females' interest and participation in these careers have been limited (Beede et al., 2011; Meece, Parsons, Kaczala, & Goff, 1982; National Science Foundation, 2009). Despite a slight increase in the number of degrees in math awarded to females (Hyde, Lindberg, Linn, Ellis, & Williams, 2008), research suggests females still are unlikely to enter STEM fields (Beede et al., 2011; Singletary, Ruggs, Hebl, & Davies, 2009). A 2011 report by the Economics and Statistics Administration of the United States Department of Commerce (Beede et al., 2011) on the gender gap in STEM careers indicated that, "Although women fill close to half of all jobs in the U.S. economy, they hold less than 25 percent of STEM jobs" (p. 1). This governmental report alluded to the fact that it is not only important that America's female students become interested in STEM careers to be competitive in our own job market, but also to contribute to the field to help the United States stay competitive with other countries in innovation and technology (Beede et al., 2011).

Research has shown that one reason females avoid STEM careers is related to differences typically found between males and females in math performance and this gender difference deters females from pursuing STEM careers (Singletary et al., 2009). It has been observed that males outperform females in mathematics, and this performance gap has been found to be greater in more difficult and more advanced math subjects, such as calculus (Smith & White, 2002; Spencer, Steele, & Quinn, 1999). In the past, theorists and researchers proposed that these performance and interest gaps between males and females were due to differences in genetics and natural abilities (Benbow & Stanley, 1983). It was suggested that females have lower abilities than males in mathematics and math-related fields; however, recently another explanation has been proposed because several studies have shown that females can perform just as well as males and that their abilities are, on average, comparable to males within the same age group (Gresky, Ten Eyck, Lord, & McIntyre, 2005; McIntyre et al., 2005; Smith & White, 2002; Spencer et al., 1999). In order to explain the historical gender performance gap, Steele and Aronson (1995) proposed the idea that *stereotype threat* hinders females' performance in math.

Steele and Aronson (1995) define stereotype threat as "being at risk of confirming, as self-characteristic, a negative stereotype about one's group" (p. 797). There is a long-standing stereotype that females are not as able and intelligent in the areas of math and science compared to males. Individuals are exposed to this stereotype from a young age through various sources, including the media, television programs, toys, parents, teachers, and authority figures (Davies, Spencer, & Steele, 2005; Eccles, Jacobs, & Harold, 1990). Stereotype threat is enacted when individuals are placed in situations where there is potential for them to confirm a negative stereotype about their group. It is proposed that when females are placed in a situation where they have to perform math problems, their performance is hindered by the stereotype threat (Spencer et al., 1999; Steele & Aronson, 1995). Performance is hindered because of the fear of confirming the negative stereotype of their gender group that females are not as good in math as males, and this concern interferes with their performance due to heightened anxiety and increased cognitive load (Steele & Aronson, 1995). When females are placed in a stereotype-threat-inducing situation, their cognitive load is increased due to increased self-evaluation and self-regulation to avoid confirming the negative stereotype about their group (Schmader & Johns, 2003).

Studies have supported the idea that stereotype threat explains the gender gap in performance and interest in mathematics and math-related fields. When stereotype threat is activated, females' math performance is decreased, which leads them to avoid or drop out of mathematics and related subjects. The lack of interest and avoidance of math and math-related fields can be explained by the Social Cognitive Career Theory (SCCT) developed by Lent, Brown, and Hackett (1994, 2000), which proposes that there are three variables involved in career development: self-efficacy, outcome expectations, and goals. Lent et al. (1994, 2000) suggest that one's self-efficacy, or beliefs about one's capabilities, in a particular subject affects one's expected performance in that subject, which shapes the decision to pursue or avoid long-term goals. According to Bandura (1982), self-efficacy is not a general concept of one's self-worth, but rather a set of self-beliefs one has about his or her abilities in specific domains. Self-efficacy can be influenced by various sources; however, personal performance in a domain can have the greatest influence and lead to a decline of interest in that domain (Lent, 2005).

Studies have shown that when an intervention is implemented to reduce threat, females perform comparably to males (Gresky et al., 2005; McIntyre et al., 2005; Smith & White, 2002; Spencer et al., 1999). A major emphasis of stereotype-threat research in the past few decades has focused on creating and testing the effectiveness of interventions to decrease the threat and its consequences. Interventions, such as reframing the task to be gender-fair, have been effective in decreasing stereotype threat experienced by minorities and females. Additional research on stereotype-threat-reduction interventions include deemphasizing threatened social identities, encouraging self-affirmation, providing role models, and emphasizing an incremental view of intelligence. The intervention of reframing the task as gender-fair has been utilized often in research studies as it is easy to implement. This intervention entails telling the subjects in the experimental condition that the test they are about to complete has shown no gender differences in performance in the past.

Researchers have studied variables that may mediate the relationship between stereotype threat and performance and have found that anxiety, arousal, and working memory each play an important role in this process (Schmader & Johns, 2003; Spencer et al., 1999; Steele, 1997). Studies also have discovered that individual differences in gender identification and domain identification influence the degree to which stereotype threat decreases females' math performance (Cullen, Waters, & Sacket, 2006; Keller, 2007a; Steele, 1997). Stigma consciousness, which refers to the level of expectation one has of being a target of a stereotype (Pinel, 1999), also has been found to moderate the relationship between stereotype threat and the targeted group's math performance. Previous research found that individuals who are more aware of their group's stereotyped status are more likely to underperform on math tests when placed in stereotype-threat situations (Brown & Pinel, 2003).

Most of the previous research in this field of study has been conducted in controlled settings with college students. This study sought to extend the research in the area of stereotype-threat effects on females' math performance by utilizing a setting of actual high school math classrooms, which increased the ecological validity of the study. This study proposed to test the previously researched moderators of domain identification, gender identification, and stigma consciousness and a proposed protective factor of math self-efficacy in a setting with high school students instead of utilizing a college student sample. This study also examined the effects of a gender-fair intervention to decrease stereotype threat female students experience while taking a math exam amongst their male peers.

Statement of the Problem

Research has shown that stereotype threat is a hindrance for females when faced with a negative stereotype-threat situation such as a math test (Ambady, Shih, Kim, & Pittinsky, 2001; Good, Aronson, & Harder, 2008; Inzlicht & Ben-Zeev, 2000; Spencer et al., 1999; Walsh, Hickey, & Duffy, 1999). Because stereotype threat can lead to decreased math performance in females, this can affect their self-confidence related to math and lead them to believe that they are incapable of performing well in math and math-related fields. It has been found that repeated failures in a particular domain tend to lead to lower self-efficacy in that domain (Lent, 2005). According to Lent et al.'s (1994, 2000) SCCT, a vocational development theory, if an individual has low self-efficacy in a particular academic domain, this lack of confidence in his or her personal abilities in this area can lead to lower outcome expectations and in turn a lack of interest and goal pursuit in that domain. Additionally, one's self-efficacy in a specific domain is influenced by other factors including personal variables, such as gender and race, and environmental variables, such as peer, parental, and teacher feedback, vicarious learning, and role model influences. The negative stereotype that females are not as capable as males in math, along with females' actual decreased performance on math tests as a result of the stereotype threat, can lead to a damaging cycle and have long-lasting effects.

High school females tend to enroll in advanced math classes less than males (Bleeker & Jacobs, 2004). This places them at a disadvantage in the future because advanced math subject areas are involved in college entrance exams and course requirements in the attainment of degrees with prestige and high-paying salaries (i.e., engineering, scientific and medical careers, computer science, and business) (Bleeker & Jacobs, 2004). Research also has found that stereotype threat can impact major life choices, such as which major to choose and which careers to pursue, and may prevent females from reaching their full potential, indirectly denying them the possibility of a STEM career (Steele, James, & Barnett, 2002). Blickenstaff (2005) states that, "as long as women are underrepresented in STEM, a substantial number of intelligent, talented women are choosing other subject areas in which to study and work. . . . women who could make important contributions to science or engineering if given a chance" (p. 370).

In order to alleviate this problem of too few females in STEM, researchers are looking at how to ameliorate the negative effects of stereotype threat (Gresky et al., 2005; Shih, Pittinsky, & Ambady; 1999; Stricker & Ward, 2004). Several interventions to reduce stereotype threat have been studied (Keller & Dauenheimer, 2003; Marx &

Roman, 2002; McGlone & Aronson, 2006; Quinn & Spencer, 2001; Smith & White, 2002), and it is apparent that more studies are needed to examine which interventions work best at reducing stereotype threat. Also, further research is needed that utilizes different populations, besides college students. Most studies in this area have been conducted with college students, and it is possible that stereotype threat affects high school students differently than college students. This study utilized a high school sample, and it was conducted in high school classrooms. This study sought to determine the role that gender identification, math identification, stigma consciousness, and math self-efficacy play in the relationship between stereotype threat and math performance in high school females. Additionally, this study examined the effectiveness of an intervention to reduce stereotype threat within a high school sample.

Justification

Two major criticisms of the body of research on stereotype-threat effects are the overreliance on, and overuse of, college samples (Whaley, 1998) and a failure to generalize findings to real-world situations (Stricker & Ward, 2004). Whaley (1998) proposed that "research on college populations may be too narrow a base on which to rest social psychological theories of human behavior" (p. 679). There are many reasons one could suggest in proposing that stereotype threat may affect high school females differently than college females, such as differences in identity development, self-concept, and experience and confidence in math. Because of these possible differences between high school and college females, more studies need to be conducted with high school females in natural academic settings. A meta-analytic study by Nguyen and Ryan (2008) included 116 studies that examined the effects of stereotype threat on minorities' test performance. Of the included studies, only six published studies utilized high school female participants, and five of those studies were conducted in Germany.

Some studies have been conducted utilizing students in classroom settings and have found the damaging effects of stereotype threat (Ambady et al., 2001; Huguet & Régner, 2007; Neuville & Croizet, 2007); however, only a few studies have used high school students with standardized math tests. Several studies have used some sort of "memory game" such as completing the Rey-Complex Figure task (Huguet & Régner, 2007) or other non-math tests such as Raven Progressive Matrices (Desert, Preaux, & Jund, 2009) and the APR Spatial Ability Test (Kellow & Jones, 2005) in order to disguise the task. It is difficult to generalize these results because a math test requires different skills than a memory, reasoning, or spatial ability test even if they are all considered difficult and can activate stereotype threat in females.

In order to identify factors which may increase the number of females in STEM careers, it is vital to conduct studies in the high school setting due to the fact that this time period has a major impact on the career choices females make for their futures. If a better understanding is developed of how stereotype threat affects female high school students and if a stereotype-threat-reducing intervention is effective with this population, steps can be taken in high school classrooms across the country to intervene earlier with career decisions and to increase the number of females in STEM careers. Lent et al.'s (1994, 2000) SCCT proposes that domain-specific self-efficacy and outcome expectations are the key to promoting students' career interests and aspirations, and according to Lent (2005) these aspirations "can become constricted either because their environments provide limited or biased exposure to particular efficacy-building experiences (e.g., few opportunities to succeed at scientific pursuits, no gender-similar role models in math) or because they acquire inaccurate self-efficacy or occupational outcome expectations" (p. 130). If interventions are put in place to reduce the negative effects of stereotype threat on females' math performance, females' math self-efficacy may increase, which could lead to increased interest and career aspirations in STEM.

Literature Review

Females in STEM

Females are significantly underrepresented in (STEM) careers (National Science Foundation, 2009). The number of women awarded bachelor degrees in science and engineering fields has increased over the past decade; however, "women's share of bachelor's degrees in computer sciences, mathematics, and engineering has declined in recent years" (National Science Foundation, 2009, p. 5). Blickenstaff (2005) asserts that females lose interest and drop out of participation in sciences and math at different times in their lives: during high school while making the decision to take advanced math courses and of which major to pursue in college, while in college changing majors from science and mathematics to other fields, and even upon graduating with a STEM degree and not pursuing a job in those fields. Females who pursue careers in STEM, especially in academia, have a tendency to drop out of those careers at a higher rate than males (Settles, Cortina, Malley, & Stewart, 2006). Blickenstaff refers to this loss of women from STEM as the "leaky pipeline." Attention to fixing this problem is necessary in order to ensure that females do not limit their job options and miss out on in-demand careers with the possibility of high-paying salaries.

A report by the United States Department of Commerce (Beede et al., 2011) states that the number of college-educated females has increased over the past decade and they make up almost half of America's workforce; however, females hold 24% of STEM jobs. Additionally, this report asserts that even though the number of females in engineering and physical and life sciences has increased over the past decade, the amount of females in math jobs has decreased by 3% (Beede et al., 2011). The lack of participation has led to speculation of what causes this gender gap in STEM careers.

The outdated idea that this gender gap can be explained by differences in males' and females' math abilities has been disproven over the years. In recent years it has been found that females often earn better math grades than males (Kenney-Benson, Pomerantz, Ryan, & Patrick, 2006) even if they do not pursue more advanced math courses than males. Research has shown that there are no differences between males' and females' general math ability; however, studies have found differences between the sexes in interests and specific abilities of mathematics (Monastersky, 2005). For example, it has been found that boys are more interested in figuring out how systems work, which leads to a tendency to participate in exercises involving math, while girls are more interested in wanting to understand the mental states of others (Monastersky, 2005).

Research also has found that boys have greater spatial abilities than females, which are involved in tasks such as mentally rotating objects (Halpern et al., 2007). Additionally, studies have found that boys tend to be faster at fact retrieval and may have better problem solving skills (Hyde, Fennema, & Lamon, 1990; Royer & Wing, 2002). Data from a longitudinal study titled the Study of Mathematically Precocious Youth indicated that "males are much more variable in their mathematical ability, meaning that females of any age are more clustered toward the center of the distribution of skills and males are spread out toward the ends" (Halpern et al., 2007, p. 46). This means that there are more mathematically-gifted males than females, but there are also more males than females at the low end of math-ability spectrum (Benbow & Stanley, 1983).

One major difficulty in determining what leads to an underrepresentation of females in STEM is that it almost is impossible to parse the effects of multiple sources, including innate cognitive abilities, cultural and societal influences, and educational opportunities. Even though some research has found sex differences in cognitive abilities, it cannot be definitely determined if innate abilities in math and sciences leads to a gender gap in STEM. For example, in a meta-analytic study by Baenninger and Newcombe (1989) the researchers found that males had superior spatial abilities when compared to females, but they also found that with training females' spatial skills easily rise to the same level as males. If spatial skills is the major difference between the sexes and females' skills in this area can easily be improved with training, then this must not account for the gender gap in STEM. Additionally, it is known that females are capable of getting into college, graduating with advanced degrees, and often making higher grades than males (Halpern et al., 2007).

With this evidence in mind, it is important to turn the focus of research away from innate sex differences to other factors that lead to gender gaps which can be controlled and changed, such as attitudes and interests. Else-Quest, Hyde, and Linn (2010) found no significant overall gender differences internationally in mathematics achievement; however, males scored considerably higher on measures of math attitudes. Lubinski and Benbow (2006) found in their Study of Mathematically Precocious Youth that special education opportunities strengthen the development of one's mathematical talent. This means that children at a young age should begin to receive specialized educational opportunities based on their academic talents in order to continue development of those talents. However, if females are not as interested in math and have a poor attitude toward the subject, they will not seek out this enhancement, which could be one place where the gender gap in STEM begins. Steele et al. (2002) suggest that females' perceptions of discrimination in STEM have created and maintained that gender gap.

A variety of societal explanations have been given to explain this gender gap in STEM careers, including sexism and discrimination experienced by females in the workplace (Settles et al., 2006). Other societal explanations have included barriers such as parenting roles and lack of social support and communal goals in STEM work environments (Settles et al., 2006). However, these barriers do not give support to the explanation of why females are not interested in STEM careers initially. The social psychology concept coined by Steele and Aronson (1995), stereotype threat, gives an excellent explanation as to why females are not interested in STEM careers, but it also help explain why females drop out of STEM. Steele et al. (2002) found that females are likely to change their majors if they experience a great amount of stereotype threat in male-dominated majors.

In a study by Murphy, Steele, and Gross (2007), the researchers found that females who were exposed to an advertisement video of a math, science, and engineering conference with more men than women in the video, later reported having a lower sense of belonging and desire to attend the advertised conference. Additionally, the females who saw the video with an unbalanced ratio of men to women showed higher levels of cognitive and physiological vigilance than females who saw a video of the conference with an equal number of males and females. Steele, Reisz, Williams, & Kawakami (2007) point out that other barriers for females in STEM fields do exist and contribute to creating the gender gap in these careers, including discrimination and social roles; however, stereotype threat has a powerful effect on females' attitudes and behaviors which can have long-standing impacts.

Researchers have applied Lent et al.'s (1994, 2000) SCCT to STEM, and according to Soldner, Rowan-Kenyon, Inkelas, Garvey, & Robbins (2012) "three related constructs have been incorporated into the theory's framework: (a) students' interest in STEM pursuits (e.g., reading about STEM, or STEM-related problem solving), (b) the presence of social supports, and (c) present or anticipated barriers" (p. 315). Stereotype threat has been found to be a significant barrier to interest in STEM careers due to poor performance as a result of stereotype threat.

Stereotype Threat

As defined by Steele and Aronson (1995), *stereotype threat* is "being at risk of confirming, as self-characteristic, a negative stereotype about one's group" (p. 797). Steele and Aronson first used this term when they found in several studies that African American students performed lower that White students when stereotype threat was induced, and the African American students performed just as well as White students when stereotype threat was not emphasized. The stereotype threat was highlighted in the "diagnostic condition" by informing the students before taking a test that the exam was used to judge their reading and verbal abilities. In this condition, the stereotype threat was activated because the African American students were afraid of confirming the negative stereotype that African American individuals are not as intelligent as White individuals (Steele & Aronson, 1995).

According to Steele (1997) "stereotype threat is a general threat not tied to the psychology of particular stigmatized groups. It affects the members of any group about whom there exists some generally known negative stereotype" (p. 617). Results similar to Steele and Aronson's seminal work have been produced in numerous studies utilizing ethnic minorities as well as females and individuals from low economic status backgrounds (Singletary et al., 2009). Kellow and Jones (2005) conducted a study with high school freshmen in order to determine the degree of negative effects that stereotype threat can have on African American high school students. The results of this study indicated that stereotype threat can have significant effects on this population because not only did the African American participants score substantially lower on a mathematic reasoning test than the White subjects, but they also reported higher anxiety and lower feelings of self-competence and expectations for success than the African American participants in the condition where stereotype threat was not induced.

A study by Blascovich, Spencer, Quinn, and Steele (2001) highlighted the physical effect of stereotype threat as they found that African American subjects had increased blood pressure when placed in a situation where stereotype threat was activated. The African American subjects who were told that they were taking a newly developed test and would be part of creating a nationally representative sample had increased blood pressure and decreased performance on the test when compared with the African American subjects in the control condition. The idea that they could confirm the negative stereotype about African Americans' intelligence led to a physiological response and hindered their performance.

Desert et al. (2009) conducted a study with six to nine year olds and found that children of low socioeconomic status had lower performance on an intelligence test compared to children of higher socioeconomic status when they were told that their abilities were being evaluated, but the two groups performed equally in the non-evaluative condition. Croizet and Claire (1998) found similar results with college students; participants with lower socioeconomic status, which was based on their parents' occupation and the amount of funding they were receiving for school, completed fewer problems than those with higher SES when told that the test was assessing their intellectual ability.

Spencer et al. (1999) showed that stereotype threat also can have an impact on test performance for females. The researchers demonstrated in three experiments that females underperform when they are in a condition that triggers stereotype threat. Female participants in Spencer et al.'s studies were apprehensive about confirming the negative stereotype that females have lower abilities than males in math because this is a stereotype that is well known in our society. Muzzatti and Agnoli (2007) found that boys and girls starting in as low as the 3rd grade can start to develop the stereotypical belief that boys are better in math than girls. Their studies showed that from a young age, girls have lower self-confidence than boys in mathematics, and girls' performance in math can start to be affected by these stereotype beliefs as early as 8th grade. These results are similar to ones found in studies about ethnicity, McKown and Weinstein (2003) conducted two studies with children ranging from age 6 to 10 with diverse ethnicities and illuminated the idea that stereotype-threat awareness or "stereotype consciousness" increases with age and that participants of minority ethnicities, African American and Latino, had more awareness of cultural stereotypes than the children belonging to the non-stigmatized ethnic groups, White and Asian. Additionally, the participants in the stigmatized group performed lower on a task when it was described to them as assessing their abilities than the children in the non-stigmatized group.

The consequences of stereotype threat, such as self-handicapping, fear of failure, lack of confidence in personal abilities, disengagement from academic domains, and avoidance of male-dominated career fields, also have been given much attention in the literature. It has been shown that stereotype threat can lead to less effort and self-handicapping when an individual is placed in a situation where there is a possibility of confirming a negative stereotype about his or her group (Stone, 2002). Stone (2002) revealed that White participants who were told that their "natural athletic abilities" would be tested with a task were less likely to practice and put forth maximum effort, and this effect was found to be even more prevalent with White participants who identified with sports. Stone proposed that the White participants self-handicapped as a way to psychologically protect themselves from future failure because the negative stereotype that African Americans are better at sports that White individuals was activated in the experimental group of the study.

Self-handicapping has been found to protect one's self-esteem and self-confidence and, typically, create the concept of a self-serving bias where individuals will attribute their successes internally and their failures externally (Rhodewalt, Saltzman, & Wittmer, 1984; Stone, 2002; Tice & Baumeister, 1990). Unfortunately, it has been discovered that stereotype threat can lead stigmatized individuals to attribute failure internally versus externally. In a study by Koch, Müller, and Sieverding (2008) female subjects were more likely than the male participants to attribute failure to themselves than external sources. In this experiment the participants were to complete a task on a computer, but the subjects were not aware that the experimenters sabotaged the task by giving the subjects a faulty USB flash drive and the task was bound to fail. The female participants in the stereotype-threat-induced condition were more likely to attribute the failure of the USB drive to their own ability rather than the actual device. This study gave some insight into why a low number of females pursue careers in the computer industry because computers, regardless of the operator, have a tendency to have malfunctions and technical difficulties, so if females make internal attributions, they may stray from this type of work in order to preserve their self-esteem.

Stereotype threat also can undermine individuals' confidence in their abilities. Two experiments by Stangor, Carr, and Kiang (1998) provided evidence that when individuals are given positive feedback on their performance under conditions of stereotype threat, the stereotype threat will negate the power of the positive feedback and the stereotype threat will lead to lower expectations for future performance. Roberson, Deitch, Brief, and Block (2003) found similar results in a real-world setting, the workplace. In their study African American subjects were less likely to accept feedback from their manager than non-threatened individuals, and this dismissing of feedback increased for individuals if they were the only person of minority ethnicity in their department.

Another consequence of stereotype threat that can have long-term effects is the impact that it can have on individuals' academic identity in general or with a specific domain when placed in situations where they can affirm a negative stereotype about their group (Spencer et al., 1999). Schmader, Major, and Gramzow (2001) state that "psychological disengagement is a defensive detachment of self-esteem from one's outcomes in a domain such that self-esteem is not contingent upon one's successes or failures in that domain" (p. 94). It has been proposed that when stereotype threat is triggered, individuals will disidentify or disengage from a domain in order to preserve their self-esteem (Major & Schmader, 1998; Osborne, 1995; Schmader et al., 2001). Whereas research has found that stereotype threat can lead to chronic, long-term disengagement from academics and specific domains for the stigmatized individuals, it also has been demonstrated that stereotype threat can cause short-term, situational disengagement, which can be beneficial for individuals' persistence and motivation (Nussbaum & Steele, 2007). The problem here is that one cannot predict whether an individual will be able to disengage only for a short period of time and not continue to disengage once out of that stereotype-threat situation.

Research has shown that negative stereotypes can have major impacts on females' self-esteem and self-efficacy in academic subjects, life choices, and career growth and development. Female participants who were shown stereotypic commercials were more likely to avoid math items on a test and instead choose verbal items, and they were less likely to endorse interest in math-related vocations (Davies, Spencer, Quinn, & Gerhardstein, 2002). Stereotype threat also can lead to females straying from leadership roles due to the masculine undertones that leadership typically brings. Two studies by

Davies et al. (2005) illuminated the effect that media can have on females' leadership aspirations; female participants who were shown a commercial of women portrayed in stereotypical roles, hoping to become homecoming queen and obsessed with personal appearance, were less likely to later choose to be in leadership roles, but instead chose subordinated roles.

According to SCCT, career goals and aspirations are largely influenced by self-efficacy and outcome expectations, which are affected by personal performance in specific domains and by societal influences such as views of which careers are gender appropriate (Lent, 2005). As such, stereotype threat also can have long-term effects on what majors females choose and which careers to pursue, and this may hinder their ability to reach their full potential (Steele et al., 2002). Gupta and Bhawe (2007) found that females with proactive personalities had lower intentions of pursuing a career in a male-dominated job, such as an entrepreneur, when placed in a stereotype-threat condition. In a study by Bergeron, Block, and Echtenkamp (2006) there were two conditions: masculine sex role-type condition and feminine sex role-type condition. Participants in the feminine sex role-type condition were presented with a predecessor of female sex. The female predecessor was described with feminine adjectives such as understanding and creative. Participants in the masculine sex role-type condition were informed of a male predecessor who was described with masculine adjectives such as aggressive and decisive. The results showed that female participants underperformed when compared to the male participants on a managerial task, but only significantly in the masculine sex role-type group. In both groups, the authors found that the female participants experienced significantly more stereotype threat than the male participants;

however, female participants who were faced with a female predecessor or role model did not show performance decrements.

Mechanism Underlying and Factors Affecting Stereotype Threat

It is helpful to know what mechanisms underlie the relationship between stereotype threat and decreased math performance in order to better understand its impact. Researchers have proposed and found evidence that anxiety, arousal, and working memory all mediate the relationship between stereotype threat and decreased math performance (Singletary et al., 2009). Spencer et al. (1999) established evidence that anxiety is related to the relationship between stereotype threat and math test performance; however, they did not find conclusive evidence that anxiety acts as a mediator between the two. Later studies found significant evidence that stereotype threat causes anxiety in the stigmatized individuals (Bosson, Haymovitz, & Pinel, 2004; Osborne, 2001), which can lead to decreased performance on a task in a stereotype-threat situation. The results of Osborne‘s (2001) study showed anxiety as a partial mediator in the relationship between racial group and test scores; level of anxiety accounted for up to 41% of the variation in test scores between African American subjects and White subjects.

Bosson et al. (2004) found that even though stereotyped individuals may not report feeling anxiety caused by the stereotype-threat situation, there is indirect evidence of their anxiety which can be observed through nonverbal cues. In their study, there were two conditions to which the subjects were assigned: the stereotype-threat manipulation condition where the participants had to indicate their sexual orientation on a demographic survey and the no-prime survey where there was no indication of sexual orientation.

Results showed that when homosexual men had to indicate their sexual orientation before interacting with children at a daycare, they showed nonverbal signs of being nervous, such as fidgeting, gaze averting, and smiling nervously. This research shows that stereotype threat can have consequences even when individuals are unaware of the effect it has on them. On a positive note, Ford, Ferguson, Brooks, and Hagadone (2004) found that females who were more likely to use humor as a coping mechanism showed fewer decrements in performance because the humor decreased their anxiety when placed in stereotype-threat situations.

Researchers have been successful in demonstrating that arousal is a mediator between stereotype threat and females' math performance. In line with previous research on arousal theories that arousal is helpful on easy tasks and detrimental on difficult tasks, O'Brien and Crandall (2003) found that females who were given difficult math tests while under stereotype-threat conditions had lower performance than females who took easy tests under the same conditions. Similar results were found by Ben-Zeev, Fein, and Inzlicht (2005) and Blascovich et al. (2001). In these studies, participants had increased blood pressure while taking a test with stereotype threat activated. Osborne (2007) sought to confirm Claude Steele's theory that stereotype threat leads to anxiety and in turn interferes with performance. In Osborne's study, females who were in the high stereotype-threat condition had increased physiological reactions to the situation, including increased skin conductance, skin temperature, and blood pressure. These autonomic arousal reactions to the situation are indicative of individuals experiencing stress and anxiety.

Several studies have produced evidence for the theory that working memory plays a role in mediating the relationship between stereotype threat and academic performance (Beilock, Jellison, Rydell, McConnell, & Carr, 2006; Beilock, Rydell, & McConnell, 2007; Inzlicht, McKay, & Aronson, 2006; Schmader & Johns, 2003; Steele & Aronson, 1995). For example, Schmader and Johns (2003) conducted three studies examining the role of working memory capacity in the negative effects of stereotype threat on math performance. In these experiments subjects were instructed to solve math problems while holding a set of words in memory, and they were asked to recall as many of the words as possible after completing the math problems. In all three experiments, stigmatized individuals in stereotype-threat-induced groups recalled significantly fewer words, which indicated that there was reduction of their working memory capacity. Beilock et al. (2007) found similar results of the mediation of reduction in working memory capacity in the relationship between stereotype threat and reduced math performance. In their experiment, participants were instructed to complete math problems while completing a secondary task designed to reduce available phonological resources. Participants completed two types of math problems: problems with high demand on working memory capacity and problems with low demand on working memory capacity. The results indicated that for participants in the stereotype-threat-induced groups only show reduced performance on the secondary task when completing the high demand math problems.

These studies have supported the hypothesis that stereotype threat increases the amount of cognitive load on individuals because stereotype threat increases self-evaluation, self-monitoring, and self-regulation due to the fact that they are trying to avoid confirming the negative stereotype about their group. However, it appears that this cognitive overload only causes performance decrements for individuals in the stereotyped group; it does not appear to negatively impact the performance of the non-stigmatized individuals. Beilock et al. (2007) stated that "in working memory intensive tasks such as mathematical problem solving, stereotype threat harms the cognitive system by co-opting working memory resources—and especially verbal resources—needed to perform certain types of math problems" (p. 274).

Evidence for the hypothesis that stereotype threat increases cognitive load due to an increase in self-evaluation and self-regulation was shown in a study by Inzlicht et al. (2006). These researchers had African American and White subjects complete a Stroop task. They found that African American subjects in the stereotype-threat condition, where the participants were told that the task would measure their intellectual ability, took longer to complete the Stroop task than African American subjects in the control group. Participants in the control conditions were told that the task was not a test of their intellectual ability. No significant differences were found among the White participants. A Stroop task requires attention and self-regulation as the participants have to report the color the words are printed in and ignore the actual color words, and these results showed that the subjects' executive resources of attention and self-regulation were depleted with increased stereotype-threat (Inzlicht et al., 2006).

Several factors have been suggested for the cause of the cognitive overload or depletion of executive functioning resources, such as emotional regulation and negative thinking related to the task. Johns, Inzlicht, and Schmader (2008) proposed that individuals attempt to suppress the anxiety that is associated with stereotype threat. This reduces their working memory resources, and in turn leads to decreased task performance. The authors found evidence for this hypothesis in several of their studies where they told the experimental group of college females that the working memory task they were going to complete was to assess their mathematic ability. In the middle of the administration of the working memory task, an attention allocation measure was used to assess whether their cognitive resources were being depleted as a result of suppressing their anxiety. The participants were either told that the attention task was measuring their perceptual focus or their anxiety. Females in the stereotype-threat condition who were told that the attention measure was assessing their perceptual focus paid more attention to the anxiety-related words on the computer screen than the females who were told the task was to measure their anxiety, as these females were trying to suppress the experience of anxiety. Cadinu, Maass, Rosabianca, and Kiesner (2005) proposed that stigmatized or threatened individuals experience decreases in their performance due to negative thinking that depletes their cognitive resources and distracts them from the task. In their study, female participants in the stereotype-threat condition answered fewer math problems correctly and reported more negative math-related thoughts during the examination than females in the control group.

Other potential mechanisms underlying the impact of stereotype threat include internal locus of control, lower expectations, and mode of regulatory focus. Cadinu, Maass, Lombardo, and Frigerio (2006) explored the moderating role of locus of control on the impact of stereotype threat, and they proposed that stigmatized individuals with more of an internal locus of control would have larger performance deficits than individuals with more of an external locus of control. This hypothesis was confirmed in their two studies, which shed light into the question of why some individuals in the stereotype-threat groups seem unaffected by stereotype threat. They found that individuals with an external locus of control, individuals who are more likely to attribute successes and failures to external sources, were not affected by the stereotype-threat manipulation. Typically, having an internal locus of control proves to be more psychologically healthy and beneficial academically; however, when stereotype threat is involved, that is not the case as it may hinder performance.

Level of expectation for performance on a task has been found to moderate the relationship between stereotype threat and decreased performance (Cadinu, Maass, Frigerio, Impagliazzo, & Latinotti, 2003). Cadinu et al. (2003) found that when female participants were given negative information about females' mathematical abilities they tended to report lower expectations of their performance as well as decreased performance on the test when compared to the females who were given positive information. The researchers suggest that stereotype-threat situations activate a self-fulfilling prophecy for the stigmatized individuals that they are expected to perform poorly and they expect themselves to will perform poorly.

Keller (2007b) revealed that the influence of negative expectations is moderated by the mode of self-regulatory focus. When individuals have a prevention focus (i.e., lose points for wrong answers on a test), they tend to perform worse on a task than individuals who have a promotion focus (i.e., no points are deducted for wrong answers). Other moderators have been proposed and researched, including domain identification and group identification.

Group identification

Research has found that the more a stigmatized individual identifies with his or her in-group (i.e., gender or ethnicity), the more susceptible he or she is to stereotype threat (Cole, Matheson, & Anisman, 2007; Schmader, 2002; Wout, Danso, Jackson, & Spencer, 2008). For example, Cole et al. (2007) discovered that minority students who had higher identification with their ethnic group had poorer performance and more symptoms of psychological distress during their first year of college than minority students who did not highly identify with their ethnic in-group. McFarland, Lev-Arey, and Ziegert (2003) measured participants' racial identity before and after taking an intelligence test, and in this study they found evidence that African American subjects who lowered their level of racial identity from pretest to posttest had higher performance on the test than African American subjects who did not alter their level of racial identity. The authors suggested that the higher performing African American participants disidentified with their racial identity during the administration of the test in order to rid themselves of the impact of stereotype threat.

This suggests a moderation effect in that stereotype threat should be highest at high levels of gender identity. In line with taking a social identity perspective, Schmader (2002) proposed that individuals are motivated to maintain a positive social identity, and individuals whose social identity is a large part of their self-definition are even more motivated to have a positive social identity. Schmader hypothesized and found evidence that females who have higher gender identification are likely to perform worse on a math test than females who have low gender identification and do not view female identity as a significant part of their self-definition.

Kiefer and Sekaquaptewa (2007) also found that females high in gender identification tended to perform more poorly than females who have less gender identification. In this study by Kiefer and Sekaquaptewa, 63 college female students completed measures of gender identification and career goals related to math after their first exam in a math course. The authors obtained their final exam grade from the math course and compared them to the measures previously obtained. The results showed the females who were low in gender identification performed better on the final exam than females with high gender identification. The authors also found that females who were high in gender identification were the least likely to interested in pursuing math-related careers.

Wout et al. (2008) investigated whether gender identification has different moderating effects on group- and self-threat. Their results revealed that level of gender identification only affected females' math performance when under group-threat. In the group-threat condition the participants were told before taking the math test that their performance would help the researchers understand their gender's math ability. For females in the self-threat condition who were told that their performance would be used to assess their individual math ability, level of gender identification was not a factor. This study highlighted the idea that stereotype threat only seems to be activated and moderated by the level of gender identification when the targeted group is reminded of their gender identity and their membership in their gender group.

Domain identification

Researchers also have discovered that the more individuals identify with a domain, the greater the impact stereotype threat can have on those individuals when performing in that domain (Aronson et al., 1999; Cadinu et al., 2003; Keller, 2007a; Leyens, Desert, Croizet, & Darcis, 2000; Spencer et al., 1999; Stone, Lynch, Sjomeling, & Darley, 1999). Major and Schmader (1998) explain that "individuals who are highly engaged in a domain link their self-evaluations and self-esteem to feedback received in that domain. Individuals who are disengaged from a domain, in contrast, are relatively impervious to feedback or outcomes received in that domain" (p. 220-221). This damaging effect has been found with different populations and domains when placed in stereotype-threat-induced situations, including African Americans who identified with verbal language (Lawrence, Marks, & Jackson, 2010), White males identifying with math when compared to Asian males (Aronson et al., 1999), and with females who identify with mathematics (Keller, 2007a; Lesko & Corpus, 2006).

In one of the first studies that examined the moderating effect of domain identification, Aronson et al. (1999) studied a population that typically is not a target of negative stereotypes, white males, except when they are compared to Asian individuals in math performance. In their study, the participants were White males enrolled in a year-long calculus course at a university. There were two conditions in which participants could be assigned: a stereotype-threat condition in which they were told that Asians perform better in math than Whites, and a control condition where there was no mention of math ability differences between Asians and Whites. The participants who highly identified with math in the stereotype-threat condition performed worse than the participants in that condition who had moderate to low math identification. In the control condition, subjects who had high math identification performed significantly better than individuals with moderate math identification.

Similar results were found in African American college students, 46 females and 22 males, who identified with verbal achievement (Lawrence et al., 2010). In the diagnostic condition the subjects were informed that the test, which consisted of moderate-difficult items from the verbal Scholastic Aptitude Test (SAT), was designed to measure their verbal ability, and in the control condition subjects were told that the test was to judge their problem solving ability. The results indicated that participants with higher verbal identification had a significantly lower number of correct items on the test. Lawrence et al. pointed out that this result is of concern because college students are likely to face moderate-difficult tests more frequently than easy or difficult test items in real-world academic settings.

Keller (2007a) demonstrated an interaction between domain identification and math problem difficulty when females were placed in a stereotype-threat condition. Females who were high on math identification performed worse than females who were lower in math identification on difficult math problems; however, this interaction was not found on easy items. This finding is alarming because math courses and content increase in difficulty and complexity as one enters college and progresses through their degree plan. Studies have shown that females who feel threatened will utilize various ego-protecting strategies. For example, Steele et al. (2002) found that females in male-dominated fields, such as math, reported higher levels of perceived sex discrimination against females in their fields than females in non-male-dominated fields. Having this perception can protect females' ego in male-dominated fields if they happen to perform poorly because they will attribute their poor performance to the perceived discrimination rather than to their abilities.

A study by Lesko and Corpus (2006) highlighted the ego protecting strategy of discounting the validity of the test. In their study, females in the stereotype-threat condition who reported high levels of math identification were more likely to discount the math test as being a valid measure of one's mathematical ability. An encouraging finding of Lesko and Corpus was that even though females in the stereotype-threat condition performed worse than males and they discounted the validity of the test, they did not lose their math identity as females who reported high levels of math identification during pretest also reported high levels at posttest.

In three studies Pronin, Steele, and Ross (2004) established evidence for the coping strategy of disidentifying with one's gender. In their first study they discovered the following:

> The women who had spent more time in the math environment (and presumably endured greater exposure to the relevant stereotype threat) reported less identification with ''feminine'' traits seen as highly incompatible with math success (e.g., being flirtatious or showing interest in having children) but no less identification with feminine traits seen as irrelevant to, or at least less incompatible with, such success (e.g., being nurturant or empathic). (p. 164)

Additionally, in studies two and three a manipulation was used to induce stereotype by having the subjects read an article stating that men had higher abilities in math than females. Females who identified with math at high levels were more likely to reject having feminine characteristics in order to remove themselves from the stereotyped group than females who showed lower levels of math identification. Pronin et al.'s studies produced positive evidence that females chose to disidentify with their gender instead of mathematics. As mentioned previously, this is not always the case as stereotype targets tend to disidentify with the academic area instead, which can have lasting effects. For example, Smith and White (2001) were interested in examining the negative stereotype that females are inferior to males in computer technology (CT), so in their study they inquired about subjects' level of CT identification and interest in a career in CT. They discovered that females had lower computer technology identification than males and that their level of CT identification predicted the likelihood that they would consider a career in CT.

Stigma consciousness

Another proposed moderator of the relationship between stereotype threat and decreased performance is stigma consciousness, which is a heightened perception or belief that one will be stigmatized or a target of a negative stereotype (Brown & Pinel, 2003; Pinel, 1999). This construct was proposed by Pinel (1999), who explained individuals experience stereotype threat differently and a reason why some individuals are more vulnerable to the effects of stereotype threat. In explaining the difference between stereotype threat and stigma consciousness, Pinel noted that "stereotype threat refers to a concern about one's own behavior (e.g., "Am I going to confirm the stereotype?"); high levels of stigma consciousness reflect an expectation that one will be stereotyped, irrespective of one's actual behavior" (p. 115).

In Pinel's (1999) five studies that validated the Stigma Consciousness Questionnaire (SCQ) she developed, she found interesting and informative results. For example, it was discovered that females who reported having higher levels of stigma consciousness also reported having a tendency to conform to implicit sex roles.

Additionally, when female subjects were asked to write as many instances of sexism they could remember, including personal experiences and acts they had witnessed, females with higher stigma consciousness reported more instances of discrimination and with more specificity than females with lower levels of stigma consciousness. In another one of the studies female participants sat a computer to play a trivia question game, one similar to jeopardy, and they could not see their opponent, but were told the sex of their opponent. The results of this study showed that females who were high on stigma consciousness were more likely to avoid stereotypic questions when facing a male opponent than a female opponent. Females who were low on stigma consciousness showed no preference in question topic with either sex of opponent.

Pinel (2004) wanted to provide evidence for the idea that stigma consciousness arises not only from individuals' past experiences with discrimination but also can be increased in a certain situation. The results of her study with 148 undergraduate females showed the following:

> Stigma consciousness levels, whether dispositional (i.e., trait) or situationally induced (i.e., state), influence targets' attributions for performance feedback. Despite having received the same exact evaluation, targets high in trait and state stigma consciousness demonstrated a greater tendency than targets low in both trait and state stigma consciousness to make attributions to discrimination (p. 47).

Pinel proposed that further research needed to be conducted in this area to determine if stigma consciousness interferes with possible benefits of discrimination attributions, namely protecting one's self-esteem.

Pinel, Warner, and Chua (2005) illustrated in their study that level of stigma consciousness can impact stigmatized individuals' probability of disengaging from academics and their self-esteem. Participants in this study completed a SCQ in reference to how conscious they were of being part of a stigmatized group before arriving at a predominantly White college, and they completed a SCQ concerning their stigma consciousness level after arriving at the college. Pinel et al. also gathered information from participants on their GPA, psychological disengagement, and self-esteem. The results of this study showed that stigmatized males (African American and Latino students) with increased levels of stigma consciousness had a tendency to disengage from school while stigmatized females with increased levels of stigma consciousness showed a tendency to increase their level of academic engagement. On the surface the fact that females increased in academic engagement seems like a positive finding; however, the authors suggest that this result for females is concerning because they believe that disengagement protects individuals' self-esteem, and they found evidence for this proposal as females in this study with high levels of stigma consciousness reported low levels of self-esteem.

Brown and Lee (2005) sampled 128 undergraduates at a highly selective liberal arts college in New England and administered a modified version of the SCQ that asked participants questions related to their race or ethnicity in general. This study showed that stigmatized students (i.e., African American and Latino) who reported high levels of stigma consciousness had lower grade-point averages (GPAs) than stigmatized students with lower stigma consciousness. Additionally, the results indicated that students in the stigmatized group with low levels of stigma consciousness had similar to equal GPAs as the non-stigmatized subjects (i.e., White and Asian students) with low levels of stigma consciousness. Mosley and Rosenberg (2007) also found evidence that stigmatized undergraduates with higher levels of stigma consciousness produced academic performance deficits, and she suggested that interventions should be in place when stigmatized individuals enter predominantly White universities, such as mentoring and role model programs as well as organizations that create a sense of belonging.

Similar negative results have been found in other studies even though the term "stigma consciousness" was not utilized, but the construct studied was the same. For example, Aronson and Inzlicht (2004) showed with a sample of undergraduate students that individuals who believed they were going to be a target of a stereotype had lower performance than others in the studies; however, they had high perceptions of their abilities, which were inaccurate. Aronson and Inzlicht had participants, who were African American and White undergraduates, complete a measure of "stereotype vulnerability" which measures an individual's level of expectancy and perception of being rejected due to one's minority status. Participants also completed a verbal task and reported the perceived likelihood of getting each problem correct. Results showed that African American subjects who were high in "stereotype vulnerability" tended to self-report higher expectations of their performance than African American subjects with low "stereotype vulnerability" and White subjects, and the latter two groups performed better than the high "stereotype vulnerability" group. The authors proposed that this inaccuracy and overconfidence is used as a method of self-preservation, but could be harmful to these individuals by having an unstable and inaccurate view of themselves.

Brown and Pinel (2003) established evidence for stigma consciousness as a moderator of the relationship between stereotype threat and females' math performance. Brown and Pinel screened the participants for math identification and decided only to allow subjects who scored above the 20^{th} percentile on a measure of math identification to participate in the study in order to weed out individuals who were highly disidentified with math and likely did not care about the experiment. There were two conditions in this experiment: high threat and low threat. In the low threat condition, participants were informed that the test they were about to complete was gender-fair, and participants in the high threat condition were told that the study was being conducted in order to understand what factors account for the large gender differences on math standardized tests with no mention of which gender tends to score higher. As found in previous research, females in the high threat condition scored lower on a math test than females in the low threat condition, but this only occurred for females with high stigma consciousness. Females in the high threat condition with low levels of stigma consciousness did not score significantly different from all females in the low threat condition.

Further research has been conducted on the idea that females' level of awareness of stigmas and stereotypes related to their math abilities can have negative effects in the short-term, such as on a specific math test, and in the long-term, such as their self-confidence in math and pursuit of math careers. Schmader, Johns, and Barquissau (2004) had a sample of undergraduate females majoring in math complete questionnaires about their endorsement of the stereotype that females are inferior to men in mathematics, on their continuation in math including graduate school and careers in math, and their self-perceptions of their confidence, abilities, and self-esteem in math. Results indicated that females with a tendency to endorse the negative stereotypes about females' math ability reported lower self-confidence in their ability to succeed in math, lower self-esteem in their ability to perform in math, and less of a desire to pursue graduate studies in math.

Mathematics self-efficacy

A proposed variable to protect against the negative effects of stereotype threat is self-efficacy. Self-efficacious beliefs are judgments of one's capabilities or, in other words, perceptions that individuals have about how well they perform a certain task or in a specific area (Bandura, 1982). Misjudgments of ourselves or inaccurate self-efficacy beliefs can have significant consequences. Bandura (1993) stated the following:

> People make causal contributions to their own functioning through mechanisms of personal agency. Among the mechanisms of agency, none is more central or pervasive than people's beliefs about their capabilities to exercise control over their own level of functioning and over events that affect their lives. Efficacy beliefs influence how people feel, think, motivate themselves, and behave. (p. 118)

Self-efficacy plays an important role in the selection of environments as well as influences the choices people make on which career paths to pursue and which areas they will put forth much effort. According to Lent (2005), "self-efficacy may be the more influential determinant in many situations that call for complex skills or potentially costly or difficult courses of action (e.g., whether to pursue a medical career)" (p. 105). The determinant function of self-efficacy beliefs also regulates human motivation, affect, and cognition (Bandura, 1989). The cognitive effects can take the form of goal setting, selfappraisals, and predictions. Self-efficacy can alter one's affect in negative ways such as experiencing stress, depression, and anxiety.

Studies have found that math self-efficacy is higher in males than in females (Pajares & Miller, 1994; Wigfield, Eccles, & Pintrick, 1996). Pajares and Miller (1994) discovered through path analysis that gender appears to be directly related to math self-efficacy and that math self-efficacy mediated the relationship between gender and performance on a math test. Males had higher math self-efficacy than females and performed better on the math test. Sex differences in levels of self-efficacy have been found as early as 5th grade (Ewers & Wood, 1993). Ewers and Wood conducted a study in which they had a sample of gifted and average-ability fifth-grade students estimate how well they would perform on a math test before they actually completed the math test. It was found that in both groups, gifted and average-ability, males showed higher self-efficacy than both groups of female participants because they predicted that they would get a high number of the math items correct.

This finding that females tend to have lower math self-efficacy has been found in other studies along with the indication that there is a relationship between female's self-efficacy in math and their math performance, which tends to be lower than males (Betz & Hackett, 1983; Hacket & Betz, 1989; Junge & Dretzke, 1995). Additionally, studies have shown that math self-efficacy is a strong predictor of college-major choice, and it is a stronger predictor of performance than previous math performance and math achievement (Betz & Hackett, 1983; Hackett & Betz, 1989). This has significant implications in the selection of college majors and careers and could help to explain the gender gap in mathematic careers. If females tend to have low math self-efficacy, and math self-efficacy predicts college-major choice, then females will be less likely to choose math-related majors and occupations. Social cognitive theory proposes that individuals will discount potential occupations due to faulty self-efficacy beliefs, and the greater barriers to an occupation appear to individuals, the less likely they will be to choose that major and occupation to pursue (Bussey & Bandura, 1999).

Several studies have demonstrated the great effects of math self-efficacy on math performance (Betz & Hackett 1983; Hackett & Betz, 1989; Junge & Dretzke, 1995; Liu, 2009; Pajares & Miller, 1994). Liu (2009) conducted a study examining differences in math self-efficacy, interest, motivation, and learning strategies between 15-year-old males and females from the United States and from Hong Kong. Results of the study indicated that males from both countries displayed higher math self-efficacy than their female counterparts and that math self-efficacy was the strongest predictor in the study for math performance. Self-efficacy has been found to influence other outcomes that can be related to math performance and selection of college major and career including anxiety (Wilfong, 2006), and goal orientation (Donovan & Hafsteinsson, 2006; Shim & Ryan, 2005). Wilfong (2006) completed a study with 242 university students in which questionnaire data were collected on computer self-efficacy, computer use, and computer experience in order to determine their relationship with anxiety and anger related to computers. Results found that self-efficacy had the most significant relationship with computer anxiety and anger, which was a negative relationship.

Donovan and Hafsteinsson (2006) found that self-efficacy is a moderator in the relationship between positive goal-performance discrepancies and goal revision. Goal-performance discrepancies are differences found between the goal one sets for himself and his actual behavior or performance towards that goal. The researchers recruited a sample of 139 job applicants at an Icelandic selection company. The procedure included asking participants to complete simple math problems on a computer, and after they completed the questions, they were asked what their self-set goals were for the test and their self-efficacy was assessed. They then were given feedback on their performance and asked to set personal goals for the second trial of completing the math problems. Results indicated that individuals who had higher self-efficacy set higher goals for the second trial. Individuals with lower self-efficacy still engaged in upward goal revision; however, the level of the goal revision was much smaller than that of the highly self-efficacious group.

Spencer et al. (1999) did not find a relationship between self-efficacy and math performance when participants were placed in a stereotype-threat induced situation. This intriguing finding will be part of the present study as we are interested in understanding what happens to math self-efficacy when individuals are placed in a stereotype-threat situation. There are three potential outcomes: self-efficacy could buffer the effects of stereotype threat and act as a protective barrier, self-efficacy could increase the effects of stereotype threat in a similar way that domain identification has been shown to do, or self-efficacy could play no role in the relationship between stereotype threat and math performance. In the present study, it is proposed that math self-efficacy will act as a protective barrier against stereotype threat in the control condition and the positive impact of high math self-efficacy will be even stronger for participants in the stereotype-threat-reduction condition.

Stereotype Threat and Female Math Performance

Many studies of the effects of stereotype threat have examined the impact that the phenomenon has on females' math performance (Brown & Pinel, 2003; Davies et al., 2002; Good et al., 2008; Spencer et al., 1999; Walsh et al., 1999). Spencer et al. (1999) propose that "in situations where math skills are exposed to judgment—be it a formal test, classroom participation, or simply computing the waiter's tip—women bear the extra burden of having a stereotype that alleges a sex-based inability" (p. 6). From a young age, girls are exposed to negative stereotypes about female performance in math compared to their male counterparts, and these messages can start having an effect on performance as young as six years old (Davies et al., 2005; Desert et al., 2009; Eccles et al., 1990). Eccles et al. (1990) hypothesized that "both parents' causal attributions for their children's successes, and parents' category-based gender role stereotypes, would lead to perceptual bias in their impressions of their children's competencies in gender role stereotyped activity domains" (p. 197), and that is exactly what they found over several studies. Davies et al. (2005) demonstrated how the media plays a role in portraying stereotypes in our society by showing television commercials to participants that portrayed females in stereotypic roles, which led to lowered aspirations of females in the experimental group.

One of the first set of studies that looked at the effect stereotype threat has on female math performance was by Spencer et al. (1999). These researchers found evidence that female participants' math performance was hindered in stereotype-threat conditions. In their first experiment, they found evidence for the supposition that females' performance typically is only lesser than males' performance when taking difficult math tests because females performed just as well as male participants when taking an easy math test. In their second experiment they were able to reduce the impact that stereotype threat has on female math performance by presenting the math test as gender-fair, showing no gender differences. Keller (2002) replicated the results that females under stereotype-threat conditions had decreased performance on a math test, and additionally, this study showed that self-handicapping mediates the relationship between stereotype threat and decreased math performance in females.

In an attempt to better understand why females perform lower than males and how stereotype threat affects females, Quinn and Spencer (2001) conducted two studies looking at the participants' mathematical problem-solving abilities. The results of the first study showed that females performed worse than males on math word problems, but when the word problems were turned into numerical math problems, the females performed just as well as the male participants. Furthermore, in their second study Quinn and Spencer found additional evidence that stereotype threat impacts females' performance in mathematical problem solving. In their second study participants were asked to say out loud what they were thinking or what strategies they were using to solve the math problems. In the high stereotype-threat condition, females were unable to formulate strategies to solve the problems and performed worse than males; however, in the reduced stereotype-threat condition where the participants were told that the problems were gender-fair, the females performed just as well as the males. The authors proposed that when females experienced frustration while trying to solve the problems in the gender-fair condition, they did not allow their emotions to affect their performance because they were not feeling the pressure to avoid confirming the negative stereotype about their gender.

Brown and Josephs (1999) found similar results that females performed significantly worse than males on a math test, but this was only when they were told that the test would be used to determine who in the group had weak mathematic abilities. When the females were told in another condition that the test would be used to assess who has exceptional mathematical abilities, the females performed equally as well as the males. In the latter condition, the females did not feel as much pressure to disconfirm the negative stereotype that females are not as good in math as males because the wording of the instructions negated the threat. These researchers also presented evidence that stigmatized individuals can perform just as well as non-stigmatized individuals if there is an external handicap or excuse for possible failure. In two of their studies, in one of the experimental conditions the subjects sat down at a computer in order to practice some math problems before taking the test; however, they were unable to complete the practice section because the computer crashed. The results showed that females in this condition performed just as well as the males.

Krendl, Richeson, Kelley, and Heatherton (2008) found neurological evidence that different regions of the brain are activated when females are under stereotype-threat conditions while completing math tests than when they are not in stereotype-threat conditions. Their study indicated that females in the control condition had regions in their brains activated that are typically associated with mathematical learning and working memory and females in the stereotype-threat condition, who were reminded of gender differences in math performance, had regions of their brains activated that are usually associated with emotion-regulation processing. This study provides hard evidence that stereotype-threat induces emotions and emotional regulation, thus hampering one's working memory capacity.

Several studies have been conducted on the role that a threatening environment plays in the relationship between stereotype threat and deficits in females' math performance (Inzlicht & Ben-Zeev, 2000; Inzlicht & Ben-Zeev, 2003; Sekaquaptewa & Thompson, 2003). Inzlicht and Ben-Zeev (2000) conducted a study with a sample of 72 undergraduate females with four conditions. Participants were either placed in a group composed of all females (same-sex condition) or in a group with more males than females (minority condition). Additionally, they were either given a math test or a verbal test to complete. All participants, in both the same-sex conditions and minority conditions, were told that their results on the tests would be told to the rest of the group. The results of this study indicated that when females are placed in a threatening environment, they only underperform in a stereotype-threat-related academic area such as math, but not in areas they do not experience stereotype threat, such as verbal skills. In this study, females who were in the minority condition significantly performed worse on a math test composed of Graduate Record Examination (GRE) study items than females in the same-sex condition who also took the math test. There was no significant difference in the performance of the participants in two conditions that took the verbal test. In a second study Inzlicht and Ben-Zeev (2000) conducted they found evidence to support the idea that the more males there are in the testing environment, the worse a female would perform. In this study they have three sex composition conditions:

minority condition, mixed-sex condition, and same-sex condition. Their math performance scores were lowest to highest for each condition, respectively.

Similar results were found in a study completed by Sekaquaptewa and Thompson (2003) in which female participants completed a math test either in a group of all females (non-solo group) or in a group where they were the only female and the rest of the group consisted of males (solo group). There also were two stereotype-threat conditions; one in which stereotype threat was induced and one in which stereotype threat was reduced by telling the participants that the math test showed no gender differences in the past. In this study the experimenters measured the dependent variable of math performance differently from the majority of the previous research studies; participants in this study had to answer the math questions verbally in the presence of the rest of the group rather than writing it on paper like most previous research studies in this area. The results of this study showed that females in the solo condition performed significantly lower than females in the non-solo condition. Additionally, females who were in the stereotype-threat condition performed significantly worse than the females in the stereotype-threat-reduction condition in both the solo and non-solo groups.

The two previously described studies showed that females underperform when placed in an academic environment with more males than females. However, in both of these studies the participants were told that their performance results would be revealed to the other participants in their group either at the end of the test as in the Inzlicht and Ben-Zeev (2000) study or during the test as in the Sekaquaptewa and Thompson (2003) study. In order to determine if this effect still would be found without participants' performance results being broadcasted to the rest of the participants, Inzlicht and Ben-

Zeev (2003) conducted a study with female undergraduates in which they completed a math test in a minority condition or in a same-sex condition, and the results either would be announced to others in their group or not. The results of this study showed that the environment can be threatening with more males than females even if the females are told that their scores would be kept confidential. The results also revealed that females in a minority condition, in which there were more males than females, performed significantly worse than females in the same-sex condition in both the public and private condition.

Not only does stereotype threat impair females' math performance, it also can affect them in other ways related to the math domain. Rivardo, Rhodes, Camaione, and Legg (2011) conducted a study to test a stereotype-threat-reduction intervention of framing a math test as problem-solving instead of a test that evaluates one's math abilities, and it was observed that female participants in the stereotype-activated groups attempted fewer problems on the math test. Experiments by Rydell, Rydell, and Boucher (2010) provided evidence that stereotype threat affects females' mathematic learning. The results of these studies showed that females' ability to memorize math-related information and to learn mathematical operations were decreased when under stereotype-threat conditions.

Davies et al. (2002) also found that stereotype threat can have detrimental effects on females' math performance, and in addition, their results illuminated the fact that stereotype threat can have negative effects on females' achievement-related choices. Participants in their experimental conditions were exposed to television commercials with gender stereotypes portrayed, and females who were exposed to stereotypic messages were less likely to express interest in math-related or quantitative domain vocations.

Implicit vs. Explicit Stereotype Threat

In research focused on stereotype threat's effects on females' math performance, two types of stereotype-threat exposure or conditions have been identified: implicit stereotype threat and explicit stereotype threat. In an implicit condition there is no mention of gender differences in math abilities, and this can be considered a control condition because there is no manipulation of participants' perceptions, attitudes, or emotions. Stereotype threat still has been found to be present in this type of condition because this is a naturally occurring form of stereotype threat (Kiefer & Sekaquaptewa, 2007; Quinn & Spencer, 2001; Smith & White, 2002).

Stereotype threat in this type of situation is said to be due to *implicit gender beliefs* that individuals learn early in life and use to unconsciously and automatically judge others', and their own, abilities (Rudman & Phelan, 2010). These implicit gender beliefs include those about academic domains, with females typically associating math and science with males and arts and humanities with females (Kiefer & Sekaquaptewa, 2007; Rudman & Phelan, 2010). Kiefer and Sekaquaptewa (2007) examined the effect of implicit gender-math stereotypes on females and results showed that females who have strong implicit gender-math stereotypes performed worse on a math test in a condition where stereotype threat was presumed to be reduced than females with low implicit gender-math stereotypes. In an explicit stereotype-threat condition, stereotype threat is purposefully activated with some manipulation, such as telling the participants that the test has produced gender differences in the past (Smith & White, 2002; Spencer et al., 1999).

The control condition in one of Spencer et al.'s (1999) experiments was a condition in which there was no explicit mention of gender differences, and females in this experiment underperformed compared to the males on the math test. Smith and White (2002) discovered that implicit stereotype threat has equally damaging effects on females' math performance as explicit stereotype threat. Thoman, White, Yamawaki, and Koishi (2008) replicated Smith and White's findings, and they found no significant differences in performance between the females in the control condition, who were told nothing about gender differences in math before taking a math test, and the females in the explicit stereotype-threat condition, who were told that males outperform females in math due to their higher natural abilities.

Additionally, in a meta-analytic study by Nguyen and Ryan (2008) it was shown that subtle stereotype-threat activation cues were more effective at lowering test performance than blatant and moderately explicit cues. The present study will only use an implicit stereotype-threat condition due to the fact that it has been shown that shown that implicit conditions are just as detrimental to performance and also to strengthen the ecological validity of the study because stereotype threat typically is not blatantly pointed out in real-world situations.

Stereotype-threat Interventions

Almost since the beginning of research on the negative effects of stereotype threat, researchers have tested interventions to reduce these negative effects. The present study will utilize a method of reframing the task to be gender-fair or producing no gender differences, but additional stereotype-threat-reduction interventions will be discussed here, including deemphasizing threatened social identities, encouraging self-affirmation, providing role models, and emphasizing an incremental view of intelligence. Additionally, the reasons for choosing a gender-fair task intervention for use in this study will be discussed.

Shih et al. (1999) have shown that subtly highlighting females' gender identity can lead to stereotype threat and lower performance. In a study involving Asian-American undergraduate females, Shih et al. had participants complete a questionnaire before taking a math test that highlighted their Asian identity, their female identity, or neither identity. The researchers found that participant who completed the female-identity survey performed lower than females in the Asian-identity survey on a math test. Additionally, it was found that females in the Asian-identity-salience group performed better than females in the control group. This finding that highlighting different social identities in typically stigmatized groups, such as females, can decrease stereotype threat, prompted further researcher into utilizing this manipulation to reduce the effects of stereotype threat (Gresky et al., 2005; Stricker & Ward, 2004).

In a study with 129 male and female undergraduate students, both male and female, Gresky et al. (2005) randomly assigned participants to three conditions: self-concept maps with many nodes, self-concept maps with few nodes, or no self-concept maps. The participants in the experimental conditions completed a math identification questionnaire earlier in the semester and a math test after completing the self-concept map. The data showed that females who highly identified with math and created self-concept maps with few nodes or did not create a self-concept map at all performed lower than males on a math test who also highly identified with math; however, females high in math identification who drew self-concept maps with many nodes performed just as well as their male counterparts on the math test. This study showed that by making stigmatized individuals aware of their other social identities the negative effects of stereotype threat can be reduced. Similar results were found by McGlone and Aronson (2006) who also had participants shift their focus to different social identities other than their stereotyped identity.

Ambady, Paik, Steele, Owen-Smith, and Mitchell (2004) conducted a study that used a manipulation of deemphasizing the threatened social identity by highlighting individuation. The study consisted of female undergraduate participants with a 2 (gender prime or no prime) by 2 (individuated or non-individuated) factorial design. Participants who were in the gender-primed condition as well as the individuated condition, in which the participants were asked to answer questions about their individual interests and personality traits, performed better on a math test than participants in the gender-prime and non-individuated conditions. They also performed better than participants in the control condition who were in the no prime and non-individuated condition.

Another stereotype-threat-reduction intervention that has been studied involves encouraging self-affirmation. This entails having the stigmatized individuals affirm their self-worth by having them focus on individual characteristics, skills, and values they view important about themselves. Martens, Johns, Greenberg, and Schimel (2006) showed how to combat stereotype threat by using self-affirmation. The researchers had females in the study who were in the experimental condition think about characteristic about themselves that they value and write a short description of a time when that characteristic was important to them. Females in the stereotype-threat condition who were in the self-affirmation group scored just as well as females in the no-threat condition. Cohen, Garcia, Apfel, and Master (2006) found similar results in a "real world" setting using self-affirmation with ethnic minority seventh-grade students. The results of their intervention had lasting results throughout the semester of school. African-American subjects who were in the self-affirmation group, in which they had to list values that were important to them and write a short essay about why they were important, had significantly higher GPAs at the end of the semester than African-American subjects who were not in the self-affirmation group.

It has been discussed that having more males than females in a testing environment is threatening for a female when taking a math test, and additionally, it also has been found that females tend to perform lower than males on a math test when a male administers the test (Marx & Roman, 2002). In order to combat this stereotype threat experienced from the threatening environment, Marx and Roman (2002) and other researchers have provided role models with high math competency as experimenters during the testing. Marx and Roman told participants in one group that the female experimenter created the difficult math test they were going to complete in order to indicate high competency in the field. They found that females in this condition performed equally to males in this condition, but performed lower than males in the condition where the test was administered by a male. Marx and Goff (2005) conducted a similar study but examined stereotype threat experienced by African-Americans in academic settings. Similar to Marx and Roman's results, Marx and Goff found that participants did not show performance decrements in a condition in which a verbal test was administered by a fellow African American; however, individuals who were given the test my a White experimenter performed worse.

McIntyre, Paulson, and Lord (2003) were interested in determining whether reading about female role models in differing fields would decrease the negative effect of stereotype threat on females' math performance. Before completing a math test, participants in the experimental condition read short biographies about four successful women in architecture, law, medicine, and invention. Results of this study were that females who were informed of other females' success performed better on the math test than females in the control condition, who read about successful companies. McIntyre et al. (2005) replicated this study, but wanted to determine whether the number of essays about successful females read increased females math performance. They did find similar results as McIntyre et al. (2003) in terms of finding differences between the experimental and control groups; however, they did not find a significant difference between females' performance who read one biography and females who read four biographies.

Another experimental manipulation utilized in studies attempting to reduce the negative effects of stereotype threat is shifting stigmatized individuals' view of intelligence to a malleable, incremental view rather than a fixed, entity view. The fixed view of intelligence is the more traditional view that intelligence comes from individuals' genetics and cannot be changed, and the malleable view of intelligence means that one believes that intelligence can be molded and changed through learning and experience. Aronson, Fried, and Good (2002) randomly assigned White and African American participants to one of three conditions, one being a control condition. In the other two conditions participants were asked to write letters to younger students who were struggling academically. In one condition the participants were asked to endorse a malleable view of intelligence and in the other condition they were asked to endorse the idea that there are different views of intelligence. The results showed that African American subjects who wrote letters endorsing the malleable view of intelligence reported valuing and enjoying education more and were earning higher grades nine weeks later than individuals in the other two groups.

Good, Aronson, and Inzlicht (2003) conducted a similar study with seventh-grade males and females who were mentored by college students who discussed the malleable view of intelligence and brain plasticity, the difficult experience of transitioning to a new school and how this difficulty typically can be overcome, or both messages. Good et al. found that "when the participants learned about the expandability of intelligence the gender gap in math performance disappeared. The incremental condition increased both boys' and girls' math performance, but this increase in math scores was particularly pronounced for the female students" (p. 657).

One of the simplest and easiest stereotype-threat-reducing interventions is to reframe the way an experimental task is described. One way this has been done is to describe the task as gender-fair, meaning that the test has produced no gender differences in the past. Spencer et al. (1999) were among the first researchers to use this nullifying stereotype-threat manipulation. They found that females who were told before completing a math test that the test had produced gender differences in the past performed significantly worse than males did, but this was only found in that condition because females who were told that the math test showed no previous gender differences had performances equal to males. These results were replicated by other researchers (Keller & Dauenheimer, 2003; Quinn & Spencer, 2001; Smith & White, 2002), so it can be determined that this type of manipulation is effective at reducing the negative effect of stereotype threat of decreasing females' math performance.

For the present study, this gender-fair manipulation will be utilized because it has shown to be effective, it is simple and easy to implement without experiment variation, and the manipulation is under the control of the experimenter or test-giver. Even though the previously discussed interventions have been shown to be effective at reducing stereotype-threat consequences, there are some issues with each. For example, in reference to shifting one's attention to other social identities, some researchers have found that highlighting a different social identity other than the stigmatized identity has not been sufficient enough to negate the effects of stereotype threat when high-stakes testing is involved (Stricker & Ward, 2004). The self-affirmation manipulations used in the studies discussed would take too long to implement before every math test and does not seem as likely to occur in a "real world" classroom setting. Providing role models for target groups of stereotype threat is an excellent intervention to encourage and motivate individuals to work hard academically at succeeding; however, at the present time there are not enough females in mathematics to be role models for the millions of females in the country. This type of intervention is more of a long-term investment and should be looked into by schools and universities. Reframing the task at the current time appears to be the easiest to implement in a quasi-experimental study with the most evidence for its effectiveness and utility for us in "real-world" settings.

Stereotype-threat Effects on High School Females

Not many studies have been conducted using high school students to examine the effect of stereotype threat on female math performance, and there are some issues with the few that have been conducted. For example, Johannes Keller, a German psychologist, has published research in this area utilizing high school students as subjects. Keller's (2002) study was previously discussed, and the results showed that stereotype threat decreased female high school students' math performance when compared to their male counterparts. An important finding from this study was that females in the stereotype-threat-manipulation condition, who were informed about gender differences on the test, tended to self-handicap by stating that the test was unfair or tricky which was related to the performance decrements found in these participants. Another study utilizing high school females by Keller and Dauenheimer (2003) found that emotional dejection mediates the relationship between stereotype threat and decreased math performance. A more important finding with relation to the present study is the finding that a gender-fair manipulation was effective. Females who were told that the test did not produce gender differences performed equally to the males in that condition.

Additionally, the researchers found promising results in a real-world setting of high school classrooms. Another study with high school females by Keller (2007a) was previously discussed in relation to domain identification and how the more identified females are in math, the more it affects their performance when under stereotype-threat conditions.

The studies conducted by Keller and his colleagues are of great importance in the field due to the use of high school students and real-world settings. However, these studies were conducted in secondary schools in Germany with German high school students, and it cannot be assumed that high school environments in Germany are equal to high school environments in the United States. This present study seeks to understand more about American high school and college females in order to better understand the gender gap in STEM that has occurred in the United States, not necessarily in Germany. It is important to gain a better view of the issues that occur in high school that deter females from pursuing STEM majors and careers so that educators can intervene at an early age before it is too late. It has been noted that females tend to avoid taking advanced math courses in high school, which later puts them at a disadvantage compared to males when taking college entrance exams and advanced math courses in college that are typically required for STEM degree. There needs to be a focus in high school settings on improving females' math self-efficacy, confidence, and abilities, which could lead to pursuing degrees and careers in mathematics.

Summary

There is a significant gender gap in STEM, and females hold about 25% of STEM jobs (Beede et al., 2011; National Science Foundation, 2009). Even though the number of females in some STEM fields has increased over recent years, there has been a 3% decrease of females in math-related jobs (Beede et al., 2011). There is some evidence of sex differences in math-related abilities in favor of males, such as spatial abilities and problems solving skills (Halpern et al., 2007; Hyde et al., 1990; Monastersky, 2005; Royer & Wing, 2002); however, there has been no conclusive evidence for sex differences in general math abilities (Ceci, Williams, & Barnett, 2009). It is difficult to completely explain what causes the underrepresentation of females in STEM due to a variety of influences, such as intellectual abilities, societal influences, and educational opportunities.

One societal variable that is being studied to help explain the gender gap in STEM is stereotype threat. Stereotype threat can help explain why females avoid STEM careers due to the threat they experience in the classroom setting. Stereotype threat also can help explain why females drop out of STEM majors and careers because it has been found that females are likely to leave the field if they experience threat (Steele et al., 2002). Stereotype threat is experienced when an individual is in a situation where there is a risk of confirming a negative stereotype about his or her group (Steele & Aronson, 1995). Stereotype threat is experienced by a variety of groups, including females.

It has been found that the stereotypic belief that boys are better than girls in math can develop in school-age children as early as the 3rd grade (Muzzatti & Agnoli, 2007). Spencer et al. (1999) demonstrated that females' math performance is decreased in stereotype-threat situations. Stereotype threat helps to explain the lack of interest and participation of females in STEM through the SCCT. Lent, Brown, and Hackett's (1994) SCCT suggests that vocational development is shaped by self-efficacy, outcome expectations, and career aspirations or goals. When females experience decreased math performance due to stereotype threat, they have lower self-efficacy in math, which leads to lower outcome expectations for future math performance and in turn avoid goal pursuits in STEM.

Additional consequences of stereotype threat include decreased effort and self-handicapping (Stone, 2002); internal attribution of failures (Kock et al., 2008); decreased self-confidence of abilities (Roberson et al., 2003; Stangor et al., 1998); domain disengagement (Major & Schmader, 1998; Schmader et al., 2001); declines in self-esteem and self-efficacy (Davies et al., 2002; Davies et al., 2005); and avoidance of certain majors and careers (Bergeron et al., 2006; Gupta & Bhawe, 2007; Steele et al., 2002). There are a variety of mechanisms that have been proposed to underlie the relationship between stereotype threat and decreased math performance. Studies have found evidence for the following mediators of this relationship: anxiety (Bosson et al., 2004; Osborne, 2001); physical arousal (Ben-Zeev et al., 2005; Blascovich et al., 2001; O'Brien & Crandall, 2003); and increased cognitive load on working memory (Beilock et al., 2006; Ryan & Ryan, 2005; Schmader & Johns, 2003; Steele & Aronson, 1995). Additionally, internal locus of control (Cadinu et al., 2006); lower expectations (Cadinu et al., 2003); and mode of self-regulatory focus (Keller, 2007b) have been found to moderate the relationship between stereotype threat and decreased females' math performance. Other moderators have been proposed and researched, including domain identification and group identification.

Research has shown that when stigmatized individuals highly identify with their gender (i.e., female) or an academic domain (i.e., math), they are more susceptible to stereotype threat and its potential negative effects. This means that when females identify with their gender group, they are more likely than females with low gender identification to have decreased math performance in a stereotype-threat situation (Kiefer & Sekaquaptewa, 2007; Schmader, 2002; Wout et al., 2008). The same effect has been illustrated with high domain identification. Keller (2007a) and Lesko and Corpus (2006) found evidence that when females who are high on math identification were placed in a stereotype-threat situation, they underperformed compared to females with low math identification. Another moderating variable in the relationship between stereotype threat and decreased female math performance is stigma consciousness, which is the level of belief that one will be stigmatized due to their membership in a stereotyped group (Brown & Pinel, 2003; Pinel, 1999). The results of a study by Brown and Pinel (2003) indicated that a stereotype-threat manipulation had a negative impact on math performance only for females with high stigma consciousness because females in the stereotype-threat condition with low stigma consciousness performed just as well as females in the low threat condition. Several studies have found that females tend to have lower math self-efficacy and that there is a relationship between female's math self-efficacy and their math performance, which tends to be lower than males (Betz & Hackett, 1983; Hackett & Betz, 1989; Junge & Dretzke, 1995; Pajares & Miller, 1994; Wigfield et a., 1996). However, the role that math self-efficacy plays in the relationship between stereotype threat and math performance is unclear.

Several studies have examined the negative effect that stereotype threat has on females' math performance (Brown & Pinel, 2003; Davies et al., 2002; Good et al., 2008; Spencer et al., 1999; Walsh et al., 1999). In these studies different stereotype-threat-inducing manipulations have been used as well as a variety of stereotype-threat-reducing interventions. Most of the experimenters in the earlier years of development of this research area would manipulate the environment to explicitly induce stereotype threat by making the subjects more aware of their stereotyped status or by pointing out the negative stigmas that are normally linked to one's group and the situation (i.e., telling a group of female participants that a math test has shown that males tend to perform better than females). However, studies have shown that explicit stereotype-threat manipulations are not necessary to produce the negative effects of stereotype threat, such as decreased performance, because negative effects have been found in the control conditions where no mention was made of gender differences (Kiefer & Sekaquaptewa, 2007; Quinn & Spencer, 2001; Smith & White, 2002).

In recent years, studies in this area have focused on determining the effectiveness of stereotype-threat-reducing interventions, such as deemphasizing threatened social identities, encouraging self-affirmation, providing role models, emphasizing an incremental view of intelligence, and reframing the task. Reframing of the task, such as explaining to the participants that the test is gender-fair and produced no sex differences in the past, has been found in several studies to be an effective intervention to reduce the negative effect of stereotype threat on decreasing females' math performance (Keller & Dauenheimer, 2003; Quinn & Spencer, 2001; Smith & White, 2002). Additionally, this type of intervention is simple and easy to implement, and the manipulation is under the control of the individual who is giving the test.

It has been proposed that one explanation for the underrepresentation of females in STEM, specifically math-related majors and careers, is the stereotype threat that females experience about the subject. Due to this possible explanation, researchers have been studying interventions that could eliminate this threat in order to increase the number of females interested in STEM. However, research has mostly been conducted with college students. There needs to be more studies with high school female participants because high school is the time when educators need to intervene. Intervention at this time in females' lives is necessary in order to encourage females to take more advanced math classes in order to score higher on math sections of college entrance exams and to choose math and math-related majors in college. To date there have been few published research studies that include the participation of high school female subjects in this area of study (Keller, 2002; Keller, 2007a; Keller & Dauenheimer, 2003). These researchers have found that female high school students' math performance is lower in stereotype-threat conditions when compared to their male counterparts All of the previous studies have been conducted at a secondary school in Germany, and the results cannot be generalized to high school students and classroom environments in the United States.

The Present Study

Decades of research have shown that stereotype threat has a damaging effect on females' math performance, and this gender difference in performance can lead to a gender gap in STEM careers. Previous studies in this area have mostly utilized college student samples, and few studies have looked at high school students. It is likely that stereotype threat affects these two populations differently as college students may have more self-confidence in their academic abilities in general, as well as more math self-efficacy, because they already have been accepted into college and have a sense of mastery in that area. The present study examined the effect that implicit stereotype threat had on the math performance of high school females, and these effects were compared to the effects of a gender-fair intervention in which stereotype threat was nullified. Measures of gender identification, math identification, and stigma consciousness were given in order to determine the role that these moderating variables played in the relationship between stereotype threat and females' math performance in high school. Additionally, a measure of math self-efficacy was given to examine the role this variable plays between stereotype threat and females' math performance. Relationships between math grades and other study variables were explored. This study was conducted in a "naturalistic setting," math classrooms in a public high school. Based on the literature the following hypotheses were proposed, and they are written in the future tense because they were proposed prior to completion of the study.

Hypothesis One

There will be a significant interaction between gender and stereotype-threat condition. Specifically, a) female participants in the implicit-stereotype-threat condition will score significantly lower on the math test compared to male participants in the same condition, and b) female participants in the nullified-stereotype-threat condition will not score significantly different from male participants in the same condition.

Justification for Hypothesis One

Several studies over the past couple of decades have found that females experience stereotype threat when placed in situations where they have to complete math problems, and the stereotype threat hinders their math performance (Brown & Pinel, 2003; Davies et al., 2002; Good et al., 2008; Spencer et al., 1999; Walsh et al., 1999). It is predicted the same results will be found in the present study. An implicit-stereotype-threat condition will be used because previous research has found that stereotype threat can have a significant effect on females' math performance even if there is no mention of gender differences to explicitly induce threat (Kiefer & Sekaquaptewa, 2007; Quinn & Spencer, 2001; Smith & White, 2002). This form of stereotype threat likely is more of an accurate representation of what females experience in the real world.

Research in the area of stereotype threat's effects on females' math performance has begun moving in a more positive direction by exploring interventions that may reduce the detrimental effects of stereotype threat. There are several interventions that have been created and studied; however, the simplest and most cost-effective strategy is to reframe the task. In this study, the reframing of the task occurred by informing the participants in that condition that the math test they will take has shown no gender differences. This strategy which has been referred to as a gender-fair or nullified-stereotype-threat condition has shown that when females are given this information, they perform just as well as their male counterparts (Keller & Dauenheimer, 2003; Quinn & Spencer, 2001; Smith & White, 2002). Equalization of math performance is thought to occur because once stereotype-threat interference is removed, actual abilities are measured, and recent research has shown that there are no substantial gender differences in math abilities (Else-Quest et al., 2010; Kenney-Benson et al., 2006).

Hypothesis Two

In the implicit-stereotype-threat condition, female participants with high gender identification will perform significantly lower on the math test compared to females with low gender identification.

Hypothesis Three

In the nullified-stereotype-threat condition, female participants with high gender identification will not score significantly different from females with low gender identification.

Hypothesis Four

There will be an interaction between gender identification and stereotype-threat condition on females' math performance. Female participants with high gender identification in the nullified-stereotype-threat condition will score significantly higher on the math test compared to females with high gender identification in the implicit-stereotype-threat condition.

Justification for Hypotheses Two, Three, and Four

Various research has produced results that the more an individual from a stigmatized group identifies with his or her in-group, the more susceptible he or she is to stereotype threat (Cole et al., 2007; Schmader, 2002; Wout et al., 2008). More specifically for gender identification, Kiefer and Sekaquaptewa (2007) and Schmader (2002) found that females who have high gender identification are likely to perform worse on a math test than females who have low gender identification. Schmader (2002) found that female participants with high gender identification scored lower on a math test than females with low gender identification in a stereotype-threat-induced condition. Additionally, Schmader found that females with high gender identification in the condition without the presence of stereotype threat performed significantly higher compared to females with high gender identification in the stereotype-threat-induced condition. Thus, it was hypothesized that similar results would be found in this study in which females with high gender identification would not perform as well as low gender identified females, but only in the stereotype-threat condition. In the nullified condition in which an intervention removed the stereotype threat, no significant relationship was expected between gender identification and math performance.

Hypothesis Five

In the implicit-stereotype-threat condition, female participants with high math identification will perform significantly lower on the math test compared to females with low math identification.

Hypothesis Six

In the nullified-stereotype-threat condition, female participants with high math identification will perform significantly higher on the math test compared to females with low math identification.

Hypothesis Seven

There will be an interaction between math identification and stereotype-threat condition on females' math performance. Female participants with high math identification in the nullified-stereotype-threat-condition will score significantly higher on the math test compared to females with high math identification in the implicit-stereotype-threat condition.

Justification for Hypotheses Five, Six, and Seven

Several studies suggest that the more individuals identify with a domain, the greater the impact stereotype threat can have on those individuals when performing in that domain (Aronson et al., 1999; Cadinu et al., 2003; Keller, 2007a; Leyens et al., 2000; Spencer et al., 1999; Stone et a., 1999). Keller (2007a) conducted a study with two stereotype conditions: threat and no threat. In the no threat condition, the math test was described as gender fair in order to remove the stereotype threat. He found that females who were high on math identification performed worse than females who were lower in math identification in the stereotype-threat condition, and females with high math identification scored higher in the no threat condition than in the threat condition. It is reasonable to assume that similar results will be produced in this study that high math identification will decrease females' math performance in the implicit-stereotype-threat condition, but will increase their performance in the nullified-stereotype-threat condition.

Hypothesis Eight

In the implicit-stereotype-threat condition, female participants with high stigma consciousness will perform significantly lower on the math test compared to females with low stigma consciousness.

Hypothesis Nine

In the nullified-stereotype-threat condition, female participants with high stigma consciousness will not score significantly different from females with low stigma consciousness.

Hypothesis Ten

There will be an interaction between stigma consciousness and stereotype-threat condition on females' math performance. Female participants with high stigma consciousness in the nullified-stereotype-threat condition will score significantly higher on the math test compared to females with high stigma consciousness in the implicit-stereotype-threat condition.

Justification for Hypotheses Eight, Nine, and Ten

Stigma consciousness has been found to moderate the relationship between stereotype threat and math performance. Studies have demonstrated that females with high levels of stigma consciousness perform worse on a math task than females with lower stigma consciousness (Brown & Pinel, 2003; Pinel, 1999). Brown and Pinel

(2003) found that females with high stigma consciousness in a stereotype-threat-induced condition performed lowered than females with low stigma consciousness in both conditions (high threat and low threat) as well as females with high stigma consciousness in the low threat condition. For this reason, it is proposed that female participants in the current study with high stigma consciousness in the implicit-stereotype-threat condition will perform significantly lowered than all of other participants. In the nullified-stereotype-threat condition, stigma consciousness will have no significant relationship with math performance.

Hypothesis Eleven

In the implicit-stereotype-threat condition, female participants with high math self-efficacy will perform significantly higher on the math test than females with low math self-efficacy.

Hypothesis Twelve

In the nullified-stereotype-threat condition, female participants with high math self-efficacy will perform significantly higher on the math test than females with low math self-efficacy.

Justification for Hypotheses Eleven and Twelve

Research indicates that there is a relationship between females' self-efficacy in math and their math performance (Betz & Hackett, 1983; Hackett & Betz, 1989; Junge & Dretzke, 1995). Additionally, studies by Betz and Hackett (1983) and Hackett and Betz (1989) have shown that math self-efficacy is a strong predictor of math performance. The research thus far on the role of math self-efficacy in the relationship between stereotype threat and females' math performance has been mixed. However, in the current study it was proposed that math self-efficacy would act as a protective barrier against stereotype threat in the control condition and the impact of high math self-efficacy would be even stronger for females in the nullified-stereotype-threat condition.

CHAPTER TWO

METHOD

Participants and Design

Participants were recruited from ninth-grade math classes at a medium size, public high school in north Louisiana. Prior to conducting the study, the university's institutional review board and the principal of the high school approved the study. Before participating in the study, participants were given a consent form to be completed and signed by their parents. The consent form explained the nature of the project, what was expected of the participants, the use of the information, and the safeguards for individuals' information. The students' permission forms, math tests, and questionnaires were completed in math classes at the school.

The experiment took the form of a 2 (female vs. male) x 2 (control/implicit stereotype condition vs. nullified stereotype condition) factorial ANOVA design. The dependent variable was math performance on a norm-referenced achievement test. All participants completed a demographic questionnaire, the Basic Achievement Skills Inventory (BASI)—Math Skills Inventory, the Impression and Test Concern Scale (ITCS), Domain Identification Measure (DIM), Collective Self-Esteem Scale (CSES), Stigma Consciousness Questionnaire (SCQ), and The Fennema-Sherman Mathematics Attitudes Scales (FSMAS).

Measures

Demographic Questionnaire

The demographic questionnaire included items that inquired about the participants' age, gender, race, current and previous year's letter math grades, future career plans, and parents' or guardians' highest level of education and occupation.

Basic Achievement Skills Inventory (BASI)—Math Skills Survey

The BASI (Bardos, 2004) is a norm-referenced achievement test used to measure math, reading, spelling, and language skills. This test was standardized on a sample of more than 4,000 students in grades 3^{rd} through 12^{th} and college and has two versions: comprehensive and survey. The survey tests are single, brief versions of the comprehensive test and are available for math and verbal skills. For the purposes of this study, only the math skills survey was utilized because the study only sought to evaluate math performance. The BASI Math Skills Survey is a 25-minute timed test with questions on math calculations and math application. The test can be given in group administration, and it uses multiple-choice format with four options for each answer. Internal consistency reliability coefficients for the BASI range from .69 to .96, and the test-retest reliability coefficients, after a two-week interval, range from .70 to .92 (Bardos, 2004). The BASI is highly correlated with other academic achievement tests, specifically the Iowa Achievement Test, Wechsler Individual Achievement Test-Second Edition, and Woodcock-Johnson Psychoeducational Battery-Third Edition, ranging from .54 to .80 (Bardos, 2004).

Impression and Test Concern Scale (ITCS)

The ITCS was used as a manipulation check. This scale was adapted from a scale used by Marx and Goff (2005) to measure the perceived experience of stereotype threat. This nine item scale has acceptable reliability (Cronbach's α =.80). Example statements include "I worry that my ability to perform well on standardized tests is affected by my gender" and "I worry that if I perform poorly on this test, the experimenter will attribute my poor performance to my gender." The participants responded to the statements on a 7-point Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). A high score on this scale indicates that participants experienced high levels of stereotype threat.

Domain Identification Measure (DIM)

The DIM (Smith & White, 2001) is designed to measure how self-identified a person is with a particular academic domain. To assess participants' identification with mathematics the math domain nine-item scale was utilized in this study, which has good test-retest reliability, $r = .89$. Participants responded to the items using a 5-point Likert-type scale ranging from 1 (*not at all*) to 5 (*very much*). The instrument asks respondents to indicate the degree to which they agree with the statements or items. Sample items from the DIM include: "How much is math related to the sense of who you are?" and "How important is it to you to be good at math?" This assessment has been validated according to Smith and White (2001) as they stated that the math domain of the DIM has evidence of validity "from identification differences in performance and phenomenological variables. Participants, who scored high on the Math identification subscale outperformed, were more motivated and committed to doing well, and had a more favorable evaluation of the math exam…" (p. 1052). The alpha coefficient for inter-item correlation is .93 and the test retest coefficient is .89 (Smith & White, 2001).

Collective Self-Esteem Scale (CSES)

The CSES is a self-report inventory that uses a 7-point Likert scale that ranges from 1 (*strongly disagree*) to 7 (*strongly agree*) and asks respondents to rate statements on this scale about their perceptions and feelings related to their membership in their social group (i.e., gender) (Crocker, Luhtanen, Blaine, & Broadnax, 1994). This scale consists of four subscales: a) Membership Esteem, b) Private Collective Self Esteem, c) Public Collective Self Esteem, and d) Importance of Identity. The Importance of Identity scale was utilized to measure gender identification in this study. There are four items on this subscale, and a sample item is "Being a female is an important reflection of who I am." Higher scores on this subscale will indicate higher gender identification. The internal consistency reliability of this subscale has been found to be .86 (Crocker et al., 1994).

Stigma Consciousness Questionnaire (SCQ)

The SCQ was developed and validated by Pinel (1999) in order to assess stigma consciousness with a variety of stereotyped groups, so the items can be altered to fit each group by inserting the names of the ingroup and outgroup (Brown & Pinel, 2003). It is a 10-item measure, and participants respond to the items using a 7-point Likert-type scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). The instrument asks respondents to indicate the degree to which they agree with the statements or items. Only female participants completed this questionnaire in the current study due to the nature of the questions focusing only on females and because the research questions only focus on the effect of stigma consciousness on females' math performance. Sample items from the SCQ for women include: "When interacting with males, I feel as though they interpret all of my behaviors in terms of the fact that I am a female" and "Stereotypes about females have not affected me personally." Stigma consciousness, using this measure, was found to be positively correlated with public and private self-consciousness, sex-role conformity, Henderson-King and Stewart's Sensitivity to Sexism scale, and Rickard's Feminist Identity scale. The scale has a test-retest reliability of $r = .76$, which showed that stigma consciousness is stable over time (Pinel, 1999).

The Fennema-Sherman Mathematics Attitudes Scales (FSMAS)

The FSMAS (Fennema & Sherman, 1976) was developed for research of gender differences in math achievement and is used to evaluate individuals' attitudes towards mathematics. There are nine scales on this measure of math attitudes: (a) Confidence in Learning Mathematics, (b) Mathematics Anxiety, (c) Father, (d) Mother, (e) Usefulness of Mathematics, (f) Mathematics as a Male Domain, (g) Attitude toward Success in Mathematics, (h) Teacher, and (i) Effectance Motivation in Mathematics (Mulhern & Rae, 1998). The nine scales can be used together or individually, and for the present study, the Confidence in Learning Mathematics scale was used in order to judge subjects' math self-efficacy. There are 12 items that make up the Confidence scale, and the items are rated on a Likert-type scale ranging from 1 (*strongly agree*) to 5 (*strongly disagree*). The scale consists of both positively worded items (e.g. "Generally I have felt secure about attempting mathematics") and negatively worded items (e.g. "I don't think I could do advanced mathematics"). Split-half reliabilities for all of the scales range from .69 to

.89, and it has been found that the Confidence in Learning Math scale is one of the most stable scales (Sherman, 1980).

Procedure

The participants were recruited from ninth-grade math classes at a medium size, public high school in north Louisiana, and informed consent forms were sent home to participants' parents and collected before the study commenced. The math test and all of the questionnaires were given on paper at the high school during a regular class period by a female experimenter. Random assignment was used to assign participants to either the control group or the nullification group.

After the subjects read through and signed an informed assent form, instructions were given to begin the math test and questionnaires. Before beginning the test and questionnaires, participants in the nullified-stereotype-threat condition read the following statement on the second page of the packet: "The following math test has been shown NOT to produce gender differences in the past. The average achievement of male participants was equal to the achievement of female participants. Complete the following math test. Please answer the questions to the best of your abilities." This statement will be in bold font and on a page with nothing else on it in order to ensure that students read it before starting the math test. Participants in the control condition did not have the statement about sex differences in their packet, but did have the same basic instructions of "Complete the following math test. Please answer the questions to the best of your abilities." Completion of the math test and questionnaires took about 45 minutes. After participants completed the test and questionnaires, they were debriefed on the purpose and importance of the study and thanked for their participation.

Statistics and Data Analysis

First, the frequency and percentages of the demographic variables were calculated. Next, means, standard deviations, ranges, and reliabilities for all study variables were calculated. Additionally, Pearson *r* correlations were performed on all continuous variables included in the study. An independent samples *t*-test was performed comparing the group means of the two experimental conditions in order to determine if stereotype threat was experienced in the control group and removed in the intervention group.

Hypothesis one stated that there would be a significant interaction between gender and stereotype-threat condition; specifically, a) female participants in the implicit-stereotype-threat condition would score significantly lower on the math test than male participants in the same condition, and b) female participants in the nullified-stereotype-threat condition would not score significantly different from male participants in the same condition. This hypothesis was tested by conducting a two-way independent analysis of variance (ANOVA). The independent variables were gender (male or female) and stereotype-threat condition (implicit-stereotype-threat condition or nullified-stereotype-threat condition). The dependent variable was performance on the BASI-Math Survey.

Hypothesis two stated that in the implicit-stereotype-threat condition, female participants with high gender identification, as measured by the Importance of Identity Scale of the CSES, would perform significantly lower on the math test compared to females with low gender identification. This hypothesis was tested by conducting a two-way independent analysis of variance (ANOVA). The independent variables were stereotype-threat condition (implicit-stereotype-threat condition or nullified-stereotype-threat condition) and gender identification (low or high). A median split was conducted on gender identification to convert the variable to a dichotomous variable, which was completed by splitting the variable at the sample median and thereby defining low and high groups on gender identification. The dependent variable was performance on the BASI-Math Survey. The gender identification main effect was examined for this hypothesis.

Hypothesis three stated that in the nullified-stereotype-threat condition, female participants with high gender identification would not score significantly different from females with low gender identification. This hypothesis was tested by conducting a two-way independent analysis of variance (ANOVA). The independent variables were stereotype-threat condition (implicit-stereotype-threat condition or nullified-stereotype-threat condition) and gender identification (low or high). The dependent variable was performance on the BASI-Math Survey. The gender identification main effect was examined for this hypothesis.

Hypothesis four stated that there would be an interaction between gender identification and stereotype-threat condition on females' math performance. Female participants with high gender identification in the nullified-stereotype-threat-condition would score significantly higher on the math test compared to females with high gender identification in the implicit-stereotype-threat condition. This hypothesis was tested by conducting a two-way independent analysis of variance (ANOVA). The independent variables were stereotype-threat condition (implicit-stereotype-threat condition or nullified-stereotype-threat condition) and gender identification (low or high). The dependent variable was performance on the BASI-Math Survey. The interaction term in the ANOVA was examined to determine the presence of moderation.

Hypothesis five stated that in the implicit-stereotype-threat condition, female participants with high math identification, as measured by the DIM—Math, would perform significantly lower on the math test compared to females with low math identification. This hypothesis was tested by conducting a two-way independent analysis of variance (ANOVA). The independent variables were stereotype-threat condition (implicit-stereotype-threat condition or nullified-stereotype-threat condition) and math identification (low or high). A median split was conducted on math identification to convert the variable to a dichotomous variable. The dependent variable was performance on the BASI-Math Survey. The math identification main effect was examined for this hypothesis.

Hypothesis six stated that in the nullified-stereotype-threat condition, female participants with high math identification would perform significantly higher on the math test compared to females with low math identification. This hypothesis was tested by conducting a two-way independent analysis of variance (ANOVA). The independent variables were stereotype-threat condition (implicit-stereotype-threat condition or nullified-stereotype-threat condition) and math identification (low or high). The dependent variable was performance on the BASI-Math Survey. The math identification main effect was examined for this hypothesis.

Hypothesis seven stated that there would be an interaction between math identification and stereotype-threat condition on females' math performance. Female participants with high math identification in the nullified-stereotype-threat-condition would score significantly higher on the math test compared to females with high math identification in the implicit-stereotype-threat condition. This hypothesis was tested by conducting a two-way independent analysis of variance (ANOVA). The independent variables were stereotype-threat condition (implicit-stereotype-threat condition or nullified-stereotype-threat condition) and math identification (low or high). The dependent variable was performance on the BASI-Math Survey. The interaction term in the ANOVA was examined to determine the presence of moderation.

Hypothesis eight stated that in the implicit-stereotype-threat condition, female participants with high stigma consciousness, as measured by SCQ, would perform significantly lower on the math test compared to females with low stigma consciousness. This hypothesis was tested by conducting a two-way independent analysis of variance (ANOVA). The independent variables were stereotype-threat condition (implicit-stereotype-threat condition or nullified-stereotype-threat condition) and stigma consciousness (low or high). A median split was conducted on stigma consciousness to convert the variable to a dichotomous variable. The dependent variable was performance on the BASI-Math Survey. The stigma consciousness main effect was examined for this hypothesis.

Hypothesis nine stated that in the nullified-stereotype-threat condition, female participants with high stigma consciousness would not score significantly different from females with low stigma consciousness. This hypothesis was tested by conducting a two-way independent analysis of variance (ANOVA). The independent variables were stereotype-threat condition (implicit-stereotype-threat condition or nullified-stereotype-threat condition) and stigma consciousness (low or high). The dependent variable was performance on the BASI-Math Survey. The stigma consciousness main effect was examined for this hypothesis.

Hypothesis ten stated that there will be an interaction between stigma consciousness and stereotype-threat condition on females' math performance. Female participants with high stigma consciousness in the nullified-stereotype-threat-condition would score significantly higher on the math test compared to females with high stigma consciousness in the implicit-stereotype-threat condition. This hypothesis was tested by conducting a two-way independent analysis of variance (ANOVA). The independent variables were stereotype-threat condition (implicit-stereotype-threat condition or nullified-stereotype-threat condition) and stigma consciousness (low or high). The dependent variable was performance on the BASI-Math Survey. The interaction term in the ANOVA was examined to determine the presence of moderation.

Hypothesis eleven stated that in the implicit-stereotype-threat condition, female participants with high math self-efficacy, measured by the Confidence in Learning Mathematics scale of the FSMAS, would perform significantly higher on the math test than females with low math self-efficacy. This hypothesis was tested by conducting a two-way independent analysis of variance (ANOVA). The independent variables were stereotype-threat condition (implicit-stereotype-threat condition or nullified-stereotype-threat condition) and math self-efficacy (low or high). A median split was conducted on math self-efficacy to convert the variable to a dichotomous variable. The dependent variable was performance on the BASI-Math Survey. The math self-efficacy main effect was examined for this hypothesis.

Hypothesis twelve stated that in the nullified-stereotype-threat condition, female participants with high math self-efficacy would perform significantly higher on the math test than females with low math self-efficacy. This hypothesis was tested by conducting a two-way independent analysis of variance (ANOVA). The independent variables were stereotype-threat condition (implicit-stereotype-threat condition or nullified-stereotype-threat condition) and math self-efficacy (low or high). The dependent variable was performance on the BASI-Math Survey. The math self-efficacy main effect was examined for this hypothesis.

A Bonferroni correction was utilized when testing hypotheses two through twelve in order to control for the familywise error rate which can be inflated by making multiple comparisons on a set of data. Four two-way ANOVA tests were conducted to test a priori hypotheses on the selected cases of female participants in hypotheses two through twelve using Bonferroni adjusted alpha levels of .0125 per test (.05/4).

CHAPTER THREE

RESULTS

Participants

Overall Sample

Participants were 100 ninth-grade students at a medium size, public high school in north Louisiana. The sample was 66% female (n = 66) and 34% male (n = 34) with an average age of 14 years (SD = .60, $Range$ = 14-17). The sample was 46% Caucasian (n = 46), 42% African American (n = 42), 4% Asian/Pacific Islander (n = 4), 1% American Indian/Alaskan Native (n = 1), and 5% "Other" (n = 5).

In reference to their parents' or guardians' highest level of education, 49% of the participants reported "college" (n = 49), 29% reported "graduate school" (n = 29), 12% reported "some college" (n = 12), 6% reported "high school" (n = 6), 3% reported "middle school (6^{th}-8^{th} grade)" (n = 3), and 1% reported "some high school" (n = 1). When the participants were asked if they planned to attend college, 94% of the participants answered "yes" (n = 94), 5% responded "unsure" (n = 5), and 1% answered "no" (n = 1).

A Levene's test of homogeneity of variance was used to examine the treatment groups for homogeneity in terms of age, gender, ethnicity, and parents' or guardians' highest level of education. The groups did not differ significantly in terms of age, F(1,

98) = 1.5, gender, $F(1, 98) = 3.65$, ethnicity, $F(1, 98) = 0.15$, or parents' or guardians' highest level of education, $F(1, 98) = 0.21$.

Control Group/Implicit-stereotype-threat Condition

The 51 participants in the control group were 71% female ($n = 36$) and 29% male ($n = 15$) with an average age of 14 years (*SD* = .54; *Range* = 14-16). The control group was 51% Caucasian ($n = 26$), 35% African American ($n = 18$), 6% Asian/Pacific Islander ($n = 3$), and 8% "Other" ($n = 4$). In regards to parents' or guardians' highest level of education the control group had 43% "college" ($n = 22$), 31% "graduate school" ($n = 16$), 16% "some college" ($n = 8$), 6% "high school" ($n = 3$), 2% "some high school" ($n = 1$), and 2% "middle school (6^{th}-8^{th} grade)" ($n = 1$). When participants were asked if they plan to attend college, 90% of control-group participants responded "yes" ($n = 46$) and 10% responded "unsure" ($n = 5$).

Intervention Group/Nullified-stereotype-threat Condition

The 49 participants in the intervention group were 61% female ($n = 30$) and 39% male ($n = 19$) with an average age of 14 years (*SD* = .68; *Range* = 14-17). The intervention group was 49% African American ($n = 24$), 41% Caucasian ($n = 20$), 4% Hispanic Latino ($n = 2$), 2% American Indian/Alaskan Native ($n = 1$), 2% Asian/Pacific Islander ($n = 1$), and 2% "Other" ($n = 1$). In regards to parents' or guardians' highest level of education the intervention group had 55% "college" ($n = 27$), 27% "graduate school" ($n = 13$), 8% "some college" ($n = 4$), 6% "high school" ($n = 3$), and 4% "middle school (6^{th}-8^{th} grade)." When participants were asked if they plan to attend college, 98% of the intervention-group participants responded "yes" ($n = 48$) and 2% responded "no" ($n = 1$).

Descriptive Statistics and Reliabilities

Table 1 presents the reliability coefficients, means, standard deviations, and ranges for the Basic Achievement Skills Inventory (BASI)—Math Skills Survey, the Impression and Test Concern Scale (ITCS), the Domain Identification Measure (DIM), the Collective Self-Esteem Scale (CSES)—Importance of Identity Scale, the Stigma Consciousness Questionnaire (SCQ), and the Fennema-Sherman Mathematics Attitudes Scales (FSMAS)—Confidence in Learning Math Scale. The current sample was compared to normative samples using one-sample t-tests.

Table 1

Means, Standard Deviations, Range, and Reliabilities for Entire Sample

Variables	*M*	*SD*	*Range*	α
BASI—Math Skills Survey	93.05	15.25	63-133	**
Males	96.00	16.62	63-133	
Females	91.53	14.39	70-133	
ITCS	3.04	1.24	1-6	.86
Males	3.09	1.22	1-5	.84
Females	3.01	1.26	1-6	.88
DIM	3.32	0.92	1-5	.88
Males	3.36	0.91	1-5	.88
Females	3.29	0.93	1-5	.88
CSES	4.53	1.34	1-7	.58
Males	4.51	1.18	3-7	.45
Females	4.54	1.42	1-7	.62
SCQ	***	***	***	***
Males	***	***	***	***
Females	4.09	0.86	2-6	.59
FSMAS	3.73	1.08	1-5	.95
Males	3.96	0.97	1-5	.95
Females	3.62	1.12	1-5	.95

Note: BASI = Basic Achievement Skills Inventory; ITCS = Impression and Test Concern Scale; DIM = Domain Identification Measure; CSES = Collective Self-Esteem Scale; SCQ = Stigma Consciousness Questionnaire; FSMAS = Fennema-Sherman Mathematics Attitudes Scales.
**Single scale score; no reliability calculated. ***Only female participants completed the SCQ.

Results of the one sample t-test revealed that the overall mean on the BASI-Math Survey for the current sample ($M = 93.05$) is significantly lower than the mean ($M = 99.6$) Bardos (2004) obtained when developing the BASI—Math Survey scale, $t(1, 99) = -4.3, p < .01$.

With respect to the ITCS, a one sample t-test revealed that the current sample scores on the ITCS ($M = 3.04$) are significantly higher than the sample ($M = 2.26$) with which Marx and Goff (2005) developed the ITCS, $t(1, 99) = 6.27, p < .01$.

The results of a one sample t-test showed that the current sample mean on the DIM ($M = 3.32$) is significantly higher than the mean for the sample ($M = 3.12$) utilized for a factor analysis and validation study of the DIM by Smith, Morgan, and White (2005), $t(1, 99) = 2.14, p < .05$.

In terms of the CSES—Importance of Identity Scale, it was discovered through a one sample t-test that the current sample mean ($M = 4.53$) does not differ significantly from the mean of the sample ($M = 4.68$) with which Luhtanen and Crocker (1992) developed and standardized the CSES, $t(1, 99) = -1.12$.

Only female participants completed the SCQ due to the nature of the research questions, and a one sample t-test revealed that the mean for the female participants ($M = 4.09$) in the current sample did not differ significantly from the mean ($M = 3.95$) in a previous study by Brown and Pinel (2003) that examined the impact of stigma consciousness on female participants' math performance, $t(1, 65) = 1.36$.

Lastly, the results of a one sample t-test showed that the participants in the current sample ($M = 3.73$) did not score significantly different on the FSMAS—Confidence in

Learning Math Scale than participants ($M = 3.61$) in a construct validity study by Broadbooks, Elmore, Pedersen, and Bleyer (1981), $t(1, 99) = 1.16$.

Table 2 presents the descriptive statistics for the control group. The control group's mean on the BASI—Math Skills Survey was 92.18. With respect to the ITCS the mean was 2.87. The control group's mean on the DIM was 3.30, and the mean on the CSES—Importance of Identity Scale for the control group was 4.41. The control group's mean on the SCQ was 4.12, and the mean on the FSMAS—Confidence in Learning Math Scale for the control group was 3.78.

Table 2

Means, Standard Deviations, Range, and Reliabilities for Control Group

Variables	*M*	*SD*	*Range*	*α*
BASI—Math Skills Survey	92.18	15.82	70-133	**
ITCS	2.87	1.36	1-6	.91
DIM	3.30	0.97	1-5	.90
CSES	4.41	1.36	1-7	.60
SCQ	4.12	0.90	2-6	.63
FSMAS	3.78	1.05	1-5	.95

Note: BASI = Basic Achievement Skills Inventory; ITCS = Impression and Test Concern Scale; DIM = Domain Identification Measure; CSES = Collective Self-Esteem Scale; SCQ = Stigma Consciousness Questionnaire; FSMAS = Fennema-Sherman Mathematics Attitudes Scales.
**Single scale score; no reliability calculated.

Table 3 presents the descriptive statistics for the intervention group. The intervention group's mean on the BASI—Math Skills Survey was 93.97. With respect to the ITCS the intervention group's mean was 3.21. The intervention group's mean on the

DIM was 3.33, and the mean on the CSES—Importance of Identity Scale was 4.66. The intervention group's mean on the SCQ was 4.01, and the intervention group's mean on the FSMAS—Confidence in Learning Math Scale was 3.68.

Table 3

Means, Standard Deviations, Range, and Reliabilities for Intervention Group

Variables	*M*	*SD*	*Range*	*α*
BASI—Math Skills Survey	93.97	14.47	63-118	**
ITCS	3.21	1.09	1-5	.78
DIM	3.33	0.88	1-5	.85
CSES	4.66	1.32	2-7	.55
SCQ	4.01	0.78	3-6	.46
FSMAS	3.68	1.11	1-5	.95

Note: BASI = Basic Achievement Skills Inventory; ITCS = Impression and Test Concern Scale; DIM = Domain Identification Measure; CSES = Collective Self-Esteem Scale; SCQ = Stigma Consciousness Questionnaire; FSMAS = Fennema-Sherman Mathematics Attitudes Scales.
**Single scale score; no reliability calculated.

A Levene's test of homogeneity of variance was conducted to examine if the groups differed significantly on any of the variables. The test revealed that the group variances were not significantly different on any of the variables: BASI—Math Skills Survey, $F(1, 98) = 0.01$; ITCS, $F(1,98) = 2.13$; CSES, $F(1, 98) = 0.01$; DIM, $F(1, 98) = 0.82$; SCQ, $F(1, 71) = 0.99$; and FSMAS, $F(1, 98) = 0.99$.

One-way ANOVA was used to test for variable differences among males and females on the variables in the study. No significant differences were found between males and females on any of the variables: BASI—Math Skills Survey, $F(1, 98) = 1.95$,

$p = .166$; ITCS, $F(1, 98) = 0.09, p = .772$; CSES, $F(1, 98) = 0.01, p = .935$; DIM, $F(1, 98) = 0.11, p = .74$; and FSMAS, $F(1, 98) = 2.22, p = .14$.

Due to possible pre-existing differences in participants' math abilities, a one-way ANOVA was conducted to check for differences in math ability between participants in the control group and the intervention group. Results of the one-way ANOVA indicated there were no significant differences in self-reported math grades between the control group and intervention group, $F(1, 98) = 0.01, p = .918$. An additional one-way ANOVA was conducted including only female participants, and the results indicated there were no significant differences in female participants' self-reported math grades when comparing participants in the control group and intervention group, $F(1, 64) = 0.04, p = .849$.

Correlations between Variables

Table 4 presents the correlations between all of the continuous variables in the study. The BASI—Math Skills Survey was significantly positively related to the DIM ($r = .39, p < .01$) and the FSMAS—Confidence in Learning Math Scale ($r = .26, p < .05$). The ITCS also was significantly positively related to the DIM ($r = .20, p < .05$), and the DIM was significantly positively related to the FSMAS—Confidence in Learning Math Scale ($r = .60, p < .01$). The CSES—Importance of Identity Scale was significantly positively related to the SCQ ($r = .43, p < .01$).

Additionally, Table 4 presents the correlations between the participants' self-reported current math grades and the study variables. Participants' math grades were significantly positively related to scores on the BASI—Math Survey ($r = .48, p < .01$); to the DIM ($r = .60, p < .01$); and to the FSMAS—Confidence in Learning Math Scale ($r = .42, p < .01$); and significantly negatively related to SCQ ($r = -.28, p < .05$).

Table 4

Correlation Matrix of Variables

Variable	1	2	3	4	5	6	7
1 BASI—Math Survey	1						
2 ITCS	.06	1					
3 CSES	-.06	.16	1				
4 DIM	.39**	.20*	.11	1			
5 SCQ	-.05	.02	.43**	-.16	1		
6 FSMAS	.26*	.04	.01	.60**	-.14	1	
7 Math Grades	.48**	.03	- .03	.60**	-.28*	.42**	1

Note: BASI = Basic Achievement Skills Inventory; ITCS = Impression and Test Concern Scale; DIM = Domain Identification Measure; CSES = Collective Self-Esteem Scale; SCQ = Stigma Consciousness Questionnaire; FSMAS = Fennema-Sherman Mathematics Attitudes Scales; *$p <$ .05 two-tailed, ** $p < .01$ two-tailed.

Manipulation Check

In order to determine if the manipulation or the gender-fair intervention was effective, a comparison was made of the ITCS scores for the control group and the intervention group. This comparison would determine if the experience of stereotype threat was no longer present in the intervention group. An independent-samples t-test was conducted of female participants with scores on the ITCS as the dependent variable and group membership (control versus intervention group) as the independent variable. There was no significant difference in the ITCS scores for the control group (M = 2.88, SD = 1.36) and intervention group (M = 3.17, SD = 1.13), t (1, 64) = -.93. These results suggest that female participants in the control group and intervention group did not differ in the amount of stereotype threat they experienced.

Hypotheses

Hypotheses One

Hypothesis one stated that there would be a significant interaction between gender and stereotype-threat condition; specifically, a) female participants in the implicit-stereotype-threat condition would score significantly lower on the math test compared to male participants in the same condition, and b) female participants in the nullified-stereotype-threat condition would not score significantly different than male participants in the same condition. To test hypothesis one a two-way independent ANOVA was employed. The independent variables were gender (male or female) and stereotype-threat condition (implicit-stereotype-threat condition or nullified-stereotype-threat condition). The dependent variable was performance on the BASI-Math Survey. There was a significant interaction (See Figure 1) between the gender of the participant and the stereotype-threat condition on math performance, $F(1, 96) = 4.47, p < .05, \eta_p^2 = .05$. This indicates that male and female participants were affected differently by the stereotype-threat condition, and the results support hypothesis one (See Table 5). Specifically, math performance for males ($M = 100.20, SD = 17.55$) was significantly higher than females' math performance ($M = 88.83, SD = 13.97$) in the implicit-stereotype-threat condition (i.e., the control group), and math performance was similar for males ($M = 92.68, SD = 15.50$) and females ($M = 94.77, SD = 14.44$) in the nullified-stereotype-threat condition (i.e., the intervention group). Hypothesis one was supported.

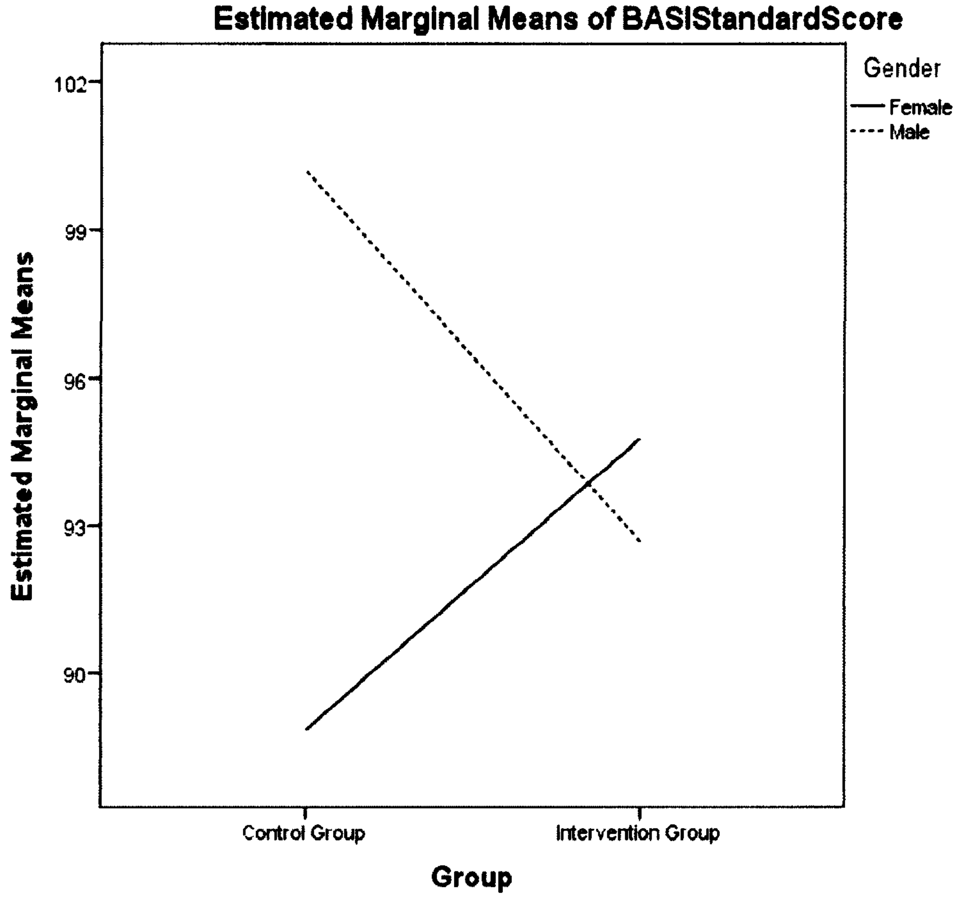

Figure 1 *Scores on BASI Math Survey for Both Groups Separated by Gender Group*

Table 5

Results of the ANOVA for Hypothesis One

	df	*F*	*p*	η_p^2
Group	1, 96	0.06	.804	.001
Gender	1, 96	2.13	.148	.022
Group*Gender	1, 96	4.47	.037*	.045

*Note:** *p* < .05

Hypotheses Two

Hypothesis two stated that in the implicit-stereotype-threat condition, female participants with high gender identification, as measured by the Importance of Identity Scale of the CSES, would perform significantly lower on the math test compared to females with low gender identification. To test hypothesis two a two-way independent analysis of variance (ANOVA) was conducted with stereotype-threat condition (implicit-stereotype-threat condition or nullified-stereotype-threat condition) and gender identification (low or high) as the independent variables and performance on the BASI-Math Survey as the dependent variable. There was a non-significant main effect for level of gender identification on females' math performance, $F(1, 62) = 0.60, p = .44$ (See Table 6). Thus, level of gender identification did not have an effect on female participants' math performance. Female participants with high gender identification did not perform significantly different on the math test than female participants with low gender identification. The results of the ANOVA did not support hypothesis two.

Hypothesis Three

Hypothesis three stated that in the nullified-stereotype-threat condition female participants with high gender identification would not score significantly different from females with low gender identification. To test hypothesis three a two-way independent analysis of variance (ANOVA) was conducted with stereotype-threat condition (implicit-stereotype-threat condition or nullified-stereotype-threat condition) and gender identification (low or high) as the independent variables and performance on the BASI-Math Survey as the dependent variable. There was a non-significant main effect for level of gender identification on females' math performance, $F(1, 62) = 0.60, p = .44$ (See

Table 6). Thus, level of gender identification did not have an effect on female participants' math performance. Female participants with high gender identification did not perform significantly different on the math test than female participants with low gender identification. The results of the ANOVA support hypothesis three because female participants in the nullified-stereotype-threat condition with high gender identification scored comparably to female participants with low gender identification.

Hypothesis Four

Hypothesis four stated that there would be an interaction between gender identification and stereotype-threat condition on females' math performance. Female participants with high gender identification in the nullified-stereotype-threat-condition would score significantly higher on the math test compared to females with high gender identification in the implicit-stereotype-threat condition. To test hypothesis four a two-way independent analysis of variance (ANOVA) was conducted with stereotype-threat condition (implicit-stereotype-threat condition or nullified-stereotype-threat condition) and gender identification (low or high) as the independent variables and performance on the BASI-Math Survey as the dependent variable. There was a non-significant interaction between the stereotype-threat condition and level of gender identification on math performance, $F(1, 62) = 0.43, p = .51$ (See Table 6). The results of the ANOVA did not support hypothesis four.

Table 6

Results of the ANOVA for Hypotheses Two, Three, and Four

	df	*F*	*p*	η_p^2
Group	1, 62	2.95	.091	.045
Gender Identification	1, 62	0.60	.441	.010
Group*Gender ID	1, 62	0.43	.514	.007

*Note:** $p < .0125$

Hypotheses Five

Hypothesis five stated that in the implicit-stereotype-threat condition female participants with high math identification, as measured by the DIM—Math, would perform significantly lower on the math test compared to females with low math identification. To test hypothesis five a two-way independent analysis of variance (ANOVA) was conducted with stereotype-threat condition (implicit-stereotype-threat condition or nullified-stereotype-threat condition) and math identification (low or high) as the independent variables and performance on the BASI-Math Survey as the dependent variable. There was a non-significant main effect for level of math identification on females' math performance, $F(1, 62) = 5.32, p = .024$ (See Table 7). Thus, level of math identification did not have an effect on female participants' math performance. Female participants with high math identification did not perform significantly different on the math test than female participants with low math identification. The results of the ANOVA did not support hypothesis five.

Hypothesis Six

Hypothesis six stated that in the nullified-stereotype-threat condition female participants with high math identification would perform significantly higher on the math test compared to females with low math identification. To test hypothesis six a two-way independent analysis of variance (ANOVA) was conducted with stereotype-threat condition (implicit-stereotype-threat condition or nullified-stereotype-threat condition) and math identification (low or high) as the independent variables and performance on the BASI-Math Survey as the dependent variable. There was a non-significant main effect for level of math identification on females' math performance, $F(1, 62) = 5.32$, $p = .024$ (See Table 7). Thus, level of math identification did not have an effect on female participants' math performance. Female participants with high math identification did not perform significantly different on the math test than female participants with low math identification. The results of the ANOVA did not support hypothesis six.

Hypothesis Seven

Hypothesis seven stated that there would be an interaction between math identification and stereotype-threat condition on females' math performance. Female participants with high math identification in the nullified-stereotype-threat-condition would score significantly higher on the math test compared to females with high math identification in the implicit-stereotype-threat condition. To test hypothesis seven a two-way independent analysis of variance (ANOVA) was conducted with stereotype-threat condition (implicit-stereotype-threat condition or nullified-stereotype-threat condition) and math identification (low or high) as the independent variables and performance on the BASI-Math Survey as the dependent variable. There was a non-significant interaction between the stereotype-threat condition and level of math identification on math performance, $F(1, 62) = 0.16, p = .69$ (See Table 7). The results of the ANOVA did not support hypothesis seven.

Table 7

Results of the ANOVA for Hypotheses Five, Six, and Seven

	df	*F*	*p*	η_p^2
Group	1, 62	2.55	.115	.040
Math Identification	1, 62	5.32	.024	.079
Group*Math ID	1, 62	0.16	.693	.003

*Note:** $p < .0125$

Hypotheses Eight

Hypothesis eight stated that in the implicit-stereotype-threat condition female participants with high stigma consciousness, as measured by SCQ, would perform significantly lower on the math test compared to females with low stigma consciousness. To test hypothesis eight a two-way independent analysis of variance (ANOVA) was conducted with stereotype-threat condition (implicit-stereotype-threat condition or nullified-stereotype-threat condition) and stigma consciousness (low or high) as the independent variables and performance on the BASI-Math Survey as the dependent variable. There was a non-significant main effect for level of stigma consciousness on females' math performance, $F(1, 62) = 1.68, p = .20$ (See Table 8).

Table 8

Results of the ANOVA for Hypotheses Eight, Nine, and Ten

	df	*F*	*p*	η_p^2
Group	1, 62	2.29	.136	.036
Stigma Consciousness	1, 62	1.68	.200	.026
Group*SC	1, 62	1.56	.217	.024

*Note:** $p < .0125$

Thus, level of stigma consciousness did not have an effect on female participants' math performance. Female participants with high stigma consciousness did not perform significantly different on the math test than female participants with low stigma consciousness. The results of the ANOVA did not support hypothesis eight.

Hypothesis Nine

Hypothesis nine stated that in the nullified-stereotype-threat condition female participants with high stigma consciousness would not score significantly different from females with low stigma consciousness. To test hypothesis nine a two-way independent analysis of variance (ANOVA) was conducted with stereotype-threat condition (implicit-stereotype-threat condition or nullified-stereotype-threat condition) and stigma consciousness (low or high) as the independent variables and performance on the BASI-Math Survey as the dependent variable. There was a non-significant main effect for level of stigma consciousness on females' math performance, $F(1, 62) = 1.68, p = .20$ (See Table 8). Thus, level of stigma consciousness did not have an effect on female participants' math performance. Female participants with high stigma consciousness did not perform significantly different on the math test than female participants with low stigma consciousness. The results of the ANOVA supported hypothesis nine.

Hypothesis Ten

Hypothesis ten stated that there would be an interaction between stigma consciousness and stereotype-threat condition on females' math performance. Female participants with high stigma consciousness in the nullified-stereotype-threat-condition would score significantly higher on the math test compared to females with high stigma consciousness in the implicit-stereotype-threat condition. To test hypothesis ten a two-way independent analysis of variance (ANOVA) was conducted with stereotype-threat condition (implicit-stereotype-threat condition or nullified-stereotype-threat condition) and stigma consciousness (low or high) as the independent variables and performance on the BASI-Math Survey as the dependent variable. There was a non-significant interaction between the stereotype-threat condition and level of stigma consciousness on math performance, $F(1, 62) = 1.56, p = .22$ (See Table 8). The results of the ANOVA did not support hypothesis ten.

Hypotheses Eleven

Hypothesis eleven stated that in the implicit-stereotype-threat condition female participants with high math self-efficacy, measured by the Confidence in Learning Mathematics scale of the FSMAS, would perform significantly higher on the math test than females with low math self-efficacy. To test hypothesis eleven a two-way independent analysis of variance (ANOVA) was conducted with stereotype-threat condition (implicit-stereotype-threat condition or nullified-stereotype-threat condition) and math self-efficacy (low or high) as the independent variables and performance on the

BASI-Math Survey as the dependent variable. There was a non-significant main effect for level of math self-efficacy on females' math performance, $F(1, 62) = 6.29$, $p = .015$ (See Table 9). Thus, level of math self-efficacy did not have an effect on female participants' math performance. Female participants with high math self-efficacy did not perform significantly different on the math test than female participants with low math self-efficacy. The results of the ANOVA did not support hypothesis eleven.

Hypothesis Twelve

Hypothesis twelve stated that in the nullified-stereotype-threat condition, female participants with high math self-efficacy would perform significantly higher on the math test than females with low math self-efficacy. To test hypothesis twelve a two-way independent analysis of variance (ANOVA) was conducted with stereotype-threat condition (implicit-stereotype-threat condition or nullified-stereotype-threat condition) and math self-efficacy (low or high) as the independent variables and performance on the BASI-Math Survey as the dependent variable. There was a non-significant main effect for level of math self-efficacy on females' math performance, $F(1, 62) = 6.29$, $p = .015$ (See Table 9). Thus, level of math self-efficacy did not have an effect on female participants' math performance. Female participants with high math self-efficacy did not perform significantly different on the math test than female participants with low math self-efficacy. The results of the ANOVA did not support hypothesis twelve.

Table 9

Results of the ANOVA for Hypotheses Eleven and Twelve

	df	*F*	*p*	η_p^2
Group	1, 62	1.96	.167	.031
Math Self-efficacy	1, 62	6.29	.015	.092
Group*Math Self-efficacy	1, 62	1.09	.302	.017

*Note:** $p < .0125$

CHAPTER FOUR

DISCUSSION

This section will begin with a general overview of the results, followed by a discussion of each hypothesis. The general implications for the study also will be discussed, followed by the limitations of the study and suggestions for future research.

General Overview of Results

Data analysis revealed that the current sample scored significantly lower on the BASI math survey than the sample on which the survey was standardized. The current sample experienced higher levels of perceived stereotype threat than the sample with which the ITCS was developed. Additionally, results showed that the current sample reported more personal identification with mathematics than the sample on which the DIM was validated. Results of a one-way ANOVA indicated there were no significant differences found overall among males and females on any of the continuous variables (i.e., math performance, perceived stereotype threat, gender identification, math identification, and math self-efficacy).

Math scores were found to be significantly positively correlated with math identification and math self-efficacy. These correlations are consistent with previous research findings. In a study conducted by Aronson et al. (1999), in the control condition, when stereotype threat was not intentionally highlighted, participants with high math identification had higher math performance than individuals with moderate to low math identification. Studies conducted by Betz and Hackett (1983) and Lui (2009) indicated that math self-efficacy is a strong predictor of math performance. Perceived stereotype threat was significantly positively correlated with math identification, which gives evidence to support the claim by previous researchers (Keller, 2007a; Lesko & Corpus, 2006) that females with higher math identification perform worse on math tests than females with lower math identification because they are more aware of the stereotype threat because of their personal link with the domain. Math identification was significantly positively related to math self-efficacy. Previous research (Betz & Hackett, 1983; Hackett & Betz, 1989) has indicated that level of math self-efficacy can predict college major and career choice, specifically that individuals with high math self-efficacy are more likely to choose college majors and careers in math and related subjects. This correlation is consistent with this research because it is likely that someone who chooses to pursue a career in math or a related subject also considers math as a significant part of his or her identity.

Gender identification was found to be significantly positively related to stigma consciousness. This correlation is not surprising given that stigma consciousness is defined as a heightened perception that one will be a target of a negative stereotype (Brown & Pinel, 2003; Pinel, 1999), and the negative stereotype evoked in this study was the negative stigma that females are not as capable as males in math. It is presumed that the more a female identifies with her gender, and views it as a significant part of her identity, then the more aware she will be of the stigma about her gender group. Participants' self-reported math grades were found to be significantly positively related to scores on the math survey and to math self-efficacy. These correlations are consistent with previous research studies (Betz & Hackett 1983; Hackett & Betz, 1989; Junge & Dretzke, 1995) that have indicated that math self-efficacy is positively correlated with math performance and math grades. Additionally, math grades were found to be significantly negatively related to stigma consciousness. This correlation has not been revealed in previous research and suggests that the more a female is aware of the potential for her group to be the target of a negative stereotype, then the lower her math grades will be. A similar result was found in a previous study (Brown & Lee, 2005) when stigmatized students, including African American and Latino students, who had higher levels of stigma consciousness reported having lower grade-point averages than stigmatized students with lower stigma consciousness.

In a manipulation check analysis, results revealed that there was no significant difference in the level of perceived stereotype threat for female participants between the control and intervention group. This means in this study that the intervention employed to reduce stereotype threat was not effective. There are a few possible explanations for the failure of the intervention to produce significant differences between the female participants in the control group and in the intervention group on level of perceived stereotype threat. One potential explanation is that stereotype threat was not experienced by these female participants in this study; however, this likely is not that case because, as previously mentioned, this sample had higher scores on the perceived stereotype threat measure than the sample with which the scale was developed. Another possible explanation could be that the scale did not accurately measure perceived stereotype threat. Notably, Marx and Goff (2005) found good internal consistency for the ITCS with their study sample, indicating that the items were measuring a single construct.

So, if the ITCS has good internal consistency and the female participants in this study reported higher levels of perceived stereotype threat than the sample of participants with which the measure was validated, then what is the cause of the lack of significant difference between the two groups? It is possible that the intervention utilized, which entailed having the participants read a statement indicating that the math test has been shown no gender differences in the past, did not reduce stereotype threat as proposed; therefore, no significant differences were found between the two groups of female participants. Additionally, it should be noted that the intervention group endorsed experiencing slightly, but not significantly, more threat (M = 3.17) than the control group (M = 2.88), so it is possible that the stereotype threat was made more salient in the intervention group with the mention of gender differences. Remember, in the control group, there was no mention of gender differences on the math test; the participants were only given instructions to complete the following math test to the best of their abilities.

Hypothesis One

Hypothesis one stated that there would be a significant interaction between gender and stereotype-threat condition; specifically, a) female participants in the implicit-stereotype-threat condition would score significantly lower on the math test compared to male participants in the same condition, and b) female participants in the nullified-stereotype-threat condition would not score significantly different than male participants in the same condition. The results of an ANOVA supported this hypothesis, and these findings are consistent with previous research. Several studies (Smith & White, 2002;

Spencer et al., 1999; Thoman et al., 2008) have discovered that in a control group with no mention of gender differences on a math test, stereotype threat is experienced and affects females' performance on a math test in that they perform significantly lower than males in the same condition. Additionally, previous research studies have revealed that a simple intervention of reframing the math test as gender fair, or producing no gender differences, is effective at reducing stereotype threat (Keller & Dauenheimer, 2003; Quinn & Spencer, 2001; Smith & White, 2002; Spencer et al., 1999). These studies and the present study indicate that if stereotype threat is reduced by reframing the task as gender fair, females can perform similar to males on a math test.

Even though the results confirming hypothesis one are consistent with previous research, it is somewhat surprising that these findings still were produced because of the lack of significant difference of perceived stereotype threat for female participants in the two groups. One explanation for this occurrence is that females may not have been aware of the stereotype threat they were experiencing, thus not endorsing the questions on the measure accurately. On the other hand, it is possible that female participants may not have wanted to endorse items acknowledging that they experienced stereotype threat because this could legitimize that there is such a stereotype that females are not as capable in math as males. Remember that the females produced slightly lower scores on the ITCS in the control or implicit-stereotype-threat group than females in the intervention or nullified-stereotype-threat group. Even though the females in the control group did not indicate experiencing more perceived stereotype threat, it appears that they likely did experience the threat, so they performed worse than the males in their group on the math test. Even though this cannot be proven by the present study, research has shown that stereotype threat hinders performance when there is a potential to confirm a negative stereotype about one's group; however, the person actually does not have to perceive the threat to experience it (Steele & Aronson, 1995). There still is the possibility of an additional unknown variable which was not measured in this study could have played a role in producing these results.

Another potential reason for the findings, even without significant differences in females' perceived threat, could be that the males in the intervention or nullified-stereotype-threat group, performed worse in that condition than the control group due to a concept labeled stereotype lift. Stereotype lift has been defined by Walton and Cohen (2003) as, "the performance boost caused by the awareness that an out-group is negatively stereotyped" (p. 456). This performance boost has been found when there is specific mention of the out-group's lesser ability, but also found "when there is no specific reference to a stereotyped out-group, if the performance task is linked to a widely known negative stereotype" (p. 456). It is possible that because the males in the control condition in this study performed lower than the males in the intervention condition that this produced a significant difference between males and females' math performance in the control condition and not in the intervention condition.

Hypothesis Two

Hypothesis two stated that in the implicit-stereotype-threat condition, female participants with high gender identification would perform significantly lower on the math test compared to females with low gender identification. The results of the ANOVA did not support this hypothesis. The results indicate that the level of gender identification did not have an effect on female participants' math performance and that female participants with high gender identification did not perform significantly different on the math test than female participants with low gender identification. This result is inconsistent with previous research (Schmader, 2002; Sekaquaptewa, 2007). One possible explanation is that there was not a substantial difference or range in the female participants' reported level of gender identification, which led to a failure to produce a significant effect on the females' math performance. Notably, the reliability coefficient for the gender identification measure was in the questionable range (George & Mallery, 2003) for females in this sample.

Another possible explanation is that females in this study were concerned with their self-reputation in relation to their math performance more than their gender group's reputation. A recent study by Zhang, Schmader, and Hall (2013) highlighted the idea that individuals experience stereotype threat in different ways; for example, some individuals are more concerned with how their performance is going to affect their self-reputation, rather than their identified group's reputation. In the study by Zhang et al. (2013), the researchers demonstrated that females performed worse on a math test than their male counterparts when they had to identify themselves by name; however, when they were given the opportunity to unlink themselves from their personal identity by identifying themselves on the test with a fictitious name, the females' performed comparable to males on the math test in the same condition. It is possible that the females in this study were not as concerned about confirming a negative stereotype about their female gender group, but possibly more concerned about their self-reputation. This possibly could explain the non-significant relationship of gender identification on math performance in this study.

Hypothesis Three

Hypothesis three stated that in the nullified-stereotype-threat condition female participants with high gender identification would not score significantly different from females with low gender identification. The results of the ANOVA supported this hypothesis as there was no significant difference in math performance between females with low gender identification and high gender identification in this condition.

Even though the proposed hypothesis was supported, it should be noted that the theory behind the hypothesis is likely not supported. The result that female participants with high gender identification in this condition did not score significantly different from females with low gender identification likely is not related to effects of gender identification because the results of the ANOVA revealed that there was not a significant main effect of gender identification on math performance. Previous research has indicated that when females identify with their gender group, they are more susceptible to stereotype threat, and in turn perform lower on math tests when compared to males (Schmader, 2002; Sekaquaptewa, 2007). These studies also have indicated that when the stereotype threat is reduced or eliminated, then the effect of gender identification is removed. It was hypothesized in this study that this would be the case; however, this was not found because gender identification did not have a significant effect in the control or implicit-stereotype-threat condition. It likely is that the gender-fair intervention was effective, as shown in Hypothesis one, which led to all female participants in the nullified-stereotype-threat condition performing similarly.

Hypothesis Four

Hypothesis four stated that there would be an interaction between gender identification and stereotype-threat condition on females' math performance. Female participants with high gender identification in the nullified-stereotype-threat-condition would score significantly higher on the math test compared to females with high gender identification in the implicit-stereotype-threat condition. The results of the ANOVA did not support this hypothesis because there was no significant interaction found between gender identification and stereotype-threat condition on females' math performance. This result indicates that gender identification did not act as a moderator between stereotype threat and females' math performance. This finding is inconsistent with previous research (Schmader, 2002) that found level of gender identity moderated the relationship between stereotype threat and females' math performance. One possible explanation for the current finding is that there was not a significant amount of variability between the high and low gender identification groups to produce an effect. Another possibility is that the female participants (even though they reported similar levels of gender identification than the group with which the CSES was developed) were not concerned with confirming the negative stereotype about their gender group, but possibly were more concerned about their individual self-reputation in relation to math performance.

Hypothesis Five

Hypothesis five stated that in the implicit-stereotype-threat condition female participants with high math identification would perform significantly lower on the math test compared to females with low math identification. The results of the ANOVA did not support this hypothesis. The results revealed that there was a non-significant main effect for math identification, indicating that, overall, females with high math identification did not perform significantly different from females with low math identification. This finding is inconsistent with previous research. Previous research (Keller, 2007a; Lesko & Corpus, 2006) found that when females were in a stereotype-threat condition, females with higher math identification performed worse than females with low math identification. Additionally, previous research indicated that when the stereotype threat is removed, females with high math identification outperform those with low math identification in the same condition. In the present study, results indicated that females with high math identification did not perform significantly different from females with low math identification in either condition.

One explanation for this result could be due to the homogeneous nature of the sample in relation to math identification. The current sample indicated having higher levels of personal identification with mathematics than the sample on which the DIM was validated. This likely indicates that all participants identified with mathematics to some degree even those who reported having lower levels math identification. Notably, math identification was found to be significantly positively related to participants' math scores, indicating that the higher one's reported math identification the higher one performed on that math test. In the present study even though there was a positive relationship between math identification and math performance, there was not a large enough difference between reported levels of math identification for female participants in the two conditions, and therefore, no significant main effect was found.

Hypothesis Six

Hypothesis six stated that in the nullified-stereotype-threat condition female participants with high math identification would perform significantly higher on the math test compared to females with low math identification. The results of the ANOVA did not support this hypothesis. This finding is inconsistent with previous research (Keller, 2007a; Lesko & Corpus, 2006), which indicated that when stereotype threat is no longer present, females with high math identification outperform those with low math identification in the same condition. In the present study there was not a significant main effect of math identification, indicating that math identification did not have a significant influence on females' math performance. However, it was found that math identification in this study was significantly positively related to math performance; and it is possible that a significant main effect of math identification was not found due to lack of heterogeneous reporting of math identification in this sample. In a comparison sample means of the present study with the study with which the DIM was validated, results indicated that the present study's sample reported higher levels of math identification than the validated sample, indicating that all participants identified to some extent with mathematics.

Hypothesis Seven

Hypothesis seven stated that there would be an interaction between math identification and stereotype-threat condition on females' math performance. Female participants with high math identification in the nullified-stereotype-threat-condition would score significantly higher on the math test compared to females with high math identification in the implicit-stereotype-threat condition. Results did not support this hypothesis. There was not a significant interaction between math identification and stereotype-threat condition on females' math performance, indicating that math identification did not act as a moderator in this study. This finding is inconsistent with previous research (Keller, 2007a) that found that math identification moderated the relationship between stereotype threat and females' math performance. A possible explanation for the lack of interaction in this study is that math identification appeared to play more of a protective role in the relationship between stereotype threat and females' math performance. This is bolstered in the present study because females with high math identification performed better than females with low math identification in both conditions.

Hypothesis Eight

Hypothesis eight stated that in the implicit-stereotype-threat condition female participants with high stigma consciousness would perform significantly lower on the math test compared to females with low stigma consciousness. Results did not support this hypothesis because there was not a significant main effect for stigma consciousness. This indicates that the level of stigma consciousness did not have a significant effect on math performance. This finding is inconsistent with previous research. Previous research (Brown & Pinel, 2003; Pinel, 1999) has shown that females with high stigma consciousness perform worse than females with low stigma consciousness on a math test when stereotype threat is present. It is presumed that female participants in this study experienced stigma consciousness as they did not score significantly different on the measure than the sample on which the measure was develop (Brown & Pinel, 2003). However, their reported levels of stigma consciousness did not have an effect on their math performance. One possible explanation is low internal consistency of the SCQ for this sample. The reliability coefficient for the stigma consciousness measure was in the poor range (George & Mallery, 2003) for females in this sample. This could indicate that the female participants in this study did not respond consistently to the items on the measure.

Another possible explanation for the lack of significant results for stigma consciousness on females' math performance could be that the participants lacked full awareness of the magnitude of their automatic associations of the negative stereotype about their gender group and awareness of the potential negative effect of this automatic, potentially unconscious, belief. Even though the participants indicated levels of stigma consciousness comparable to those in Brown and Pinel (2003), it is possible that they were not completely aware of the extent to which they believe this negative stereotype and of the harmful effect that the stereotype can have on their performance. According to prior research (Ambady et al., 2001; Galdi, Cadinu, & Tomasetto, 2014; Neuville & Croizet, 2007) children develop automatic associations with negative ingroup stereotypes at a young age and these negative stereotypes can have damaging effects on performance before an explicit awareness of the stereotype even develops. Thus it is possible that the female participants in this study had the stereotype activated, which led to the deficits in their math performance in the implicit-stereotype-threat condition; however, they did not report high enough levels of stigma consciousness to produce a significant relationship with math performance. Interestingly, it is noted that stigma consciousness was found to significantly negatively corrected to female participants' self-report math grades, but not found to be significantly correlated with their performance on the math test completed in the study.

Hypothesis Nine

Hypothesis nine stated that in the nullified-stereotype-threat condition female participants with high stigma consciousness would not score significantly different from females with low stigma consciousness. Results supported this hypothesis as there was no significant difference in math performance between females with low stigma consciousness and high stigma conscious in this condition.

Even though the proposed hypothesis was supported, it should be noted that the theory behind the hypothesis is likely not support. The result that female participants with high stigma consciousness in the nullified-stereotype-threat condition would not score significantly different from females with low stigma consciousness in the same condition likely is not related to effects of stigma consciousness because the results revealed that there was not a significant main effect of stigma consciousness on math performance. Previous research has indicated that when females consciously are aware of the stigma that exists about their gender group in relation to math performance, they are more susceptible to stereotype threat and in turn perform lower on math tests when compared to males (Brown & Pinel, 2003; Pinel, 1999), and these studies also have indicated that when the stereotype threat is reduced or eliminated, then the negative effect of stigma consciousness is removed. It was hypothesized in this study that this would be the case; however, this was not found because stigma consciousness did not have a significant effect in the control or implicit-stereotype-threat condition. It is likely that the gender-fair intervention was effective, as shown in Hypothesis one, which led to all females in the nullified-stereotype-threat condition performing similarly. Two possible explanations for the lack of significant main effect for stigma consciousness on math performance were discussed above: low internal consistency and lack of awareness of the level of stereotype threat experienced.

Hypothesis Ten

Hypothesis ten stated that there would be an interaction between stigma consciousness and stereotype-threat condition on females' math performance. Female participants with high stigma consciousness in the nullified-stereotype-threat-condition would score significantly higher on the math test compared to females with high stigma consciousness in the implicit-stereotype-threat condition. The results of the ANOVA did not support this hypothesis as no significant interaction was found between stigma consciousness and stereotype-threat condition on females' math performance, indicating that stigma consciousness did not perform as a moderator in this study. This finding is inconsistent with previous research by Brown and Pinel (2003) that found level of stigma consciousness moderated the relationship between stereotype threat and females' math performance. A couple of possible explanations for the lack of significant effect of stigma consciousness in this study have been mentioned, and an additional possible explanation for the lack of main effect and interaction of stigma consciousness in this study could be differences in stereotype-threat conditions in the present study and the comparison study. In the study by Brown and Pinel (2003), the participants were told before completing a math exam that the test was either free of gender bias or they were told that the test was developed to understand the differences in math performance between males and females. The latter condition is considered a stereotype-threat-induced condition. In the present study, the two stereotype-threat conditions were implicit or naturally occurring stereotype threat, in which there was no mention of gender differences or lack thereof in relation to the math test, and a nullified or stereotype-threat-reduction condition, in which the test was proposed to show no gender differences in the past. It is evident that there is a significant difference in the two studies' conditions because the present study lacked a stereotype-threat-induced condition. It is possible that the result that Brown and Pinel (2003) found that females in the stereotype-threat-induced condition with high stigma consciousness performed worse than females with low stigma consciousness in the same condition, and that this difference no longer existed in the gender fair condition, could be due to the explicit mention of gender differences in math, which was not included in the present study.

Hypothesis Eleven

Hypothesis eleven stated that in the implicit-stereotype-threat condition female participants with high math self-efficacy would perform significantly higher on the math test than females with low math self-efficacy. The results of the ANOVA did not support this hypothesis. There was a non-significant main effect of math self-efficacy on female participants' math performance. Previous research examining the effect of math self-efficacy on females' math performance in stereotype-threat conditions has produced mixed results and few studies have precisely tested this relationship. Previous studies have indicated that there is a significant relationship between females' math self-efficacy and their math performance (Betz & Hackett, 1983; Hackett & Betz, 1989; Junge & Dretzke, 1995), and some studies have indicated that math self-efficacy is a strong predictor of one's math performance (Betz & Hackett, 1983; Hackett & Betz, 1989).

Additionally, previous (Roberson et al., 2003; Stangor et al., 1998) has revealed that stereotype threat can undermine individuals' confidence in their abilities, which is similar to the concept of self-efficacy, defined as judgments of one's capabilities in a specific area (Bandura, 1982), even though those studies did not use the term self-efficacy. In the studies by Roberson et al. (2003) and Stangor et al. (1998), participants who were part of a stereotyped group, including African Americans and females, discounted positive feedback and lowered their self-expectations for future performance when stereotype threat was present.

Results of the present study did not find a significant effect of math self-efficacy on math performance. The main effect analysis in the present study was approaching significance with a *p*-level of .015, which would have been significant without the Bonferroni correction which lowered the *p*-level from .05 to .0125. It is possible that there could have been a significant main effect of math self-efficacy if multiple comparisons were not conducted in the present study. It would be useful to replicate this study with only examining the potential effect of math self-efficacy on females' math performance and not the other proposed moderators as they were not shown to be significant factors in this study. Additionally, in the present study there was a significant positive correlation found between participants' math self-efficacy and math performance.

Hypothesis Twelve

Hypothesis twelve stated that in the nullified-stereotype-threat condition, female participants with high math self-efficacy would perform significantly higher on the math test than females with low math self-efficacy. Results did not support this hypothesis.

There was a non-significant main effect for math self-efficacy on female participants' math performance, indicating that females' math self-efficacy did not have a detectable effect on their math performance. This finding is inconsistent with previous research (Betz & Hackett, 1983; Hackett & Betz, 1989; Junge & Dretzke, 1995) that revealed a positive relationship between females' math self-efficacy and math performance. However, it is notable to point out that when examining correlations in the present study, math self-efficacy was found to be significantly positively related to math performance.

Implications

The results of the present study have several implications for enhancing the stereotype threat literature as well as providing potential areas for making changes in learning and classroom settings to improve females' math performance and increase their interest in math to continue working towards decreasing the gender gap in STEM careers. The first implication is related to the level of perception or consciousness that is required, or not required, for stereotype threat to have a negative impact on females' math performance. In this present study, it appears that female participants did not need to have a significant level of perceived threat for the negative stereotype about their gender group to have a negative effect on their performance on the math test. There was not a significant difference found between females in the control and intervention group on perceived threat; however, there was a significant difference found between females in the two conditions on math performance, specifically, that females in the intervention group scored higher on the math test than females in the control group. This indicates that educators and parents cannot rely solely on the self-reported levels of perceived stereotype threat from female students, but rather need to focus, and maintain focus, on eliminating and combatting stereotype threat because they cannot be certain that it is not at play through automatic associations.

The present study has implications on how educators and parents can go about eliminating or combatting stereotype threat, such as employing a simple stereotype-threat-reduction intervention before administering math tests. It was demonstrated that a simple intervention of reframing the task as gender-fair was effective in decreasing the negative effect of stereotype threat on females' math performance. There have been several other stereotype-threat-reduction interventions that have been indicated to be effective; however, several of them are not as easy to implement on a routine basis. Implementing this task-reframing intervention could be implemented simply by having educators continually remind students that there have been no significant gender differences on the math tests in the past, or in math in general.

The results of this study revealed another area for potential growth and change in the classroom environment to combat stereotype threat and to assist in boosting females' math performance and math interest. The results of positive correlations with math performance of math identification and math self-efficacy indicated that increasing females' math self-efficacy and math identification, potentially could shield females from the negative effects of stereotype threat. Results of the present study indicated that math self-efficacy and math identification were significantly positively related to performance on the math test and to self-reported math grades. This indicates that if parents and educators help build and foster the development of math self-efficacy and math identification in female students, then potentially these factors could protect them from stereotype threat; however, more research is needed to determine the significance of this effect. Increasing females' math self-efficacy and math identification could be done by giving female students opportunities to succeed in math, providing positive female role models in math, and by making females aware of the stereotype threat and its potential negative effects. Additionally, according to SCCT (Lent et al, 1994, 2000) one's self-efficacy in a particular subject affects one's expected performance in that subject and in turn shapes the decision to pursue or avoid long-term goals. Therefore, increasing female students' math self-efficacy could increase the likelihood that they pursue careers in math and math-related fields.

A significant contribution of the results of the present study is that the findings were with a high school sample. The majority of the studies in this area have been conducted with college-student samples, and this study's sample consisted of ninth-grade high school students. It likely is more beneficial to confirm that these interventions can be effective at this age rather than at a college age because students' career choices likely have not been yet decided or solidified. By increasing females' math self-efficacy and math identification, there is a potential for females to become interested in pursuing careers in STEM fields helping to decrease the gender gap that still currently exists in these careers.

Limitations and Suggestions for Future Research

This section will address the limitations of the current study and suggestions for future research. There are multiple limitations to the current study. First of all, the sample for the study was relatively small with only 100 participants split between two conditions. It is possible that the small sample size may have made it difficult to detect the effect of possible moderators in the relationship between stereotype threat and females' math performance. Another potential limitation about the sample is the generalizability of the results because the sample consisted of only ninth-grade students from a public high school in the Southern United States. It cannot be determined if these results could be generalized to students in other grades in high school, students at private schools, or students from different parts of the United States.

Another limitation of the current study is that the independent variables only were measured with one method and that method was using self-report inventories. When analyzing results in a study in which self-report measures were utilized, one assumes that participants were attentive to the items on the measures and responded truthfully. The effort was made to minimize the impact of using self-report data. For example, participants were informed that their responses would be kept anonymous and confidential, and to ensure them of this idea, their informed consent forms were collected separately from their study packet, which included the math test and self-report measures. Participants' names were reported only on the informed consent forms. A further effort to minimize the impact of potentially untruthful responding on the self-report measures, a scale measuring socially desirable responding could have been included in the study and should be included in future research studies.

A few others limitations of the study are related to experimental design, including the lack of variability in the sex of the experimenter. All of the data was collected by one individual, who was female, and it is possible that the results could have differed if the experimenter were male. Future research studies could benefit from varying the sex of the experimenter and comparing the groups to look for potential differences in results. Additionally, the sex of the participants in each condition could be altered, as well, in future studies, so that some participants complete the study in a room with only same sex participants and others complete the study in mixed-sex groups. Some previous research has shown that females in all-girls school perform better than females in coed schools, and this manipulation could examine if this difference exists in a controlled environment and can be replicated. Another potential limitation with how the present study was conducted is that the two stereotype-threat conditions occurred in the same classroom, meaning that participants assigned to each condition were sitting in close proximity to each other. It is possible that participants could have looked over at other participants' study packets and noticed the difference in the instruction page (i.e., whether there was a statement about no past gender differences on the math test or no statement about gender differences), and this potentially could have skewed the results.

A substantial limitation of the present study was the lack of the use of a covariate measuring the participants' math grades. Participants self-reported their math grades from that current academic year; however, it was decided to not utilize these grades as a covariate because they were collected by self-report, rather than officially from a teacher or administrator, so they could have been inaccurate. Additionally, the grades were reported in terms of letter grades (i.e., A, B, C, etc.), instead of as number grades (i.e., 100, 99, 98, etc.), so the grades were measured on an ordinal scale and was not a continuous variable, thus reducing variability. Lastly, another substantial limitation for this study was the number of multiple comparisons conducted which led to the utilization of a conservative Bonferroni correction. If this study were replicated in the future, it is suggested that the researcher(s) make fewer a priori hypotheses and few comparisons in order to naturally reduce the Type I error, or chance of incorrectly rejecting a true null hypothesis.

Based on this study, several suggestions for future research can be posited. First, one recommendation for future research would be to have a larger sample size in order to have more experimental conditions with the inclusion of same-sex versus mixed- sex groups, female versus male experimenter, and potentially comparing groups of students from public versus private schools. Another suggestion for future research would be for researchers to appropriately obtain participants math grades from the school administrators in order to utilize the grades as a covariate in the study.

Additionally, related to the results of the current study, future research should continue to examine the potential benefits of employing a reframing the task as gender fair intervention, specifically examining its effectiveness long-term. Future research also should examine ways to develop and increase females' math self-efficacy and math identification. Notably, more studies are needed to confirm the present finding that math identification plays a protective role between stereotype threat and females' math performance because this is inconsistent with previous research studies that indicated that higher math identification is more of a hindrance on females' math performance in stereotype threat conditions. Future studies also should examine the concept of stereotype lift and ways of measuring the concept to determine if this contributes to the differences in math between males and females (i.e., to determine if males actually are benefiting from this negative stereotype about females). Lastly, future research studies should examine the possibility that students are becoming more concerned with their self-reputation rather than their gender group's reputation to understand if gender identification plays a role in the relationship between stereotype threat and females' math performance as previous research has indicated.

Summary

Historically, there has been a gender gap in STEM careers in the United States, and even though this gap has decrease slightly in recent decades, it still is a significant issue. This gender gap in STEM careers has several implications, including hindering females from exploring a wide variety of career options and reaching their full potential, as well as, having a large percentage of the country not contributing to science, technology, engineering, and math fields, which is needed to help the United States stay competitive with other countries in innovation and technology. One major explanation for this gender gap has been the differences that exist between males and females in mathematics, which previously was understood as differences in their actual abilities in math, specifically, that males were innately better at math than females. Over time it has been discovered that females are just as capable at performing well in math as males; however, their math performance was negatively affected by the negative stereotype that females were not as capable as males in math.

Since Steele and Aronson (1995) proposed the concept of stereotype threat and revealed that it can have negative effects on females' math performance, there has been a significant amount of research in this area; however, there still are some gaps to fill in the research and some questions unanswered. The present study proposed to enhance this research area by potentially replicating previous research employing a simple intervention to reduce stereotype threat with a high school student sample in a real-world classroom setting and by examining the effects of three proposed moderators (i.e., gender identification, math identification, and stigma consciousness) and one potential protective factor (i.e., math self-efficacy) in the relationship between stereotype threat and females' math performance.

The results of the present study replicated the findings previously produced in studies with college students that females perform lower than males in an implicit-stereotype-threat condition and that they perform comparable to males when an intervention of reframing the math test as gender fair is employed. No significant moderation was found in the present study; however, math identification and math self-efficacy were discovered to be significantly positively correlated to math performance. The latter finding can have great implications in the classroom setting and in increasing females' interest and pursuit of math and other STEM careers.

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APPENDIX A

HUMAN USE COMMITTEE APPROVAL

LOUISIANA TECH
UNIVERSITY

OFFICE OF UNIVERSITY RESEARCH

MEMORANDUM

TO: Ms. Jackie Ball and Dr. Walter Buboltz

FROM: Barbara Talbot, University Research

SUBJECT: HUMAN USE COMMITTEE REVIEW

DATE: September 12, 2012

In order to facilitate your project, an EXPEDITED REVIEW has been done for your proposed study entitled:

"Stereotype Views and Mathematics Achievement"

HUC 1007*

The proposed study's revised procedures were found to provide reasonable and adequate safeguards against possible risks involving human subjects. The information to be collected may be personal in nature or implication. Therefore, diligent care needs to be taken to protect the privacy of the participants and to assure that the data are kept confidential. Informed consent is a critical part of the research process. The subjects must be informed that their participation is voluntary. It is important that consent materials be presented in a language understandable to every participant. If you have participants in your study whose first language is not English, be sure that informed consent materials are adequately explained or translated. Since your reviewed project appears to do no damage to the participants, the Human Use Committee grants approval of the involvement of human subjects as outlined.

Projects should be renewed annually. ***This approval was finalized on September 12, 2012 and this project will need to receive a continuation review by the IRB if the project, including data analysis, continues beyond September 12, 2013.*** Any discrepancies in procedure or changes that have been made including approved changes should be noted in the review application. Projects involving NIH funds require annual education training to be documented. For more information regarding this, contact the Office of University Research.

You are requested to maintain written records of your procedures, data collected, and subjects involved. These records will need to be available upon request during the conduct of the study and retained by the university for three years after the conclusion of the study. If changes occur in recruiting of subjects, informed consent process or in your research protocol, or if unanticipated problems should arise it is the Researchers responsibility to notify the Office of Research or IRB in writing. The project should be discontinued until modifications can be reviewed and approved.

*NOTE: Tests and questionnaire should not be disrupting to the students not participating.

If you have any questions, please contact Dr. Mary Livingston at 257-4315.

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APPENDIX B

DEMOGRAPHIC QUESTIONNAIRE

Demographic Questions

Please answer each of the following:

1) Age: ___

2) Gender (circle one):
   a) Female
   b) Male

3) Grade/Classification (circle one):
   a) Freshman
   b) Sophomore
   c) Junior
   d) Senior

4) Race/Ethnicity (circle one):
   a) American Indian/Alaskan Native
   b) Asian/Pacific Islander
   c) African American
   d) Caucasian
   e) Hispanic Latino
   f) Other: ___________________

5) What is the highest level of education completed by your parent(s)?
   a) Elementary school (Kindergarten through 5^{th} grade)
   b) Middle school (6^{th} grade – 8^{th} grade)
   c) Some high school
   d) High School
   e) Some college
   f) College
   g) Graduate School

6) Number of math courses completed (circle one):
   a) 0-1
   b) 2-3
   c) 4-5
   d) 5+

7) Currently, what are your grades in math? (circle one)
   a) A+, A, A-
   b) B+, B, B-
   c) C+, C, C-
   d) D+, D, D-
   e) F

8) In the past school year, what were your grades in math? (circle one)
   f) A+, A, A-
   g) B+, B, B-
   h) C+, C, C-
   i) D+, D, D-
   j) F

9) What career do you want to work in after finishing school?

____

10) What is the occupation(s) of your parent(s)?

____

11) Do you plan to attend college?
   a) Yes
   b) No
   c) Unsure

APPENDIX C

IMPRESSION AND TEST CONCERN SCALE

Impression and Test Concern Scale (adapted from Marx and Goff (2005))

Directions: For each of the following statements, please circle the number which best indicates how strongly you agree or disagree with the statement, using the following scale:

1	2	3	4	5	6	7
Strongly Disagree	**Disagree**	**Somewhat Disagree**	**Neutral**	**Somewhat Agree**	**Agree**	**Strongly Agree**

1. I worry that my ability to perform well on this math test will be affected by my gender.
   1 2 3 4 5 6 7
2. I worry that if I perform poorly on this math test, others will attribute my poor performance to my gender.
   1 2 3 4 5 6 7
3. I worry that, because I know the negative stereotype about females and math ability, my anxiety about confirming this stereotype will negatively influence how I perform on this math test.
   1 2 3 4 5 6 7
4. I am concerned that I will be seen as a success or failure.
   1 2 3 4 5 6 7
5. I am concerned about what other people think of me.
   1 2 3 4 5 6 7
6. I am concerned about the impression I am making.
   1 2 3 4 5 6 7
7. I am concerned that my group will be seen as a success or failure.
   1 2 3 4 5 6 7
8. I am concerned about what other people think of my group.
   1 2 3 4 5 6 7
9. I am concerned about people's impression of my group.
   1 2 3 4 5 6 7

APPENDIX D

BASIC ACHIEVEMENT SKILLS INVENTORY—

MATH SKILLS SURVEY

APPENDIX E

IMPORTANCE OF IDENTITY SUBSCALE OF THE COLLECTIVE SELF-ESTEEM SCALE

Collective Self-Esteem Scale (CSES)—Importance of Identity subscale (Luhtanen & Crocker, 1992)

Directions: For the following statements, please circle the number which best indicates how strongly you agree or disagree with the statement, using the following scale:

1	2	3	4	5	6	7
Strongly Disagree	**Disagree**	**Somewhat Disagree**	**Neutral**	**Somewhat Agree**	**Agree**	**Strongly Agree**

1. Being a female/male is an important part of my self-image.
   1 2 3 4 5 6 7
2. Being a female/male is unimportant to my sense of what kind of person I am.
   1 2 3 4 5 6 7
3. Being a female/male is an important reflection of who I am.
   1 2 3 4 5 6 7
4. Being a female/male has very little to do with how I feel about myself.
   1 2 3 4 5 6 7

APPENDIX F

DOMAIN IDENTIFICATION MEASURE

Domain Identification Measure (DIM) (Smith & White, 2001)

Directions: Using the following scale, please indicate the number that best describes how much you agree with each of the statements below.

1 = Strongly Disagree
2 = Moderately Disagree
3 = Neither disagree or agree
4 = Moderately Agree
5 = Strongly Agree

______ Math is one of my best subjects
______ I have always done well in math.
______ I get good grades in math.
______ I do badly in tests of math.

Directions: Please indicate the number that best describes you for each of the statements below using the following scale:

1	2	3	4	5
Not at all		**Somewhat**		**Very much**

______ How much do you enjoy math-related subjects?
______ How likely would you be to take a job in a math related field?
______ How much is math to the sense of who you are?
______ How important is it to you to be good at math?

Compared to other students, how good are you at math?

1. Very Poor
2. Poor
3. About the same
4. Better than average
5. Excellent

APPENDIX G

STIGMA CONSCIOUSNESS QUESTIONNAIRE

Stigma Consciousness Questionnaire (Pinel, 1999).

Directions: Indicate the extent to which you agree with each item on the following scale:

1-------------2-------------3-------------4-------------5-------------6------------7

Strongly Disagree	***Neither Agree or Disagree***	***Strongly Agree***

1. Stereotypes about females have not affected me personally.
   1 2 3 4 5 6 7
2. I never worry that my behaviors will be viewed as stereotypically female.
   1 2 3 4 5 6 7
3. When I am interacting with males, I feel like they interpret all my behaviors in terms of the fact that I am a female.
   1 2 3 4 5 6 7
4. Most males do not judge females on the basis of their gender.
   1 2 3 4 5 6 7
5. My being female does not influence how males act with me.
   1 2 3 4 5 6 7
6. I almost never think about the fact that I am female when I interact with males.
   1 2 3 4 5 6 7
7. My being female does not influence how people act with me.
   1 2 3 4 5 6 7
8. Most males have a lot more sexist thoughts than they actually express.
   1 2 3 4 5 6 7
9. I often think that males are unfairly accused of being sexist.
   1 2 3 4 5 6 7
10. Most males have a problem viewing females as equals.
    1 2 3 4 5 6 7

APPENDIX H

FENNEMA-SHERMAN ATTITUDE MATHEMATICS SCALES—CONFIDENCE IN LEARNING MATH SCALE

Fennema-Sherman Attitude Mathematics Scales-Confidence in Learning Math Scale (Fennema & Sherman, 1976)

Directions: As you read each statement below, indicate if you agree or disagree with the statement. Use the following scale and circle the letter that best fits your opinion.

1—Strongly Agree
2—Agree
3—Not Sure
4—Disagree
5—Strongly Disagree

1. I feel confident trying math.
   1 2 3 4 5
2. I am sure that I could do advanced work in math.
   1 2 3 4 5
3. I am sure that I can learn math.
   1 2 3 4 5
4. I think I could handle more difficult math.
   1 2 3 4 5
5. I can get good grades in math.
   1 2 3 4 5
6. I have a lot of self-confidence when it comes to math.
   1 2 3 4 5
7. I am no good at math.
   1 2 3 4 5
8. I do not think I could do advanced math.
   1 2 3 4 5
9. I am not the type to do well in math
   1 2 3 4 5
10. For some reason, even though I study, math is really hard for me.
    1 2 3 4 5
11. I do fine in most subjects, but when it comes to math I really mess up.
    1 2 3 4 5
12. Math is my worst subject.
    1 2 3 4 5