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Stereotype threat's effect on women's achievement in chemistry: The interaction of achievement goal orientation for women in science majors

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STEREOTYPE THREAT'S EFFECT ON WOMEN'S ACHIEVEMENT IN
CHEMISTRY: THE INTERACTION OF ACHIEVEMENT GOAL
ORIENTATION FOR WOMEN IN SCIENCE MAJORS

by

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A dissertation submitted in partial fulfillment
of the requirements for the

Doctor of Philosophy in Learning & Technology
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THE GRADUATE COLLEGE

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Janice Marjorie Conway-Klaassen

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The Interaction of Achievement Goal Orientation for Women in Science
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August 2010

ABSTRACT

Stereotype Threat's Effect on Women's Achievement in Chemistry: The Interaction of Achievement Goal Orientation for Women in Science Majors

by

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“Stereotype threat is being at risk of confirming, as a self-characteristic, a negative stereotype about one's group” (C. M. Steele & Aronson, 1995, p. 797). A stereotype threat effect then is described as the detrimental impact on a person's performance or achievement measurements when they are placed in a stereotype threat environment.

For women, the negative stereotype that exists in our culture states that women are typically not as capable as men in mathematics or science subjects. This study specifically explored the potential impact of stereotype threat on women who have chosen a science-based college major. They were tested in the domain of chemistry, which is related to mathematics and often involves high level of mathematics skills. I attempted to generate a stereotype threat in the participants through describing a chemistry challenge exam as either one that had consistently shown a gender bias against women and to create a nullification effect by describing the exam as one that had shown no gender bias in the past. In the third experimental condition acting as a control,

participants received only generic instructions related to taking the test itself. The second part of this study investigated whether stereotype threat effects could impact women's achievement goal orientations. In previous studies performance avoidance goal orientations have been associated with individuals placed in a stereotype threat environment.

The findings on the stereotype threat effect were not significant for the chemistry challenge test achievement scores. This may be due to several factors. One factor may be the design of the chemistry challenge test and the instructions for the test. The other factor may be the women in this study. As individuals who have chosen a science based major, they may have developed coping skills and strategies that reduced the impact of a stereotype threat. It is also possible that the testing environment itself generated an implicit stereotype type threat effect which reduced the differences among the experimental conditions.

However, there were significant findings related to the participants' achievement goal orientations. Individuals in the stereotype threat condition displayed higher levels of performance avoidance, overall performance, and overall avoidance goal orientations consistent with the existing literature. Post-hoc open-ended questionnaires revealed that most participants believed that men and women were equally capable in mathematics and sciences but that they also had an awareness of the negative stereotype against women in mathematics and sciences among the public.

This study supports the demonstration of stereotype threat effects on women who are enrolled in science based college majors. Although I was not able to create a stereotype threat effect on their chemistry challenge test scores, I was able to demonstrate

an effect on their achievement goal orientations, which has implications for instructional design and standardized testing.

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There were many people who helped me toward completion of this project. It has taken me far longer than I anticipated but with the help of my family, friends and colleagues I was able to stay on track toward my goal. Some people were directly involved and some indirectly but all of you made a difference. I would like to extend great thanks to all those of you who supported me along the way. I would like to take this opportunity to specifically acknowledge some of those individuals.

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Gita's assistance I was able to discern how many students were needed for the study. I thank her also for her patience working with me on this project.

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This dissertation is dedicated to my parents. My father John was the one who instilled in me that women are certainly capable of doing well in mathematics and the sciences. As a mechanical engineer he was quite adept at mathematics and as his daughter it was no surprise to him that I was equally proficient. He always expected me to go into a science based career and never doubted my abilities. However, when I reached college I was met with extreme program of resistance against women in science and engineering generated by the male faculty, so I eventually chose medical science which was far more receptive to women in 1970. But I never forgot his unwavering support. My mother Norma was the individual who gave me a thirst for knowledge in any subject on any topic. As an English teacher and history scholar she made sure we

always had a house full of books; reading was our constant companion. She herself was an avid reader; she made reading fun. Both of my parents taught their children that education was the key. Not necessarily to a specific career or occupation but to have the ability to choose and choices they said were the keys to everything. I will never forget their lessons, their love and their inspiration. My father did not live to see me take this path and my mother did not live to see its completion and yet I know they are with me. I only hope that I have passed some of these values on to my own children and to the students I teach.

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CHAPTER 1

INTRODUCTION

History of Stereotype Threat

“Stereotype threat is being at risk of confirming, as a self-characteristic, a negative stereotype about one's group” (C. M. Steele & Aronson, 1995, p. 797). When an individual is placed in a situation or condition where the safety of their personal identity is threatened by negative characteristics of their group identity, they are susceptible to stereotype threat. Stereotype threat effect (STE) is, in turn, described as the detrimental effect on performance outcomes of any group of individuals when placed in a situation which can activate a negative stereotype about their group and which is a threat to their individual identity. Stereotype threat seems to interfere with an individual's ability to demonstrate acquired knowledge resulting in decreased performance outcomes on task assessment or on academic achievement testing when placed in a stereotype threatening environment.

In 1995 Steele and Aronson described the phenomenon of stereotype threat on academic achievement of African American students. Since that seminal article, many other studies have investigated stereotype threat's effect in a variety of academic and social situations, including the effect on racial minorities on standardized testing assessments and women's achievement in mathematics. Stereotype threat occurs when an individual's current environment may trigger a heightened sensitivity to or concerns and self-doubts about reaffirming a society-based negative stereotype concerning their particular group. This heightened sensitivity to environmental cues may in turn trigger anxiety or distractive thoughts which interfere with cognitive processing.

Activation of stereotype threat does not have to be explicit; it may be activated by environmental cues perceived only by those with an increased sensitivity or vulnerability to the conditions (Inzlicht & Ben-Zeev, 2000; Kiefer & Sekaquaptewa, 2006, 2007). The stereotype does not have to be believed or endorsed by the targeted individual; it is enough that they are aware of its existence and that they are concerned others (minority or majority members present) may endorse the stereotype against them. The targeted individual becomes vulnerable to social perceptions of their image and they become concerned with monitoring and managing behaviors to prevent reinforcement of the stereotype in the eyes of these others around them. These concerns and self-doubts may trigger mental distractions focusing attention away from the actual task at hand such as performance on an academic achievement test (Dempster & Corkill, 1999; Osborne, 2007; Spencer, Steele, & Quinn, 1999; C. M. Steele & Aronson, 1995).

Stereotype threat and its potentially negative impact on individual assessment becomes a significant concern in the arena of academic achievement testing and perceptions of intellectual ability of students. Standardized testing is used extensively throughout American culture for assessment and ranking of individuals from situations as diverse as academic achievement in schools and college admission procedures to workplace hiring methods for employment. The average person in the American population has a perception that standardized testing provides a picture of the individual's learning or background knowledge as well as an underlying perception of that individual's intellectual ability (Aronson, Fried, & Good, 2002; Croizet & Dutrevis, 2004; Fancher, 1985). A person's view of the nature of their own intelligence may impact their self-efficacy and their valuing of the assessment tasks on which they are

being evaluated. If the target individual has a view of intelligence that supports their self-efficacy and belief in their own efforts, they may be able to manage or overcome the impact of a stereotype threat situation (Aronson et al., 2002).

Researchers have documented that the individual learner brings a number of experiential, situational and behavioral aspects to the learning or testing arena that will influence and guide their learning experiences as well as their performance. Researchers have investigated many potential interference or inhibitory factors to learning and assessment such as interference of previous knowledge, how extraneous thoughts or distractions impact working memory capacity, and test anxiety (Dempster & Corkill, 1999; Pintrich, 1999). Some of these emotional and affective factors may be more important during the initial learning process, others more relevant during information retrieval and performance on assessment measurements, while some might be factors for both initial learning and information retrieval. One of the factors that may impede outcomes assessment and academic achievement is stereotype threat. By discovering how stereotype threat impacts affective factors which in turn influence learning, we may be able to describe interventions that could minimize stereotype threat's impact on achievement.

Purpose of this Research Study

Researchers have consistently demonstrated the impact of stereotype threat on women in the mathematics domain, and at least one study (Smith, Morgan, & White, 2005) has shown that stereotype threat crosses over into the domain of computer science for women (Hackett, 1985; Inzlicht & Ben-Zeev, 2003; Keller, 2002; Kiefer & Sekaquaptewa, 2006, 2007; Kramer & Lehman, 1990; Murphy, Steele, & Gross, 2007;

Pronin, Steele, & Ross, 2004; Quinn & Spencer, 2001; Schmader, Johns, & Barquissau, 2004; Smith & White, 2002; Spencer et al., 1999; J. Steele, James, & Barnett, 2002).

Additional research is needed to determine whether the stereotype threat effect extends into other mathematics-related domains such as chemistry or to women from different populations or demographic groups. The first goal of this research study was to investigate women and stereotype threat effects applied to the chemistry domain. Similar to the domain of computer science, inorganic freshman chemistry courses typically depend a great deal on mathematics skills and testing often involves mathematics-based relationships and calculations. By selecting participants enrolled in a freshman chemistry course, those who may or may not have yet chosen a major or career in science, I tested whether stereotype threat effects on women extend into the domain of chemistry which may in turn impact their career choices.

In this study, since the domain of interest was chemistry, a test was developed using chemistry questions from the GRE[®] Chemistry subject practice test and a standardized online introductory chemistry course. Participants were given different test instructions depending on their experimental condition. Instructions given to those in the stereotype threat stated explicitly that the exam had historically shown a gender bias against women while those in the control group were only told to do their best on the exam.

A second goal of this study was an attempt to replicate previous findings that stereotype threat effects could be nullified by manipulating the description of the achievement challenge task. In previous studies, researchers used an intelligence test, verbal skills test or mathematics test to demonstrate the detrimental performance impact

of stereotype threat. Participants in this nullification condition were given a written description portraying the chemistry test as never having shown gender bias in previous situations. Researchers had successfully used this mechanism to nullify the stereotype threat effect in a racial stereotype threat condition and in two articles with women in a mathematics stereotype threat situation (Aronson et al., 1998; Good, Aronson, & Harder, 2008; Quinn & Spencer, 2001; Smith & White, 2002; Spencer et al., 1999; C. M. Steele & Aronson, 1995).

The third goal of this research study was to investigate the effect of stereotype threat on women's achievement goal orientation. In a similar study, Smith (2006) found that women in a stereotype threat condition were more likely to endorse performance-avoidance goals instead of performance-approach or mastery goals compared to women who were not placed in a stereotype threat condition. The method of achievement goal assessment in Smith's study used a measurement which did not separate mastery goals into mastery-approach and mastery-avoidance. This study looked at four possible goal orientations and examined the potential correlation with stereotype threat conditions using the revised Achievement Goal Questionnaire (AGQ-R) which contains a 2x2 goal orientation matrix (Elliot & McGregor, 2001; Elliot & Murayama, 2008).

In summary this study attempted to demonstrate the effects of stereotype threat in the mathematics-related subject area of chemistry, using women who were enrolled in a basic science course (science, engineering, and allied health science majors), across three stereotype threat conditions. At the same time I investigated whether there were significant differences in achievement goal orientation between the experimental conditions.

Research Questions and Hypotheses

Three research questions were generated to address the goals of this study.

1. Do women who are enrolled in a college chemistry course and who have chosen a science-based major demonstrate detrimental effects of stereotype threat on achievement? Do these women express concerns about the existence of the stereotype in a post-hoc interview?
2. Can the effects of stereotype threat be nullified by modifying the description of the challenging achievement task to one that is perceived as gender neutral?
3. Do women enrolled in a basic science course which requires a strong mathematics foundation demonstrate differential motivational or achievement goal orientations depending on stereotype threat conditions?

For Question 1, I hypothesized those women who have chosen a science-based major would still be vulnerable to the effects of stereotype threat consistent with their counterparts in non-science oriented majors and would therefore demonstrate achievement underperformance compared to their counterparts in the implicit/control stereotype threat conditions. I also hypothesized that although women in the explicit STE group would show achievement deficits, they may not express concern for the stereotype outwardly during an interview. I predicted that although the effect was present it may be a subconscious reaction to conditional stimuli or they may outwardly deny that it was a factor.

For Question 2, I hypothesized that describing the gender neutral history of the challenge exam would nullify the impact of explicit stereotype threat on achievement. That is women in the nullified condition would demonstrate achievement levels above

women participants in the explicit stereotype threat condition and perhaps even exceed the achievement levels of women in the implicit (control) stereotype threat condition. I expected the description of the test as one that is gender neutral to provide a safe or at least less threatening test environment allowing participants focus fully on the exam.

For Question 3, I hypothesized that women in the explicitly induced stereotype threat condition would tend adopt an overall avoidance goal orientation valences (mastery or performance) compared to those in the nullified condition who will be more likely to adopt approach goal orientation valences. Furthermore, women who are in the explicitly induced stereotype threat condition would preferentially adopt performance-avoidance goal orientations over mastery-avoidance goal orientations.

Method

The general design of this study was a three group post-test only randomized design with a standardized test-derived chemistry challenge exam and achievement goal orientation as the dependent outcome variables. Students were recruited at chemistry course sessions during the summer and fall 2009 semesters with permission of the instructors. Upon arrival at the research session, participants were provided with an Informed Consent and received a research identification number. Participants were randomly assigned to one of three exam instruction groups and asked to fill out the Domain Identification Measure (DIM) survey to evaluate their strength of valuing both Chemistry and Mathematics domains. Students then received the chemistry challenge exam which contained one of three different instruction parameters depending on their research condition assignment. Following completion of the chemistry achievement test, participants filled out a demographic survey and the Achievement Goal Questionnaire

(AGQ) to see if their goal orientation was impacted by their assigned stereotype threat condition. Students were then debriefed and asked to complete a post-hoc questionnaire.

Results

Findings of this study suggest that women in a science-based major such as chemistry may not be overtly susceptible to the effects of stereotype threat as had been demonstrated in the previous literature with women in introductory college psychology courses (Good, Aronson, & Inzlicht, 2003; Pronin et al., 2004; Smith & White, 2001, 2002; Spencer et al., 1999). Although I hypothesized that the experimental conditions in this study would create a stereotype threat effect on the participants' performance, the women in this study did not exhibit a significant decrease in their achievement scores on a chemistry challenge test when placed in a stereotype threat condition nor did they demonstrate a significant elevation of achievement scores when placed in a nullified stereotype threat condition.

However, in spite of the lack of demonstrable impact on their chemistry challenge test outcome scores, there were significant differences in their achievement goal orientations. As I had hypothesized, women in the stereotype threat condition expressed higher levels of performance avoidance goal orientation than women in the control group. Women in the nullified condition exhibited even lower levels of performance avoidance goal orientation than the control condition. These findings seem to indicate that stereotype threat and the counter effect of nullification still exerted some impact on these women even if it was not seen through the challenge test results. The measurement process for the chemistry challenge test may not have been appropriate or may not have been sensitive enough to reveal the effect for a variety of potential reasons.

Organization

The purpose of this study is to examine the possible development of a stereotype effect in women who are enrolled in an introductory college chemistry course required for students in basic science, allied health and engineering majors. Situating the challenge exam in the domain of chemistry was an attempt to see if the stereotype threat demonstrated in women for the mathematics domain would also be seen in a related domain which has a strong mathematics foundation. Chapter One provides a brief overview of the research study and its outcomes. Chapter Two provides a review of relevant literature on the subject of stereotype threat effects and women's achievement. The research methodology of this study is presented in Chapter Three. In Chapter Four I provide a discussion of the results found in this study. Finally, Chapter Five presents an overall discussion of the study, relevant literature of theoretical significance, limitations of the study and implications for education and suggestions for future research analysis. I will now examine the literature which supports the goals and research questions of this study.

CHAPTER 2

REVIEW OF RELATED LITERATURE

Researchers have investigated many factors which have the potential to interfere with or inhibit student learning or student performance on assessment tools such as interference of previous knowledge, extraneous thoughts or distractions, or affective emotional factors such as test anxiety which may compete for attention and working memory (Dempster & Corkill, 1999; Pintrich, 1999). Some of these emotional and affective factors may be more important during the initial learning process while others are more relevant during information retrieval and performance on assessment measurements, or both. One of the factors that may impede performance outcomes and academic achievement is stereotype threat.

In 1995 Steele and Aronson described the effect of stereotype threat on academic achievement of African American students. “Stereotype threat is being at risk of confirming, as a self-characteristic, a negative stereotype about one's group” (C. M. Steele & Aronson, 1995, p. 797). Since that seminal article, many other studies have investigated stereotype threat's effect in a variety of academic and social situations, including the effect upon racial minorities on standardized testing assessments and women's achievement in mathematics. Activation of stereotype threat does not have to be explicit; it may be activated by environmental cues perceived only by those with an increased sensitivity or vulnerability to the conditions (Inzlicht & Ben-Zeev, 2000; Kiefer & Sekaquaptewa, 2006, 2007).

The stereotype itself does not have to be believed or endorsed by the targeted individual; it is enough that they are aware of its existence and that they are concerned

others (minority or majority members present) may endorse the stereotype against them. Stereotype threat and its potentially negative impact on individual assessment becomes a significant concern in the arena of academic achievement testing and perceptions of intellectual ability of students. By discovering how stereotype threat impacts affective factors which in turn can influence learning and performance, we may be able to develop interventions that could minimize stereotype threat's impact on student achievement.

Women's Underrepresentation in Science and Mathematics

Multiple studies and literature reviews acknowledge that the number of women entering careers in sciences and mathematics has historically been below that of men (*Beyond Bias and Barriers*, 2007; Blickenstaff, 2005; Peter, Horn, & Carroll, 2005). Even with orchestrated strategies through governmental projects to private consortiums, women's enrollment in science-based college majors and eventual science career selection is not equivalent. The National Academies of Sciences' Committee on Science, Engineering and Public Policy (COSEPUP) found that although women's abilities and levels in interest in science are the same as their male counterparts, women's participation decreases at each step along to path to a career in science (*Beyond Bias and Barriers*, 2007).

A wide variety of factors have been cited as contributing to these continuing gender gap differences. Biological differences between the genders, which had been historically cited as a rationale for the differences, have been largely discounted (Blickenstaff, 2005). Instead, inadequate access to science and mathematics courses for women, which in turn leads to inferior academic preparation, have been shown to be consistent factors involved lower performance outcomes for women (Enman & Lupart,

2000). Other studies cite social issues which impact women's selection of a science or mathematics oriented college major and career, including lower numbers of female role models as well as teacher (classroom) and parental bias (Sonnert, Fox, & Adkins, 2007). These may result in fewer positive experiences in science and lack of encouragement by peers and authority figures to continue in these domains (Eccles, 1994). Even with equal academic preparation and ability women self-select out of science careers at a higher rate than men at every stage of development. Society also provides a potential barrier in the general perception of science and mathematics as masculine subjects giving support to the stereotype that women are inherently less capable in these areas (Blickenstaff, 2005). The National Center for Education Statistics report shows that although the numbers of women entering science and mathematics college majors has increased over time, the numbers of women continuing in these majors is still considerably below the number of men (Peter et al., 2005). If these women are then consistently exposed to a stereotype threat their academic experiences, this may discourage highly qualified women from pursuing a science career. The COSEPUP report discusses the critical need for more individuals in the realm of science and technology, especially women (*Beyond Bias and Barriers*, 2007). The majority of projects and programs are directed at managing and increasing access points rather than the social domain which may impact also their choices. This research project will attempt to fill a critical gap in the research by investigating the potential impact of stereotype threat for women in a basic science domain as well as obtain a participant pool of women who are actually in the science-based college major, chemistry.

Defining Stereotype

What is a stereotype? According to *Merriam-Webster's Dictionary*, stereotype is defined as: “1. something conforming to a fixed or general pattern; *especially*: 2. a standardized mental picture that is held in common by members of a group and that represents an oversimplified opinion, prejudiced attitude, or uncritical judgment” (2007, p. 441). Similarly *The American Heritage® Dictionary* defines stereotype as: “1. A conventional, formulaic, and oversimplified conception, opinion, or image; 2. One that is regarded as embodying or conforming to a set image or type” (*American Heritage® dictionary of the English language*, 2007). In our society the word ‘stereotype’ is typically used as a method to label individuals or objects based on external, primary or initial characteristics which may or may not be relevant to the actual person or item. Although, technically, these labels could have either positive or negative connotations about the individuals, places or things, most of the time the spontaneous labeling is, at best, limiting and restrictive in nature.

A first impression of outward characteristics activates additional assumptions in our memories about other traits that individual might or should have. These stereotypes presuppose additional characteristics about individuals based on superficial traits. Redheads have fiery tempers; pretty blonde women are dumb; extremely tall men must be basketball players, especially if they are Black; a person of color in an elite college must have gotten there by affirmative action not by their own true ability; women are not capable of doing well in mathematics or computer science.

Stereotypes, which can evoke positive or negative connotations, are pre-existing patterns of knowledge, akin to schema, which we all hold in our minds and to which we

add additional representations as we experience life, if our minds are open to them. These representations can be very different from person to person depending on the individual's perspective even if they witness the same sequence of events. They can become problematic, however, when we do not expand them with experience or when we only add the negative connotations associated with the idea to our data banks--when our minds are not open to both positively and negatively labeled concepts.

The majority of research on stereotype, discrimination, and prejudice has been generated from the dominant group's perspective with the target group seen as a passive victim instead of an active or reactive participant. Whites' views about Blacks have been studied to a much greater extent than Blacks' views about Whites or even Blacks' views about other Blacks (Oyserman & Swim, 2001). Similarly the majority of research on women is done on men's attitudes towards women instead of women's reactions to those attitudes and environments. In spite of an extensive library of research on the development, origins, and potential reasons for stereotyping in human development and society, until recently very little research was focused on the impact on the target group or target individuals from their point of view (Oyserman & Swim, 2001; Sechrist, Swim, & Stangor, 2004). Like the controversial views of some Western anthropologists' interpretations of cultural activities of so-called primitive peoples, the interpretation and understanding coming from an outsider's perspective may not reflect the actual meaning behind the ritual to the insiders.

There is now an increased awareness and appreciation for the societal and affective influences directed toward target groups, and in particular the effect of stereotype threat on academic achievement. American culture has been highly dependent

on achievement measurements as mechanisms to assess people and their academic or non-academic abilities throughout history; this will probably not change. But if we can identify specific factors that affect achievement outcome, it is the responsibility of educational researchers to investigate the mechanisms and potential preventative and/or restorative activities in our educational settings which may thwart the impact of those factors or ameliorate their effects on targeted groups. In the next section, I review the literature relating to the concept of stereotype threat and its impact on achievement outcomes in a variety of settings and with a range of target groups and individuals.

The Concept of Stereotype Threat

When an individual is placed in a situation or condition where the safety of their personal identity is threatened by negative characteristics of their group identity, they are susceptible to stereotype threat. Stereotype threat effect (STE) is, in turn, described as the detrimental effect on achievement or performance outcomes of any group of individuals when placed in a situation which can activate a negative stereotype about their group and which is a threat to their individual identity.

Goffman (1963) called one of the effects of stigma or negative stereotype labeling on the individual “a spoiled identity.” A spoiled identity is a characteristic or trait, such as skin color or an obvious physical handicap, which may cause one to be broadly devalued in society. Stigma is a process by which the reaction of others spoils the individual’s chances for a normal identity within society. Steele and Aronson (1995) described stereotype threat’s effect on academic achievement as one of the potential outcomes of this spoiled identity from the perspective of the target group, in this case Black college students. Since the publication in 1995 of Steele and Aronson’s critical

work, many other studies have shown the impact of stereotype threat on achievement outcomes in sports, academics, or memory tasks from the perspective of various target groups based on race, gender, age, and socioeconomic status (SES) (Brown & Lee, 2005; Croizet & Dutrevis, 2004; Hess, Auman, Colcombe, & Rahhal, 2003; Keller, 2002; Kiefer & Sekaquaptewa, 2006; McFarland, Lev-Arey, & Ziegert, 2003; Ployhart, Ziegert, & McFarland, 2003; Spencer et al., 1999; Stone, Sjomeling, Lynch, & Darley, 1999; Wicherts, Dolan, & Hessen, 2005)

In four separate but over-lapping studies, Steele and Aronson (1995) manipulated testing conditions for students and found that when confronted explicitly about the supposed academic deficiencies of minority students, African American students' performance on challenging academic tests was compromised compared to European American students or African American students in a non-stereotype threatening condition. In the first portion of the study, a verbal ability test was described either as one of intellectual ability in the stereotype threat condition or one of problem-solving skills for the non-stereotype threat condition. By manipulating the description of the test, they demonstrated that the students' perceptions of the exam's purpose and how their performance might be interpreted, impacted outcomes (lower scores), rather than or along with their actual abilities. In a third segment of the study, Steele and Aronson looked at several potential mediation indicators including anxiety and frustration. They found that students in the stereotype threat condition spent more time on problems but were less accurate. Although anxiety was proposed as a potential mediating factor in this study, the study did not demonstrate a significant relationship between anxiety and stereotype threat conditions. They did find significant relationships between stereotype threat conditions

and activation of self-doubt (unsure of answers) and self-handicapping (excuse generation).

The final portion Steele and Aronson's study (1995) looked at racial priming, i.e., activating race as a potential issue in a task, as a potential stereotype threat through implicit means. For this part of the study a control group was used in which no description of the exam or purpose was given. In this instance, merely asking students to record their ethnicity on the exam form seemed to activate stereotype threat causing a significant decrease in exam performance levels. Although the article proposed the concept of stereotype threat as a mechanism for minority student underachievement, there is still the need to look into multiple factors that may impair performance of minority students and whether they originate in the environmental conditions or from the students themselves. Steele and Aronson proposed several possibilities -- such as divided attention, stress and anxiety, frustration and withdrawal of effort, self-consciousness and dis-identification -- as mediators of impairment, but they did not find sufficient statistical support for these factors in their initial article.

Stereotype Threat in Academic and Non-Academic Settings

The effects of stereotype threat have been demonstrated in several other situations, with different target populations, and different physical settings. Spencer et al. (1999) demonstrated the impact of stereotype threat effect on women in the domain of mathematics as a possible explanation for the disparity in mathematics scores on standardized tests between men and women. Spencer describes the existing literature concerning the stereotype of gender deficit for women in mathematics as existing in two schools of thought and explanation. One group subscribed to the inherent genetic

differences between men and women as an explanation for differences in mathematics skills while the other group attributed the differences to the divergent gender roles defined by society for men and women (Spencer et al., 1999). Spencer et al. found that when women who were taking a difficult mathematics exam were reminded of the negative gender stereotype, i.e., that most women traditionally perform lower on mathematics exams than most men, they had achievement scores significantly lower than the other experimental groups. They also found that by describing the exam as one that did not show gender bias, the underperformance effect for women was eliminated. Male participants did not show any significant difference in performance between the experimental conditions.

Walton and Spencer (2009) performed a meta-analysis of the existing stereotype threat literature representing 39 studies in five countries and involving over 18,000 students. Linear regression analysis of the achievement deficit patterns found in the literature on impact of stereotype threat was used to estimate and predict the actual test scores of individuals. They found that performance measures underestimated the true potential of targeted minorities (ethnic, women). In a portion of their meta-analysis directed at real-world situations, they found that the Scholastic Aptitude Test (SAT) underestimated women's mathematics ability by 19-21 points. When the average gender gap according to the College Board is only 34 points the implications for women in high stakes performance testing are unsettling.

In another examination of stereotype threat, Black and White college students participated in an athletic test activity under different conditions (Stone et al., 1999). In the first study, investigators told participants that the Michigan Athletic Aptitude Test

(MAAT) was based on the game of golf and that performance on this lab test correlated with actual performance ability in the sport, i.e., the number of golf swings or strokes required. The students were placed into different conditional interventions. One group was told that the test scores reflected their 'sports intelligence' while another other group was told that the test was indicative of a person's 'natural ability' in golf. The third group was not given any background information about the test or its correlations to anything other than performance in the actual sport of golf. White and African American students were randomly placed in all groups. Black participants in the sports intelligence group required a higher number of golf swings to complete the round of golf (poorer performance) than Black subjects in the natural ability group. Conversely, the White students in the group where the test was described as a reflection of natural ability did not perform as well on the lab test compared to White students in the sports intelligence group. This study investigated both negative and positive stereotype effects on performance demonstrating that conditions and environmental framing can induce or nullify stereotype threat and its potentially negative effects on performance regardless of the participant's race.

The impact of stereotype threat has also been demonstrated as an issue for older individuals and memory tasks (Hess et al., 2003). In this study investigators activated the stereotype about aging and memory ability by having individuals read a magazine article stating the effects of age on memory. The older adult group had an average age of 70.8 years while the younger group age mean was 19.3 years. Both groups were asked to complete a memory achievement and memory anxiety survey, then after stereotype activation, a memory word recall test. The group of older subjects in the stereotype

threat condition demonstrated recall of fewer words and lower memory achievement than their non-threatened counterparts or the younger study participants. Demonstrating the existence of a stereotype threat effect for older individuals raises the concern that the pressure of testing itself or being aware of the purpose of memory testing (competency issues) could significantly impact assessment tools designed for cognitive abilities and competencies of older subjects.

Ployhart (2003) investigated the potential impact of stereotype threat in an employment application testing and selection process. Black and White participants were told they were involved in a study to examine selection of individuals for retail managerial positions. To further mimic the competitive situation with job application processes, they told the participants that the individuals that scored in the top 15% on the application test would also receive a \$20 reward. In both the stereotype threat and control condition, Black participants scored lower than the White participants but not at a significantly lower level. However in the nullified stereotype threat group, mean scores for Black and White participants were closer. Limitations of this study are somewhat confounded by the authors' research design and procedures. Participants were not informed explicitly of any racial bias in the test form; it was assumed the situation (managerial selection) would generate stereotype threat implicitly. In addition, several potential covariates, e.g., the degree of subject interest and intensity of domain identification, were not fully explored. Since these factors have been found to be covariates in most other studies, this may account for the lack of statistical significance in this study. If stereotype threat effects can be fully demonstrated in application hiring practices, this could have profound implications on the job market for minorities.

Like the sociocultural stereotype belief that non-White individuals are lower in intelligence or that women have poor mathematics skills, individuals from lower socioeconomic status (SES) levels are also perceived by society to be less intelligent and/or less capable of intellectual pursuits. One of the reasons for this societal view may be because individuals from lower SES typically do not perform as well as those from higher SES on standardized testing. Croizet and Dutrévis (2004) found a potential explanation for this difference in performance within the concept of stereotype threat effects. Participants in their study were undergraduate students from high or low SES levels. Students in the stereotype threat group were told that the test was diagnostic of “verbal ability,” activating the stereotype that poor people are less intelligent, while another group of students was told that the test assessed the role of attention in building memory (stereotype neutral). Low SES students had lower test scores in the stereotype threat group than low SES students in the non-stereotype threat group and high SES students in both groups. In a second portion of their study, subjects were tested using a culturally neutral intelligence test, i.e., Raven Advanced Progressive Matrices Test. Students from low SES performed significantly lower in the stereotype threat condition but performed as well as the high SES participants in the non-stereotype threat condition. Again their study demonstrates that the conditions and environment of testing can significantly change performance outcomes for stereotype targeted individuals.

In an interesting twist on the concept of stereotype threat, Aronson et al. (1998) placed high mathematics achieving White males (SAT mathematics score 610 or higher) into a stereotype threat condition by comparing their abilities in mathematics to those of Asian students. The White male students in the test group were told of the superior

mathematics abilities and higher scores of Asian students on mathematics tests. When threatened by this stereotype concept, these White males, who would not typically be thought of as a stereotype threat target group, underperformed on the mathematics challenge test compared to those who were not told of any ability or performance differences. This demonstrates the situational component of stereotype threat; that perhaps any individual in a given situation could be impacted by stereotype threat. In a second portion of this article a direct correlation was found between the strength of the individual's mathematics identification and the impact on performance for those in the stereotype threat condition. White male students who were rated higher in mathematics domain identification were significantly more negatively influenced by the stereotype threat, i.e., lower mathematics test scores.

In another study investigating the strength of domain identification and the impact of stereotype threat, Smith and Johnson (2006) found that men who were low in domain identification with mathematics were subject to the same effects of stereotype threat as women participants; they underperformed on a challenging mathematics test. When placed in a condition highlighting the performance advantages that males typically show on mathematics tests, these low domain identification males performed at significantly lower levels than low domain identification males in a gender neutral condition or high domain identification males in either condition. Even though these individuals were low in mathematics domain identification, the stereotype may have placed pressures on them to perform, i.e., to live up to the positive stereotype about their gender.

To demonstrate the range of potential stereotype threats effects, Koenig and Eagly (2005) changed the subject domain to one where women are stereotypically considered

by sociocultural views to be superior to males: the concept of social sensitivity. In a study looking at non-verbal cues of communication, one group of men was told the testing investigated an individual's social sensitivity (stereotype threat group), while the non-stereotype threat group was told the test assessed information processing. The men in the stereotype threat group reported making more of an active and concerted effort while the men in the non-stereotype threat group relied more on intuitive methods for decoding the non-verbal communication cues. In spite of their extra efforts, males in the stereotype threat group were significantly lower in detecting non-verbal cues than the non-stereotype threat group.

It is clear from these research investigations that stereotype threat effect can be demonstrated in a number of conditions and with a diverse set of populations. There is a need for additional studies to identify the factors which promote or impeded inducement of stereotype threat effect and whether these factors can be controlled or managed so that the impact of stereotype threat can be minimized.

Factors Involved in Stereotype Threat Effect Expression

Steele and Aronson did identify, through their initial study and others, a number of key conditions which are intimately related to the development and expression of stereotype threat effect in target individuals (C. M. Steele, 1997, 1998, 1999, 2003; C. M. Steele & Aronson, 1995; C. M. Steele & Davies, 2003). The underperformance outcome found with stereotype threat is more intense when individuals are closely tied to the subject matter and their academic success in that domain is of value to them. Students with strong domain identification are more adversely affected than those with lower

domain identification when placed under stereotype threat conditions (Aronson et al., 1998; C. M. Steele, 1998).

Another factor related to the degree of STE and underperformance is the difficulty of the test questions. Test questions involved in the achievement assessment must be sufficiently challenging and must be thought of by the individual as reflecting cognitive ability in the domain with which they identify (Aronson et al., 1998; Spencer et al., 1999). If the test questions do not pose a challenge, the student's ability is not confronted and taking the test is not a threat to their personal value system and self-perception.

The final factor they investigated was the strength of the individual's identification with the stereotyped target group. Some studies suggest that individuals who strongly identify with the target group (e.g., females, African Americans) are more adversely affected by stereotype threat conditions (Pronin et al., 2004; C. M. Steele, 1997). The vast majority of research published on stereotype threat has embraced these factors as essential to the induction of negative performance effects. Within the current body of literature we can identify concepts related to the manifestation of stereotype threat effect which are generally accepted and those that may require additional investigation to show if and how they may be involved in the development of student underperformance linked to stereotype threat.

Target Group Self-Identification Issues

Stereotype threat effect has been replicated in a number of laboratory-based research settings and in a few practical settings including situations looking at the interaction of STE with racial identity, gender, age, and SES. In each of these situations, the findings continue to be robust, demonstrating a diminished performance for the

individuals in the non-dominant stereotype threat target group compared to the dominant group. Most studies have shown that the strength of the individual's identification with the target group is related to the stereotype effect on their performance.

Racial group identification. Among those who work with ethnic minorities and stereotype threat effects, Brown et al. (2000) looked at the impact of minority students' strength of group identity and whether they believed their admission into college was based on racial preferences related to affirmative action. Those with a strong minority identity who also believed their admission was based on affirmative action factors underperformed on challenging tests, supporting Steele and Aronson's evidence that students who had high target group identity were more impaired by the stereotype threat condition.

In Brown's study, students were asked to rate the degree to which they thought that their admission into college was in some way based on affirmative action issues. Traditionally stigmatized students (Blacks and Hispanics) who felt that affirmative action was involved in their admission had significantly lower grade point averages (GPAs) compared to non-stigmatized groups (White and Asian). The difference in GPAs between the groups was partially mediated by the degree to which students perceived that affirmative action played a role in their admission. In a later study, Brown investigated academic achievement and minority students who were chronically stigmatized-- students who endured constant reminders of a stereotype threat in every-day life (Brown & Lee, 2005). Students in both traditionally stigmatized groups (Blacks and Hispanics) and traditionally non-stigmatized groups (White and Asian) were assessed concerning their degree of stigma consciousness (awareness of the negative stereotype about their group

or the other group). As in his previous study, he found that stigmatized students who were high in stigma-consciousness had significantly lower college GPAs compared to minority students who were stigmatized but with lower levels of stigma consciousness or to students in non-stigmatized groups.

Cohen and Garcia (2005) looked at the concept they called “collective threat.” Collective threat goes beyond stigma consciousness (awareness of the stereotype) toward a feeling that individuals will be judged and rated based on the performance of their group. They found that minority individuals who rated high in racial identification had significantly lower GPAs when they also reported high perception of collective threat in their environment than minority students who were lower in racial identity. Students who rated collective threat higher also had lower self-esteem.

The sources of gender identity and ethnic identity are primarily of social and cultural design. Individuals may be born with innate biological attributes of gender and skin color, but social influences provide them with guidelines or a definition of their role for interacting with others. Society also provides positive reinforcement for behavior when an individual acts in socially acceptable or role-correct ways (Bandura, 2002; Bussey & Bandura, 1999).

Gender identification. Individuals are as much a product of the gender stereotypes that they encounter as they are involved in its continuation. Male children are often praised for aggressive behavior or involvement in “male” oriented tasks and play while female children are typically praised for neatness and ladylike behavior in spite of the so-called advances in gender role definitions. It is not that female children are

necessarily punished for engagement or discouraged from involvement in stereotypically male activities but neither are they praised for such involvement.

Parents, typically wanting what is best for their child and wanting positive experiences for their child, promote their child's activities toward activities and play where they believe the child will succeed or have an easier path toward success and praise. However, this same parental support and encouragement often guides children into socially traditional activities for the child's gender. In spite of equivalent achievement on assessment testing for boys and girls, most parents believed that their male children were more naturally capable in analytical skills such as mathematics (Bussey & Bandura, 1999). Without parental support, girls may begin to lose confidence in their mathematics abilities or no longer value pursuit of mathematics-oriented activities. There is minimal motivation to continue in something which is not rewarded, praised or valued in the home.

Coping Mechanisms and Strategies

Women and girls who engage in traditionally male activities from play to academics often do not have the same positive reinforcements or social support mechanisms as those found if they pursued more traditional roles and activities. This in turn can generate feelings of inadequacy and diminished desire to continue engagement in an area that does not provide some sort of extrinsic or social reward. However this is where self-efficacy, the belief by the individual they are capable of completing or succeeding on a task, can also play a role (Linnenbrink & Pintrich, 2003). Self-efficacy is essential to promotion of student engagement and learning. Students must believe they are capable of completing a task or learning new material to engage in the learning

process. Women with a strong sense of coping skills and perceived self-efficacy may be able to continue engagement through intrinsic reward mechanisms in spite of a stereotype threat condition (Linnenbrink & Pintrich, 2002, 2003). As another potential coping method, Pronin et al. (2004) first asked women to rate descriptive phrases as to “how much you think each of these characteristics would put a woman at risk for being negatively judged in quantitatively based fields and/or careers.” They then surveyed a group of women who had successfully taken a large number of mathematics classes and found that these women rejected characteristics in their self-identity that would be considered as typically associated with the negative feminine stereotype of women (e.g., flirtatiousness, stay-at-home mom). These women had instead identified with factors considered feminine but less stereotypically handicapping such as nurturing and empathy (Pronin et al., 2004).

Although many believe that stronger racial identity is one of the primary issues behind stereotype threat and underperformance of minorities, others suggest that, while still finding that stigma did impact self-esteem, strong minority identification may act instead as a buffer or resilience factor against attack on self-esteem from stereotype threat (Crocker, 1999). Minority identity can be a contributing factor to the deleterious effects of stereotype threat if the individuals are also stigmatized by their minority definition, or a compensatory factor for those who are not stigmatized. Whether it is minority self-identification (racial identity) or stigma consciousness, or both, that are involved in the activation of stereotype threat also remains uncertain.

Several possible reactive strategies for coping with stereotype threat have been suggested throughout the literature but the coping strategies that may benefit the

individual's self-esteem may come at a cost to performance. Studies have found that students under stereotype threat conditions may modify the link of identifying with their stigmatized group (dis-identification) or modify the value of the achievement task (devaluing) involved as a protective mechanism for their self-esteem. Schmader and Major (1999) looked at selective valuing as a possible coping mechanism in stigmatized individuals. When individuals in a stigmatized group (women) found that their group performed lower on testing, they placed less personal value on the task ability and appraised themselves as being lower in that task ability compared to those who were told their group performed at the same level as the non-stigmatized group, essentially devaluing the task and their domain identity.

In another study, when female students were challenged in a stereotype threat condition they drew fewer connections and less complex self-concept maps, reflecting perhaps a diminished self-worth (Gresky, Ten Eyck, Lord, & McIntyre, 2005). In an attempt to counteract this factor, they found that the effects of stereotype threat could be minimized by discussing women's multiple roles in society beyond the stereotype definition surrounding women's typical underperformance in mathematics. Clearly identification with the stereotype target group mediates a portion of the stereotype threat effect, but other factors or facets of the individual may also be involved.

The intensity of the individual's target group identification (race and/or gender) has been shown as a factor in the expression of stereotype threat but may also be at least partially involved as a coping strategy. Whether the negative impact of a target group's identification is countered through self-efficacy or another coping mechanism is outside

the scope of this study but may be partially revealed through achievement goal orientations discussed later in this review.

Subject Domain Identification (Valuing) and Ability

A series of studies have looked at domain identification as an essential factor in the manifestation of stereotype threat underperformance outcomes. Most have found that those higher in domain identification, that is those who value the domain and their ability in that domain, are more susceptible to the effects of stereotype threat (Aronson et al., 1998; Smith & Johnson, 2006; Smith et al., 2005; Smith & White, 2001; C. M. Steele, 1997, 1998).

Aronson et al. (1998) looked at inducing stereotype threat in individuals not typically stigmatized by negative stereotype about their abilities. High mathematics achieving White males were subjected to an induced stereotype threat when exposed to the stereotype concept that Asians often performed better on mathematics achievement tests (Aronson et al., 1998). The participants were White males with SAT mathematics scores from 610-800 ($M = 712$; $SD = 60.6$). One of the key findings in the study was the association between the intensity of mathematics identification of the test subjects and the impact of stereotype threat. The higher mathematics identified subjects displayed an increased stereotype threat effect on performance compared to subjects who were only moderately identified with the subject of mathematics. In follow-up interviews, the high mathematics identified subjects in the stereotype threat group expressed more concern about what the experimenter would think of them compared to subjects in the non-stereotype group or those with only moderately high mathematics identity.

Stereotype threat effect has typically been demonstrated in individuals who possess a high identification with the domain in question and also place value on their achievement in that domain (Aronson et al., 1998; Smith, 2006; Smith et al., 2005; Smith & White, 2001; C. M. Steele, 1997, 1998). What remains to be explored is the extent to which these primary domains -- those where a clear societal stereotype for a target group exists--might extrapolate or diffuse into other related domains or more general situations and whether the demographics of the participants might have an effect on stereotype threat.

Implicit Activation of Stereotype Threat

Several studies have explored whether there is a need to explicitly activate the participant's awareness of the target group stereotype to generate a stereotype threat effect on their performance. Most researchers findings clearly indicate that although the negative effect of stereotype threat on performance may be more profound under explicit activation, implicit conditions can automatically activate the stereotype threat in the minds of participants without experimental priming (Kiefer & Sekaquaptewa, 2006, 2007; Smith & Johnson, 2006; Smith & White, 2002). It is thought that simply being placed in a testing situation where the individual is an obvious minority and where a performance stereotype exists for that minority can spontaneously activate the same stresses evoked in a condition where stereotype threat is explicitly activated (Inzlicht & Ben-Zeev, 2000, 2003). Others have found that merely placing the individual in a testing situation where the stereotype exists, such as minority students taking intelligence tests or women taking mathematics tests, is sufficient to induce the effects of stereotype threat

(Kiefer & Sekaquaptewa, 2006, 2007; Kunda, Davies, Adams, & Spencer, 2002; Levi, Stroessner, & Dweck, 1998; Smith & White, 2002).

Stereotype threat can also be activated through priming, i.e., asking the individual for demographic information (race or gender) prior to testing. Steele (1995) found that asking for race on the testing form was apparently enough to activate the stereotype threat concept in the testing environment. Some controversy still surrounds this factor since Stricker and Ward (2004) of the Educational Testing Service (ETS) reportedly found no significant differences in achievement outcomes when individuals were asked for race and/or gender identification before versus after completing Advanced Placement (AP) exams. However Danaher and Crandall (2008) reexamined Stricker and Ward's (2004) statistical analysis and found there were significant differences such that women and minority participants' scores were higher when asked demographic information after the exams instead of before. Their findings suggested that the change in practice (demographics after testing) would have given over 4,000 more students credit for calculus on the AP test each year. The effects seen under implicitly threatening situations may be caused by certain types of environmental cues activating thoughts associated with the stereotype, and in turn, the stereotype threat.

Placing women in minority situations while taking a test (groups of three individuals with only one woman and two men) was sufficient to cause a decrease in performance outcome when they were led to believe their peers would know their scores at the end (Inzlicht & Ben-Zeev, 2003). In this same study, women who were placed in female-only groups did not show an underperformance outcome. These students may have been sensitive to some environment cues which activated a stereotype threat

condition or activated a stereotype threat memory from previous experiences. The implicit activation of stereotype threat should be explored further to find how far this phenomenon might extend.

In a recent study by Wout et al. (2009) five integrated experiments were performed in which the researchers manipulated the conditions of stereotype threat. These experiments demonstrated that the individuals who are targets of the stereotype must first be aware of the possibility of a negative stereotype about their group and that the negative stereotype is specific to the subject matter or domain. In addition, they must also decide that there is a probability that the stereotype will occur in the environmental condition. Even if the stereotype exists and is possible, if the conditions or situation do not lead to a probability of it being a factor in interactions with others in the environment, the target individual does not attend to it. In contrast if the stereotype is both possible and probable it may evoke the stereotype threat condition and its subsequent impact on academic achievement.

Stereotype Intervention and Nullification: Changing Task Description

Several researchers attempted a variety of methods to counteract the underperformance effect seen when students are in a stereotype threat condition. One of the simplest methods that showed promise in reducing the effects of stereotype threat is changing the description or purpose of the assessment; the test is described as gender or racially neutral. Several researchers have used this mechanism to nullify the stereotype threat effect (Aronson et al., 1998; Quinn & Spencer, 2001; Spencer et al., 1999; C. M. Steele & Aronson, 1995). In a work-place situation where leadership options were being assessed, women were exposed to a stereotype threat condition but one group was then

asked to read the following statement: “There is a great deal of controversy in psychology surrounding the issue of gender-based differences in leadership and problem-solving ability; however, our research has revealed absolutely no gender differences in either ability on this particular task” (Davies, Spencer, & Steele, 2005, p. 281). This simple “identity safe” statement was sufficient to counteract the undermining effect of stereotype threat on women’s leadership goals. Spencer et al. (1999) described the challenging mathematics test in their study of stereotype threat effects on women’s mathematics achievement as one that did or did not show a history of gender bias. This change in task description was sufficient to nullify the effect of stereotype threat.

What has not been done consistently in research is to investigate stereotype threat across the three possible experimental conditions during the same research investigation; an explicit STE condition, a nullified STE condition, as well as a control group which may actually illicit an implicit STE condition. Most researchers have chosen to focus on a control group (implicit) and a stereotype threat group (explicit) without a nullified stereotype threat condition. Others have demonstrated the ability to nullify stereotype threat against an explicit condition without the implicit experimental condition. Since stereotype threat seems potentially inducible in control (implicitly activated) conditions, it is important to compare all three conditions (implicit, explicit, and nullified) to fully understand their respective impacts on stereotype threat effects.

Motivation, Achievement Goal Orientations, and Stereotype Threat

Motivational and achievement goals are perspectives that students have in their engagement with task performances. Motivation can be used to describe an individual’s perspective toward achievement or performance in a wide variety of activities from

athletics and sports to business and leadership, academics, arts, and music, etc. Originally two types of motivation were described: intrinsic motivation, which reflects an internal drive by the individual to learn or obtain knowledge, and extrinsic motivation in which the individual is driven by the need for external gratification or reward (Dweck, 1992; Pintrich, 2000; Ryan & Deci, 2000). Someone who has intrinsic motivation is one who does not need external rewards or inducements to engage in an activity. Generally the reward is an internal one in which there is a positive reward to self-esteem or the self-concept. Intrinsic motivation is seen as positively associated with learning and the deep processing which is thought to be optimal for students, while extrinsic motivation is typically deemed counter-productive for actual learning and is thought to represent only superficial processing. Someone who is extrinsically motivated seeks or requires rewards from outside the self, external gratification of some kind such as a grade, money, or prize. It could also be something that adds to the concept of self but the source is someone else's praise or recognition. Removing that praise or external recognition may eliminate the motivation to learn or perform.

Achievement goals are those learning perspectives that guide a student's learning motivation (Ryan & Deci, 2000). Achievement goals are labeled as either mastery or performance orientations depending on the primary focus of the learner (Barron & Harackiewicz, 2001). Similar to intrinsic motivation, those individuals with a mastery goal orientation are thought to be focused on learning the content and on understanding the lesson. With mastery goal orientation students are actively engaged and persistent in their focus on learning (Pintrich & De Groot, 1990). They are engaged in a process to assimilate or accommodate knowledge. These students are usually interested in learning

for the sake of learning; they want to master the content as best they can. With performance goal orientation, students want their performance to be compared to others or to the grading scale in the classroom. They are not necessarily interested in understanding or mastering the material but in showing that they can meet the expectations for evaluation. They have a need to be recognized by the teacher, their peers, and the outside world for their accomplishments, not necessarily for what they know.

Each of these goals (mastery or performance) can also be separated into what Elliot called a valence, whether the goal is approach- or avoidance-based (Elliot & Church, 1997; Elliot & McGregor, 2001; Elliot & Murayama, 2008). With approach goal valences or orientations students want to achieve or approach success, while with avoidance goal orientation students want to prevent or avoid failure. Students who have mastery-approach goals are primarily interested in learning and understanding the course materials while those with mastery-avoidance goals--although interested in learning and understanding--come from a position and desire to avoid misunderstandings. The mastery-avoidance goal is sometimes seen with “perfectionist” students who, although driven toward understanding, are also motivated by fear of making a mistake. Students with performance-approach goal orientation are typically driven by grades and the need to do better than others in the course. There is also some evidence that students may actually demonstrate a mixture of goal orientations or different orientations in different situations (Darnon, Butera, & Harackiewicz, 2007; Elliot & Moller, 2003; Elliot & Murayama, 2008). Students with mastery and/or performance approach goals are driven toward success and although performance approach goal orientation is not optimal,

striving for grades does lead to high levels of learning (Elliot & Church, 1997). Students with performance-avoidance goal orientations, on the other hand, are obsessed with preventing failure at all costs. As a result they are not focused on learning but rather on preventing embarrassment--to the detriment of actually learning the course material (Elliot & Moller, 2003). With these achievement goal orientation definitions in mind, several studies have looked at stereotype threat conditions and the activation of achievement goal frameworks.

In an early study on motivational goals and working memory, college student participants were asked to complete a test of working memory function and a motivational goal survey, as well as a survey of affective thoughts and task-irrelevant thoughts during the working memory task (Linnenbrink, Ryan, & Pintrich, 1999). Those participants who adopted mastery goals demonstrated fewer negative affect concerns, while those with performance goals reported higher negative affect concerns (frustration, anxiety). The authors suggest that students with mastery goal orientations consider difficult tasks as a challenge, whereas performance goal oriented students became more anxious and frustrated when tasks are difficult. They did not find performance goals to be significantly correlated with working memory function or task irrelevant thoughts. However, this research occurred before the accepted separation of performance goals into performance-approach and performance-avoidance, and thus limiting goal orientation study to either mastery or performance. This may explain the inability to find correlations between performance goals and working memory or task irrelevant thoughts.

Stereotyped Task Engagement Process Model

In 2004 Smith proposed the Stereotyped Task Engagement Process (STEP) model to show how stereotype threat induction--the prediction or possibility of failure--might activate adoption of a performance-avoidance goal orientation in target individuals (Smith, 2004). In the STEP model, Smith proposed that characteristics of the individual together with a situation of stereotype threat induced the adoption of a performance avoidance goal orientation in the participant. Performance avoidance goals in turn generate self-regulating strategies which may have positive or negative results. These self-regulating strategies may include negative task behaviors, such as a feeling of anxiety, and result in an overall negative experience with the original situation. A negative personal experience can contribute to further negative or counter-productive behaviors (avoidance) and may result in additional negative experiences with repeated exposure, ultimately resulting in diminished performance outcomes.

Smith (2006) later explored this model specifically for women and mathematics performance. In this study she found that women exposed to a stereotype threat condition were more likely to endorse performance-avoidance goal orientations than their peers in a non-stereotype threat condition or men in either condition. Since participants did not actually complete the mathematics test, performance effects (underperformance) were not measured and could not be correlated with performance goal orientation.

Smith et al. (2007) examined the impact of interest, a predictor of long term persistence, on achievement motivation. Women who were high in achievement motivation and placed in the stereotype threat condition acknowledged more performance-avoidance related thoughts and lower interest in continuing the task perhaps

suggesting an effort to prevent failure or embarrassment. However, women low in achievement motivation cited more performance-approach oriented thoughts when placed in the stereotype-nullified condition perhaps demonstrating an outcome oriented approach to the task. Women who were low in achievement motivation showed low interest in continuing the task regardless of experimental condition and mastery directed thoughts in this group were too low for a valid analysis. These studies highlight the potential for stereotype threat to cause women in stereotype threat conditions who are also highly motivated to shift their goal orientation toward one of performance-avoidance. This same conclusion was drawn empirically by Steele and Aronson (1995) for African American students on tests of intelligence. Since performance goals in general and performance-avoidance goals in particular are generally associated with lower achievement outcomes, the potential interaction between these factors calls for additional investigation.

An assessment-based academic society creates an atmosphere which may be in direct conflict with students adopting mastery oriented goals--the concept of learning for the sake of learning. A student may truly endorse a mastery-approach goal orientation, but the pressure to earn high grades often leads to at least a modicum of endorsement for performance approach goal orientation during college courses. This is causing some researchers to reexamine single goal orientation and instead look at a mixture of goal orientations, perhaps one primary and one secondary, as a reflection of the real world (Pastor, Barron, Miller, & Davis, 2007). In fact one study found that although first-year college students had a mixture of mastery and performance goals, college seniors had shifted primarily toward performance goal orientation perhaps as a reflection of what is

needed to succeed in college (Lieberman & Remedios, 2007). How then do we entice students to maintain a mastery goal orientation under these conditions, especially if we add the burden of stereotype threat? Can we perhaps nullify the impact of stereotype threat making it easier for students to remain in a mastery or performance approach goal orientation?

Summary and Current Project Research Directions

Stereotype threat research on women has primarily focused on mathematics achievement and mathematics underperformance; therefore an area for potential exploration might be those subjects closely related to mathematics or those that require extensive mathematics ability as a foundation. Smith et al. (2005) found that computer technology domain identification showed similarities to previous studies demonstrating high domain identification with stereotype threat underperformance in women. But Smith et al. (2005) also found that domain identification with computer technology was responsible for a unique portion of the variance, different than the mathematics identification portion for women participants.

Like computer science technology, chemistry courses require students to have a strong mathematics foundation (pre-calculus prerequisite) and consistently use mathematics calculations in problem solving strategies. A portion of this study was therefore directed at investigating whether stereotype threat effects could be demonstrated on women's achievement outcomes (decreased performance) for challenging chemistry questions, similar to the effect of underperformance found for women's achievement on challenging mathematics questions (Cadinu, Maass, Frigerio,

Impagliazzo, & Latinotti, 2002; Cadinu, Maass, Rosabianca, & Kiesner, 2005; Johns, Schmader, & Martens, 2005; Spencer et al., 1999).

Along with the fundamentally negative effect that stereotype threat has on women's mathematics performance, several studies have looked at motivation goal orientations of those under stereotype threat conditions and how students' goal orientations may interact with achievement outcomes (Smith, 2006; Smith & Johnson, 2006; Smith et al., 2007; Thompson & Dinnel, 2007). In this study I applied the Achievement Goal Questionnaire-Revised (AGQ-R) (Elliot & McGregor, 2001; Elliot & Murayama, 2008) which separates achievement goals into 4 types: mastery approach, mastery avoidance, performance approach, and performance avoidance (see Table 1). Smith (2004) found that women students under stereotype threat conditions were more likely to adopt performance avoidance goal orientations perhaps reflecting their desire to disprove the negative stereotype about women and mathematics achievement. Smith's study examined mastery as a single concept instead of separating it into mastery approach and mastery avoidance. By applying the AGQ-R, I wanted to investigate the four possible achievement goal orientations relative to stereotype threat as well as mastery alone vs. performance goal orientation and approach vs. avoidance goal orientations for individuals in three different conditions of stereotype threat.

The majority of the research investigating stereotype threat effects which lead to mathematics underperformance in women has been conducted on subjects enrolled in non-science college courses such as introductory psychology courses (Aronson et al., 1998; Smith, 2006; Smith & Johnson, 2006; Smith et al., 2005; Smith et al., 2007; Smith & White, 2002; Spencer et al., 1999; C. M. Steele, 1998; J. Steele et al., 2002). Although

by statistical methods these researchers focused on subjects with strong mathematics domain identification and high mathematics SAT/ACT scores, the subjects in these previous studies may not actually have selected a college major that emphasizes the mathematics domain in daily practice.

College students in an introductory psychology course represent a diverse population of men and women who may have a host of other confounding factors. Stereotype threat effects have typically been demonstrated in individuals who possess a high identification with the domain in question and also place value on their achievement in that domain (Aronson et al., 1998; Smith, 2006; Smith et al., 2005; Smith & White, 2001; C. M. Steele, 1997, 1998). However no one has used women who are actually science majors as participants in their studies. Women who have chosen a college major that inherently contains an emphasis on mathematics interest and ability may have significant differences in their mathematics/science domain identification, in their achievement goal orientations and achievement strategies. Even within the sciences, different majors have varying degrees of mathematics emphasis in content, e.g. biology vs. physics. This research project therefore purposively selected women in an introductory chemistry course, a science-oriented population, to determine if underperformance on achievement tests could be demonstrated in this selective population. Initial studies on stereotype threat against women in the mathematics domain involved both male and female participants. As the impact of stereotype threat was consistently established, later studies used women only participants and manipulated secondary factors related to stereotype threat. For that reason, I chose to include only women participants in this study.

For this study I looked at the above parameters across three stereotype threat conditions (implicit/control, explicit, and nullified stereotype threat). The majority of research has looked at only two conditions at a time; i.e., explicitly induced vs. nullified stereotype threat or implicit/control vs. explicitly induced stereotype threat. In this investigation, I looked at all three conditions. The first research group condition is considered a control group for which instruction was only given relative to how to fill out the questionnaires and test instructions. Some studies have shown that even with no overt exposure, merely taking a mathematics related exam may induce a condition of stereotype threat in women (Inzlicht & Ben-Zeev, 2000). Therefore this first group could also be considered an implicitly induced stereotype threat condition. The second research group was an explicitly induced stereotype threat condition. Individuals in this group were overtly told that the achievement test has consistently shown gender bias against women in the past. The third research group was a stereotype threat nullified condition. In this group I attempted to nullify the potential for implicit stereotype threat conditions by overtly stating that the achievement test had never shown any gender bias and that we are looking at how our students perform.

Goals of this Research Study

Researchers have consistently demonstrated the impact of stereotype threat on women in the mathematics domain and at least one study has shown that this concept crosses over into the domain of computer science (Hackett, 1985; Inzlicht & Ben-Zeev, 2003; Keller, 2002; Kiefer & Sekaquaptewa, 2006, 2007; Kramer & Lehman, 1990; Murphy et al., 2007; Pronin et al., 2004; Quinn & Spencer, 2001; Schmader et al., 2004; Smith et al., 2005; Smith & White, 2002; Spencer et al., 1999; J. Steele et al., 2002).

Additional research is needed to find out whether the stereotype threat effect extends into other mathematics-related domains such as chemistry. The first goal of this research study was to investigate women and stereotype threat effects applied to the chemistry domain. Similar to the domain of computer science, inorganic freshman chemistry courses typically depend a great deal on mathematics skills and testing involves mathematics-based relationships and calculations. By selecting participants enrolled in a freshman chemistry course I proposed to test whether stereotype threat effects on women extend into the domain of chemistry. A second goal of this study was to investigate whether stereotype threat effects could be nullified by manipulating the description of the achievement challenge task. By describing the test as not showing a gender bias against women, I hoped to negate or nullify the effect of stereotype threat.

In previous studies, researchers used an intelligence test, verbal skills test or mathematics tests to demonstrate the detrimental performance impact of stereotype threat. Since the domain of interest in this study was chemistry, a test was developed using chemistry questions from the GRE[®] (ETS, 2002) and the web site General Chemistry Online practice tests (Senese, 2009). Participants were given a written description which portrayed the chemistry test in one of three ways. Condition 1 (implicit) only gave directions for taking the test. Condition 2 (explicit STE) described the test as having consistently shown a performance bias against women while Condition 3 (nullified STE) described the test as never having shown gender bias in previous situations. Several researchers have successfully used this test descriptive mechanism to nullify the stereotype threat effect (Aronson et al., 1998; Quinn & Spencer, 2001; Spencer et al., 1999; C. M. Steele & Aronson, 1995).

The third goal of this research study was to investigate the effect of stereotype threat on women's achievement goal orientation. In a similar study, Smith (2006) found that women in a stereotype threat condition were more likely to endorse performance-avoidance goals instead of performance-approach or mastery goals compared to their non-stereotype threatened counterparts: women who were not placed in a stereotype threat condition. The method of achievement goal assessment in Smith's study used a measurement which did not separate mastery goals into mastery-approach and mastery-avoidance. Using the AGQ-R this study intended to look at the four possible goal orientations and examine the potential correlation with stereotype threat conditions (Elliot & McGregor, 2001; Elliot & Murayama, 2008).

A fourth goal of this research study was to explore the thoughts of participants through an open-ended questionnaire. By asking open-ended questions about their thoughts during their participation in the research project, I wanted to see if there were common threads or contrasting ideas between participants in the three research conditions which would help explain their achievement outcomes or goal orientations.

Research Questions and Hypotheses

Three basic research questions were addressed in this research study:

1. Do women who are enrolled in a college chemistry course, and who have chosen a science-based major, demonstrate detrimental effects of stereotype threat on achievement? Do these women express concerns about the existence of the stereotype in an open-ended questionnaire?
2. Can the effects of stereotype threat be nullified by modifying the description of the challenging achievement task to one that is perceived as gender neutral?

3. Do women enrolled in a basic science course that requires a strong mathematics foundation demonstrate differential motivational or achievement goal orientations depending on stereotype threat conditions?

For Question 1, I hypothesized that women in this experimental investigation focusing on the domain of chemistry would demonstrate the underperformance achievement deficits consistent with those shown for women's achievement performance in the domains of mathematics and computer science. Furthermore, I hypothesized those women who have chosen a science-based major would still be vulnerable to the effects of stereotype threat consistent with their counterparts in non-science oriented majors and would therefore demonstrate achievement underperformance compared to their counterparts in the implicit stereotype threat conditions. I also hypothesized that although women in the explicit STE group would show achievement deficits, they may not express concern for the stereotype outwardly when answering an open-ended questionnaire. That is, although the effect may have been present, it may be a subconscious reaction to conditional stimuli or they may deny that it was a factor.

For Question 2, I hypothesized that describing the gender neutral history of the challenge exam would nullify the impact of explicit stereotype threat on achievement. That is, women in the nullified condition would demonstrate achievement levels above women participants in the explicit stereotype threat condition and would perhaps even exceed the achievement levels of women in the implicit (control) stereotype threat condition.

For Question 3, I hypothesized that women in the explicitly induced stereotype threat condition would tend to adopt avoidance goal orientation valences (mastery or

performance), whereas those in the nullified condition would be more likely to adopt approach goal orientation valences. Furthermore, women who are in the explicitly induced stereotype threat condition would preferentially adopt performance-avoidance goal orientations over mastery-avoidance goal orientations.

In summary this study attempted to demonstrate the effects of stereotype threat in the mathematics-related subject area of chemistry, using women who are in science-oriented majors (science, engineering, and allied health sciences), across three stereotype threat conditions. At the same time, I investigated whether there were significant differences in achievement goal orientation demonstrated by those exposed to the different stereotype threat conditions.

CHAPTER 3

RESEARCH METHOD

Design of the Study

The research proposal for this study was approved April 22, 2009 by the University of Nevada, Las Vegas (UNLV) Social/Behavioral Institutional Review Board (IRB) and assigned protocol #0902-3020 (see Appendix A). The general design of this study was a one-way factorial, post-test only, three condition, randomized design with (a) achievement on a chemistry challenge exam and (b) achievement goal orientation as the dependent outcome variables. Students were recruited at chemistry course sessions during Summer and Fall 2009 semesters with permission of the instructors.

Participants

Participants in this study were 61 female undergraduate college students enrolled in a two semester inorganic chemistry course series for science majors at the University of Nevada, Las Vegas. Although this course is considered an introductory course, the students represented the full range of undergraduate levels: freshman (13%); sophomore (44%); juniors (23%); seniors (13%); post-baccalaureate students (7%). The students ranged in age from 18 to 35 years ($M = 22$; $SD = 4.74$). The majority of students labeled themselves as White (38%), Asian Pacific Islander (34%), or Hispanic/Latino (18%). The remaining students were Black ($n = 1$) or Black/White mixed race ($n = 2$) while three students did not wish to disclose their race/ethnicity. The majority of students (70%) were basic science majors (biology, chemistry, geology and physics). Fifteen percent of the participants were allied health majors (kinesiology, nutrition and clinical laboratory sciences), 11% were non-science majors, and 5% were engineering majors.

Based on previous research literature, the level of a participant's math ability and intensity of their math domain identification may be contributing factors in their achievement. For that reason, I asked students to declare their highest completed math course and grade in that course. Three percent of the students ($n = 2$) had completed college algebra, 54% ($n = 33$) had completed a math course in pre-calculus (the prerequisite for the course), 31% ($n = 19$) had completed one semester of calculus and 12% ($n = 7$) had completed at least one math course above first semester calculus.

Measures and Forms

Recruitment Letter/Email

Student participants were recruited to the research project by directed emails through Rebel Mail and Web Campus. The same information letter was also handed out in class (see Appendix B). The recruitment letter listed research session times and asked interested students to sign-up for one of the sessions. The email/letter described the research study as it relates to student motivation, but withheld information about the focus on stereotype threat to avoid inadvertently activating the concept in participants prior to the study. Participants were informed of the full purpose of the research study after completion through a debriefing.

Informed Consent

During the initial phase of the study, students who have agreed to participate were asked to sign an Informed Consent document (Appendix C). The Informed Consent purposely omitted describing the concept of "stereotype threat" to prevent implicit activation of students' concerns about stereotypes. Instead it focused on the motivational

goal orientation aspects of the study. Students received a true description of the purpose of the research project when they completed the research session.

Domain Identification Measure (DIM)

Appendix D contains an adaptation of the Domain Identification Measure (DIM) published by Smith and White (2001). Their original instrument was developed for mathematics and English (verbal) domains and relied extensively on the instrument originally developed by Steele and Aronson (Aronson et al., 1998; Smith & White, 2001; Spencer et al., 1999; C. M. Steele & Aronson, 1995).

The DIM developed by Smith and White (2001) was supported by a number of criterion validity assessments correlating with mathematics achievement scores. In their study, students who rated high in mathematics identification on the DIM answered significantly more mathematics questions correctly than those rated low in mathematics identification (HI $M = 10.19$, $SD = 4.21$; LO $M = 7.32$, $SD = 3.13$). Smith and White (2001) also found that participants with high mathematics identification also demonstrated significantly more motivation and commitment to doing well on the exam. When controlling for gender in correlation analysis, the DIM could accurately predict mathematics achievement. The DIM was subsequently modified for mathematics and computer technology (Smith et al., 2005); changing the word “English” to the phrase “computer technology” in the relevant questions. This modification also demonstrated good internal consistency of the DIM with a Cronbach alpha coefficient of .83 for the mathematics domain and .78 for computer science respectively.

In a similar manner, I modified the DIM for mathematics and chemistry domains, changing the words “English” or “computer technology” to “chemistry.” Participants

rated 9 statements concerning mathematics and 7 statements relating to chemistry on a 5-point Likert scale. The first group of eight statements employed a Likert scale of 1 = strongly disagree to 5=strongly agree. An example of this group was “Chemistry is one of my best subjects.” The second group of six statements applied a Likert scale of 1 = not at all like you to 5=very much like you. Sample items for this group are “How much do you enjoy Chemistry-related subjects?”and “How important is it to you to be good at Math?” The final group of two questions used a 1 = perform poorly to 5 = perform extremely well Likert scale. “Compared to other students, how good are you at Math?” is an example from this group. Student scores were added for each domain resulting in a composite score.

Achievement Test: Chemistry Questions from Standardized Tests

Appendix E contains challenging chemistry questions selected with permission from the Educational Testing Service (ETS) Graduate Record Exam (GRE[®]) Chemistry Practice Book (ETS, 2002) and General Chemistry Online Practice Exams (Senese, 2009). The permission documents are included in Appendix F. These standardized exam questions were chosen because previous studies have shown that stereotype threat is primarily evoked when students are presented with challenging rather than non-challenging questions (Aronson et al., 1998; Spencer et al., 1999; C. M. Steele & Aronson, 1995). Students were provided with paper and pencils, a calculator (same model for all students), and a periodic table needed to complete the problems. The students were also placed under a time constraint to assist in constructing a challenging atmosphere for testing. In previous studies investigating women’s stereotype threat and mathematics performance, these types of questions (GRE[®]) were determined to be

sufficiently challenging to elicit underperformance in women when also placed within a stereotype threat condition (Inzlicht & Ben-Zeev, 2000, 2003; Kiefer & Sekaquaptewa, 2006, 2007).

In collaboration with a faculty member of the UNLV Chemistry Department, I selected 28 questions that were appropriate for the students in the participating course; items that were relevant to course content material. The questions needed to be sufficiently difficult, yet not impossible, for this level of student. The test questions were scored as correct or incorrect. Participants' total achievement scores and percent correct were recorded along with group performance on each question.

Achievement Goal Questionnaire-Revised

Appendix G contains a questionnaire instrument designed to investigate the achievement goal orientation of participants. The questionnaire is the Achievement Goal Orientation Questionnaire (AGQ) developed by Elliot and McGregor (2001), and subsequently updated and modified by Elliot and Murayama (2008). The updated Achievement Goal Questionnaire (AGQ-R) contains 12 questions which determine students' orientation toward mastery-approach (MAP), mastery-avoidance (MAV), performance-approach (PAP) or performance-avoidance (PAV) goals (Elliot & McGregor, 2001; Elliot & Murayama, 2008). An example of an item coded for mastery-approach stated, "My aim is to completely master the material presented in this chemistry class," while an item coded for performance avoidance stated, "My aim is to avoid doing worse than other students." The instrument was based on a revised (2x2) goal model, which was shown to be a better fit than the two (mastery vs. performance) or three (mastery vs. performance approach or performance avoidance) factor alternate models for

achievement goal orientation. The Achievement Goal Questionnaire developed by Elliot and Murayama (2008) displayed Cronbach alpha coefficients of .84 for Mastery Approach, .88 for Mastery Avoidance, .92 for Performance Approach and .94 for Performance Avoidance.

In this study, participants rated 12 statements concerning their goals on a 5-point Likert scale (1 =strongly disagree to 5 = strongly agree). Student scores were added for each subsection of the questionnaire (MAP, MAV, PAP, and PAV). I also computed overall subscales for mastery, performance, approach, and avoidance.

Demographic Survey

Appendix H contains the demographic survey used in the present study. Items requested the following information from participants: name (for follow-up only), age, ethnicity/race, college major, SAT/ACT mathematics scores, class standing, current college GPA, and highest mathematics course taken as well as the grade in that course. College majors were ranked by the assumed intensity of chemistry involved in the major. Non-science majors were coded as 1; allied health majors as 2; engineering majors as 3; and basic science majors as 4. Similarly students' highest mathematics courses were also coded from beginning to advanced courses. College algebra was coded a 1; pre-calculus as 2; first semester calculus as 3; and courses above calculus as level 4. Class standing was coded from 1 for freshman to 4 for seniors with a few students coded as a 5 for post-baccalaureate level class standing.

Demographic information was collected both to describe the participant sample and to determine if there were statistically significant differences in the demographic factors among the three groups. Because the focus of this study was gender, achievement

goal orientation and stereotype threat, the demographic survey requesting racial/ethnic information was administered at the end of the study since previous research indicates that simply asking for racial or gender information on a questionnaire or survey may illicit a stereotype threat condition in minority participants (Inzlicht & Ben-Zeev, 2000, 2003; Kiefer & Sekaquaptewa, 2006, 2007; Levi et al., 1998; Smith & White, 2002; C. M. Steele, 1997). Highest mathematics course completed, GPA and current major may also have an impact on susceptibility to stereotype threat since historically individuals who have high domain ability and high domain value expectancy demonstrate stereotype threat (Aronson et al., 1998; Lesko & Corpus, 2006; Smith & White, 2001).

The Demographic Survey included a request for participants to list their SAT and/or ACT mathematics scores as these had been used in previous studies as an indication of mathematics ability and a potential achievement score covariate. However UNLV does not require SAT/ACT tests for admissions and as a result only 25 of the 61 participants reported SAT scores and only 11 reported ACT scores. Several participants reported their total SAT or ACT scores instead of the mathematics subscale, further undermining the data for use in the study. Therefore SAT/ACT scores were not used as a factor or covariate in this study.

Experimental Condition Instructions

Upon arrival at the research session, participants were randomly assigned to one of three exam instruction groups: basic exam instructions (control group); stereotype threat exam instructions, or nullified stereotype exam instructions. Appendix I contains the instructions that were given to participants in each of the three experimental conditions. Participants in the control group (Group 1) read a page describing the

instructions for taking the chemistry achievement test (see Appendix E) but which did not contain any reference to gender or bias. The instructions given to Group 2 contained the same test taking instructions given to Group 1 but also contained a paragraph stating that the chemistry exam had previously and consistently shown a gender bias against women. The instructions for Group 3 contained the basic test taking instructions of Group 1 but included a paragraph stating that the chemistry exam had consistently shown no gender bias.

Debriefing Statement

Because I did not explicitly tell participants that a goal of the study was to investigate the effects of stereotype threat on chemistry achievement, a debriefing paragraph was given to all participants at the completion of the study (see Appendix J). After the debriefing, participants were allowed to ask questions and their willingness to have their data included in the study was confirmed. Participants were also given follow-up contact information should they have additional questions later or if they would like to see the final results of the study. Students received a \$10 gift card to a local coffee shop or bagel shop as compensation for participating in the research project.

Post-Hoc Questionnaire

Following completion of the study, participants were asked to volunteer to fill out an open-ended questionnaire and to discuss their answers with the researcher. The questionnaire contained five questions in open-ended format asking about the possible impact of the challenge exam instructions on their performance on the exam as well as their feelings about women's abilities in mathematics and science and their feelings about the opinions of the general public about women in mathematics and science (see

Appendix K). Participants were not limited in their time to fill out the questionnaire and were encouraged to ask clarifying questions if needed. Participants' answers were typed into a word processing program to assist with word and phrase coding. Participants' answers were collated and assessed by research condition to see if any trends or patterns were evident through a content analysis. This involved collecting the data and then after collection examining the participants' responses for themes or patterns that might emerge, reviewing those for patterns for student beliefs about stereotypes against women in mathematics and science majors or careers or common issues in their responses.

Procedure

Initial Phase: Precondition Surveys

Student volunteers were notified of the research study through recruitment emails and flyers distributed during their classes. Once the students agreed to participate, they were asked to go to one of several campus locations, days and times reserved for the study. Upon arrival at the research session, participants were provided with an Informed Consent form (see Appendix C), they were encouraged to ask questions during this initial discussion, and then asked to sign the form if they wanted to participate in the study. They then received their research participant number and collected a folder which contained a set of participant number identification labels they would apply to their completed forms. Again, a brief explanation of the project was given as well as an overview of the forms they would be asked to fill-out. Students were then asked to complete the DIM; no time limit was applied. This initial process took about 10 minutes to complete.

Second Phase: Study Conditions

Students were randomly assigned to one of three experimental conditions (implicit, explicit, or nullified), alternating based on their sign-in order. Immediately following the introduction and DIM data collection, they were provided with a prepared test booklet containing a cover page with instructions dependent on their research condition assignment. All students were directed to first read through the instructions thoroughly, ask questions if needed and then to initial the front of the test booklet signifying they had read and understood the instructions (see Appendix I). Students were allowed 30 minutes to complete the 28-question test. After completion of the chemistry achievement test (see Appendix E), participants were asked to complete the AGQ-R (see Appendix G) (Elliot & McGregor, 2001; Elliot & Murayama, 2008) followed by the demographic survey (see Appendix H). There was no time limit for completion of the AGQ-R and demographic survey. Most students took about 10 minutes to finish both forms.

Group 1 (Implicit/Control STE) received no specific instructions for completing the chemistry achievement test other than directions for how to take the exam, time limits and encouraging them to do their best. The rationale for including this condition (Group 1) is that stereotype threat may not need to be overtly or explicitly expressed to be manifest in the target group. The mere fact that women are taking a mathematics exam or mathematics-related exam has been shown to be sufficient to elicit the deleterious effects of stereotype threat on achievement and generate underperformance (Kiefer & Sekaquaptewa, 2006, 2007; Smith & Johnson, 2006). Group 1 also served as the

reference or control group in the study instead of setting up a pre/post testing which may have caused a priming effect.

Group 2 (Explicit STE) received the same written instructions for completing the exam as Group 1, but in addition their instructions included a brief paragraph which described the test as one that had previously shown a gender bias against women and that women often did not perform as well in chemistry as men during these standardized testing methods (see Appendix I).

Participants in Group 3 (Nullified STE), like participants in Groups 1 and 2, were given basic instructions for how to complete the chemistry test and time limits for completion. Group 3's instructions contained a paragraph which described the test as gender neutral, that is, specifically stating that the test had not shown any gender bias in the past (see Appendix I).

Third Phase: Debriefing and Post-Hoc Questionnaire

After completion of the research study materials, participants were given a handout describing the true and complete purpose of the experimental study (see Appendix J). They were asked to read the debriefing statement and given the opportunity to ask questions about the study. I also verbally confirmed that they still wanted to participate now that they knew the full purpose of the study. None of the participants asked to be removed. This part took between 5 and 20 minutes depending on the number and depth of participants' questions.

After completion of the formal experimental activities, students were asked to volunteer to complete a post-hoc questionnaire. It was hoped that at least four participants from each research condition would volunteer for the questionnaire; in fact

many more offered to participate. Open-ended questions were directed at their thoughts concerning the existence of a stereotype for women in mathematics (and/or sciences) and to see if they were consciously aware of it during the research study process and whether the test instructions impacted their test performance. It was hoped that open-ended questions might reveal evidence of their awareness of the stereotype and whether they expressed concerns about the existence of the negative gender bias which in turn might impact their achievement. Participants' answers might also support specific achievement goal orientations dependent on their experimental condition. The questionnaires took between 5 and 20 minutes to complete depending on the length of their answers; there was no time restriction. They wrote their answers on the form and were given the opportunity to ask more questions and add to their form. These hand-written forms were later transcribed for qualitative analysis.

In summary, students spent 45-60 minutes participating in the project. Table 2 summarizes the design and procedures involved in each stage of the research study and the time involved.

CHAPTER 4

RESULTS AND ANALYSES

In this chapter, I present the results of this study beginning with a description of the participant demographics as well as a discussion of the preliminary analyses of the measurement instruments. This is followed by a detailed discussion of the quantitative statistical analyses related to student outcomes on the chemistry challenge test and achievement goal questionnaire. I also provide a discussion of the qualitative analyses and comparison of participant post-hoc questionnaire responses reflecting participants' attitudes and thoughts during the research process.

Preliminary Analyses

With the exception of the Scholastic Aptitude Test/American College Test (SAT/ACT) data, all 61 participants successfully completed the entire set of required research measures. As described earlier, SAT/ACT test results are not mandatory for admission to University of Nevada, Las Vegas; consequently many students did not have results to report. In addition, some of the students reported their total SAT/ACT scores instead of the mathematics subscale as requested. Student SAT and/or ACT scores were therefore removed from the analytical process. Because there were no missing values in the other measures, scale or subscale sums were computed instead of means where appropriate. The means, standard deviations, skewness, and kurtosis for the participant parameters are shown in Table 3.

To confirm equivalency of the participant demographic factors (e.g. age, GPA, major) across experimental conditions and investigate the need for potential covariate factors, an analysis of variance (ANOVA) was performed. The results showed that there

were no significant differences among the research condition groups, i.e., Implicit/Control, Nullified, or Stereotype Threat conditions (see Table 3). Due to the trend towards significance of the Math Domain Identification Measure (DIM) scores across the three experimental conditions ($p = .051$), I performed a univariate ANOVA to look for interactions between the Math DIM values and experimental groups; however, no significant interaction was found [$F(1, 41) = 1.04, p = .484$]. Since there also was no significant correlation between the Math DIM values and the chemistry challenge test, the Math DIM was not used as a covariate in the study.

Variables describing the participant groups were analyzed for the presence of outliers or extreme values and for homogeneity of variance across experimental conditions. Standardized scores for age, grade point average (GPA), Math DIM, and Chem DIM, were all less than three standard deviations from their respective means. Levene's test for homogeneity of variance revealed no significant differences for age [$F(2, 58) = .75, p = .476$], GPA [$F(2, 58) = .03, p = .974$], Math DIM [$F(2, 58) = 1.674, p = .196$] and Chem DIM [$F(2, 58) = .91, p = .407$]. Skewness and kurtosis were also reviewed for normality of participant demographic data. With the exception of participant age and college major, skewness and kurtosis of the data sets were not remarkable. Both participant age and college major were expected to be somewhat skewed due to the nature of the targeted study group; women who are in science-based majors taking an introductory level chemistry course. Because the skewness and kurtosis levels for all variables (including the outcome variables) were less than twice the standard errors of the skewness and kurtosis, the assumptions of normality were upheld.

Since the preliminary analyses of demographic data showed an essentially normal distribution of data, no outliers or extreme data, and the assumption of homogeneity of variance among groups was not violated, all participants' data were used in the study in its original form.

Measures

Domain Identification Measure (DIM). To evaluate the internal consistency of the modified DIM, I performed a check on the reliability of each subscale (see Table 4). Survey items 1.6 and 1.8 were reverse-scored items; these were adjusted prior to analysis. Seven survey items focused on the participants' identification with the chemistry domain displayed a Cronbach alpha coefficient of .83. Nine survey items focused on participants' identification with the mathematics domain displayed a Cronbach alpha coefficient of .89. As the alpha coefficient scores were well above .70, the items in each subscale indicated good internal consistency. The results for this modification of the DIM were also consistent with the reliability findings in the literature (Smith & White, 2001).

Normality of the subscales was checked by assessing skewness and kurtosis of the data. The chemistry subscale displayed a mean of 27.19, standard deviation of 4.66 and a slightly negative skew with a minimal kurtosis of 0.16 indicating an essentially normally distributed data set (see Table 4). The mathematics subscale displayed a mean of 28.79 and standard deviation of 6.3 with a skewness level of -0.18 also indicating a slightly negative skew and kurtosis of -0.94 indicating a moderately flat curve. Some skew effect might be expected due to the select population in the study, i.e., students enrolled in science-based majors and taking a mathematics-based college chemistry course. In each

subscale, the skewness and kurtosis levels were less than twice the standard error values of the skewness and kurtosis, which indicated that the assumptions of normality of participant results with the DIM had been upheld.

Achievement Goal Questionnaire-Revised (AGQ). Participants in this study rated the 12 statements concerning their goals on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). Student scores were summed for each subsection of the questionnaire, Mastery Approach (MAP), Mastery Avoidance (MAV), Performance Approach (PAP), and Performance Avoidance (PAV), as well as overall subscale for mastery, performance, approach and avoidance. Table 5 displays the Cronbach alpha coefficients for each of the subscale goal orientation parameters as well as the means and standard deviations for the AGQ. Although the internal consistency of some of the subscales was below the minimum recommended level of .70 (mastery approach (.61), mastery avoidance (.63), and overall mastery (.62)), removing the item in each subscale with the lowest item-total correlations did not significantly raise the alpha coefficients. Since each 2 x 2 subscale has only three survey questions and removal of individual items did not significantly raise the inter-item reliability, the AGQ survey was used intact. However, results on those subscales need to be interpreted with some caution.

Descriptive data analysis of the AGQ outcomes showed that all kurtosis levels were less than twice the kurtosis standard error values and therefore did not void the assumptions of normality. The majority of skewness levels for the AGQ were also within normality levels. Mastery approach and mastery avoidance achievement goal orientation outcomes had skewness levels of -.76 and -.69 respectively with a standard error of skewness of .31. Because these skewness results are greater than twice the standard error

of skewness this denotes a significant negative skewness for participants' mastery approach and mastery avoidance achievement goal orientations.

Chemistry achievement test. To determine which questions would be used in the final analysis, difficulty and discrimination indexes were calculated for each question. One question (#28) which was not answered correctly by any of the participants was removed from the study after confirming that it was in fact keyed correctly. Questions represented concepts taught in semester 1 of the 2 semester course series. Research sessions were scheduled in the last 4 weeks of the first semester or first 4 weeks of the second semester course. Participants obtained a range of 3 to 22 correct answers out of a possible maximum of 27 or 11% to 81%. The mean was 10.2 correct answers or 37%. The kurtosis and skewness values were 1.12 and .82 respectively. This indicates a kurtosis within normality ($SE = .61$) but a significant positive skewness ($SE = .31$). The positive skewness is consistent with the results of a difficult assessment tool. The Difficulty Index for the remaining questions ranged from 10.53% to 86.84% ($M = 38.4\%$, $SD = 22.48\%$) indicating that questions displayed a wide range of difficulty but the mean was moderately difficult. The Discrimination Index ranged from .05 to .63 ($M = .31$, $SD = .26$) indicating that in spite of the difficult nature of the chemistry challenge test all questions were positive discriminators and therefore did not discriminate against high achieving students. Although the test questions were not specifically selected for their correlation to a specific factor or exam content within the chemistry domain, the inter-item reliability analysis for the chemistry challenge exam displayed a Cronbach alpha of .70 indicating a fairly reliable test measure.

Analyses of Interest: The Impact of Stereotype Threat

Research Question 1

Three basic research questions were addressed in this research study. My first research question asked: “Do women who are enrolled in a college chemistry course and who have chosen a science-based major demonstrate detrimental effects of stereotype threat on achievement?” I hypothesized that women who have chosen a science-based major, like their counterparts in non-science majors found in the current literature, would still be vulnerable to the effects of stereotype threat. I expected women in the stereotype threat condition to display an achievement underperformance compared to women in the implicit (control) experimental condition. To investigate the differences in chemistry test achievement between these two experimental conditions, I conducted an analysis of variance. In contrast to the hypothesis, analysis of the chemistry challenge test results for participants in the control condition ($M = 10.05$, $SD = 3.53$) compared to the stereotype threat condition ($M = 10.25$, $SD = 3.18$) showed no significant difference [$F(1, 38) = .04$, $p = .852$]. I conducted a Levene’s test to confirm whether the variances were equal for the outcome variables, chemistry test score, and achievement goal questionnaire. None of these results were significant indicating the homogeneity of variance assumption was satisfied (see Table 6).

Research Question 2

Research Question 2 asked: “Can the effects of stereotype threat be nullified by modifying the description of the challenging achievement task to one that is perceived as gender neutral?” For this question, I hypothesized that describing the gender neutral history of the challenge exam would nullify the impact of explicit stereotype threat on the

women's achievement. That is, women in the nullified condition would demonstrate achievement levels above women participants in the explicit stereotype threat condition and perhaps even exceed the achievement levels of women in the implicit stereotype threat condition. To investigate the differences in chemistry test achievement between these experimental conditions, I again conducted an analysis of variance. The analysis of the chemistry challenge test results for participants in the nullified condition ($M = 10.38$, $SD = 4.87$) showed no significant difference compared to the chemistry test results of the stereotype threat group ($M = 10.25$, $SD = 3.18$) [$F(1, 39) = .010$, $p = .920$]. Recall that Levene's test for the homogeneity of variance for test results was not significant indicating that assumption of equality was not violated (see Table 6).

Additional Analyses Related to Research Questions 1 and 2

Although there were no significant differences in the chemistry challenge test achievement scores among the experimental groups, I wanted to know if there was a difference in the number of correct answers on the chemistry achievement test based on the students' degree of mathematics or chemistry identification. I also wanted to know if any of the participants' demographic factors were related to test performance. Since the variables for college major, highest mathematics course and class standing, were ordinal, Spearman's rho correlation coefficients were calculated to investigate their relationships with other variables. As might be expected there was a significant strong positive correlation between participant age and class standing ($r = .70$, $N = 61$, $p < 0.01$) indicating that older students were more likely to be more advanced college students (see Table 7). There was also a significant negative correlation between participant age and college major ($r = -.28$, $N = 61$, $p < 0.05$) indicating that older students were more likely

to be non-science majors (label = 1) or allied health majors (label = 2) instead of engineering majors (label = 3) or basic science majors (label = 4). This trend may reflect differences in academic advising and suggested plans of study for science majors. Students in basic science majors are typically scheduled to take these chemistry courses early in their college career, as they are prerequisites to many other required courses in their major, whereas students in other majors may take this course later in the study plan. A strong positive correlation was found between the number of mathematics courses taken and participants' degree of mathematics domain identification ($r = .50, N = 61, p < 0.01$). Spearman's rho correlation factors are displayed in Table 7.

I then conducted a Pearson product–moment correlation analysis to investigate the possible relationships among interval (or ratio) level demographic variables, chemistry challenge test scores, and Math and Chem identification (DIM) results (see Table 8). A Pearson product–moment correlation analysis between the participants' chemistry test outcomes and their levels of mathematics or chemistry domain identification did show a small but significant positive correlation between the chemistry test scores and chemistry DIM ($r = .28, p = .032$) (see Table 8).

Because there was a significant correlation between both Chem DIM and participant GPA with the chemistry challenge test outcomes, these items could be potential covariates (see Table 8). However, because the Chem DIM displayed a relatively small correlation effect ($r = .28, p = .032$) with the chemistry test score, I did not apply that factor as a covariate. There was also a significant relationship between the GPA and the chemistry challenge test scores ($r = .47, p < .001$), with a partial eta squared values of .22 [$F(2, 58) = 16.130, p = .000$]. Since this was a medium to strong

correlation effect, I performed a one-way analysis of covariance (ANCOVA), applying the participant GPA variable as a covariate with the chemistry challenge test scores as the dependent variable. However, even with the use of GPA as a covariate in the ANCOVA, there was no significant difference between experimental conditions for the chemistry challenge test [$F(2, 58) = .012, p = .988$].

Research Question 3

Research Question 3 asked: “Do women enrolled in a basic science course which requires a strong mathematics foundation demonstrate differential motivational or achievement goal orientations depending on stereotype threat conditions?” For this question, I hypothesized that women who are in the explicitly induced stereotype threat condition would tend to adopt more of an avoidance goal orientation (mastery or performance) than those in the nullified condition or the implicit stereotype threat condition. I also expected women in the nullified condition to adopt the least amount of avoidance goal orientation.

Table 8 displays the results of the ANOVA for the Achievement Goal Questionnaire. Significant between subjects effects were found for performance avoidance goal orientation [$F(2, 58) = 7.57, p = .001, \eta^2 = .21$] as well as the overall performance [$F(2, 58) = 5.47, p = .007, \eta^2 = .16$] and overall avoidance goal orientations [$F(2, 58) = 8.05, p = 0.001, \eta^2 = .22$]. I conducted a Levene’s test to check whether the variances were equivalent for the achievement goal questionnaire. None of these results were significant indicating the homogeneity of variance assumption was satisfied (see Table 6).

Post-hoc pair-wise comparisons showed significant differences between participant results for the explicit stereotype threat condition compared to the nullified condition but none of the comparisons involving the control/implicit condition were significant (see Table 10). As hypothesized, participants in the stereotype threat condition tended to adopt significantly higher levels of performance avoidance goals than those individuals in the nullified condition (Mean Diff = 3.82, $p = .001$, $d = 1.10$). These same participants in the stereotype threat condition also displayed significantly more overall performance goal orientation (Mean Diff = 5.64, $p = .005$, $d = 0.96$) as well as overall avoidance orientation (Mean Diff. = 5.74, $p = .001$, $d = 1.13$) compared to participants in the nullified experimental condition.

Post Hoc Open-Ended Questionnaire

Following completion of the second phase of the study, participants were asked if they would volunteer to fill out an open-ended questionnaire. Of the 61 participants 47 agreed to fill out the post-hoc questionnaire. Volunteers were almost equally distributed across the experimental conditions with 15 volunteers from both the control and stereotype threat groups and 17 volunteers from the nullified group. The questionnaire contained five questions in open-ended format asking about the possible impact of the challenge exam instructions on their performance on the exam as well as their feelings concerning women's abilities in mathematics and science and their opinions about the general public's perceptions about women in mathematics and science. They wrote their answers on the form and were given the opportunity to ask more questions and add to their form if needed. These hand-written forms were later transcribed into word

processing documents for qualitative coding after being cross-checked for transcription accuracy.

Two independent reviewers read all of the student responses and initially rated their direct answers to the open-ended questions: yes vs. no or agree vs. disagree (see Table 11). For this portion of the analysis there was an initial agreement rate of 100, 96, 94, 100, and 89 percent for Questions 1-5 respectively. Raters then discussed the discrepancies and consensus was reached for the final ratings resulting in 100% agreement for their direct answers. Since only 3 of the 47 responses for open-ended Question 1 contained any expansion beyond yes or no; these were just discussed directly. Answers for open-ended Questions 2 through 5 were then examined for patterns or themes that might emerge from their expanded explanations or rationales for each answer. After reviewing students' answers, each reviewer independently generated a list of concepts for each open-ended question. These lists were discussed and reviewers agreed on a single set of patterns for the next level of coding. With this new rubric each reviewer evaluated the students' responses using the consolidated rubrics for each open-ended question. Table 12 contains the final inter-rater percent agreement for the students' responses and cross-tabs kappa values for these consolidated rubrics.

Due to the ordinal nature of the open-ended response data, I performed a Kruskal-Wallis H test to get an overview of the data. Results showed that there were no significant differences among the experimental conditions for the participant overall responses to each question in the open-ended questionnaire. I then performed additional statistical analyses for the responses to each of the individual post-hoc questions which I discuss individually below. Some of the student responses to each question could not be

coded and in some cases the study participant did not respond to the individual questions. Those students' responses were coded as an unknown or unable to interpret category. The answers that were coded as unknown were not included in the statistical analysis.

Open-Ended Question 1

Question 1 asked "Did the test instructions affect your ability to do well on this test? If the instructions did affect you, what was different and why?" This question was developed to support Research Question 1, in which I attempted to produce a stereotype threat condition, and Research Question 2, where I attempted to reverse the stereotype threat effect. Recall from previous results that neither of these research experiments produced significant effects. All 47 of the respondents answered this question. Most of the participants (94%) did not feel that the challenge test instructions impacted their ability to perform on the test. However, two of the other respondents (one control & one stereotype threat group) remarked that the instructions made them more at ease or relaxed during the exam. The student in the control condition remarked that the instructions "reassured me that my score would not be shown or counted" while the student in the stereotype threat group remarked that they were "more relaxed, however, I was much less focused due to the time restraint." One additional student in the stereotype threat group however specifically noted that the phrases describing the consistent gender bias in the past against women for this test "lowered my self-confidence." Since we did find a significant effect on participants' achievement goal orientations, their answers to this question bring up a number of additional questions which I will explore in the Chapter Five discussion.

Open-Ended Question 2

For Question 2 of the open-ended questionnaire, participants were asked “How do you think you did on the testing portion of the study?” In part, this open-ended question was developed to reveal additional information concerning the participants’ achievement on the chemistry challenge test. However student responses to this question might also reflect their achievement goal orientations. Both possibilities were explored. Twenty-one of the 47 students (44.7%) stated that they felt they did poorly on the exam while 19 (40.4%) felt their performance was okay or adequate. Only two students thought they actually performed well on the exam and five others either stated they did not know how well they did or did not provide an answer which could be interpreted. The five responses which could not be interpreted were not included in any further statistical analysis for this question.

When comparing the achievement scores on the chemistry challenge exam, those who rated their performance as poor had a mean score of 8.6 correct answers which was in fact below the overall mean of 10.2 answers correct (see Figure 1). Those who rated their performance as okay or adequate had a mean correct answer score of 10.4 correct answers which was just above the overall mean score. Participants who felt they performed well on the chemistry challenge test were in fact above the overall mean with an average score for this group of 11.5 correct answers.

To determine whether there were differences in women’s responses to this question related to their experimental condition, a chi-square test for independence was performed. The results indicated that there was no significant difference in students’ responses to Question 2 by experimental conditions ($\chi^2 (4) = 5.02, p = .29$). Since there

was no significant difference in the responses by condition, I then explored whether there were differences in students' scores on the chemistry challenge test or in their goal orientations based on their answers to Question 2. For this investigation, I performed a Kendall's tau correlation between the students' answer codes and the dependent variables of the study. The tau correlation was used because one of the variables was ordinal. A significant correlation result was found for the overall performance achievement goal orientation ($\tau = .41, p = .007$) as well as performance approach ($\tau = .36, p = .018$) and performance avoidance ($\tau = .36, p = .019$) goal orientations.

A content analysis for the additional comments made by students for this question revealed that a higher number of students in the stereotype threat group, almost double and triple the number in the nullified and control groups, respectively, offered an excuse for their performance on the chemistry challenge test including forgetting course material, content was not taught to them, or they had a time delay between semester 1 and semester 2 of the course series. At the same time they also stated they had guessed or skipped questions more often than the control or nullified groups. I also looked at the overall tone of their explanations and rated them as either positive or negative in nature. Both the control and stereotype threat groups' explanations contained a number of more negative tone phrases than the nullified group describing their performance with words like very bad or horrible (see Table 13).

Several students' answers and comments displayed a performance or performance avoidance focus. The following are examples of students who presented with a performance goal orientation. Each of these students shows that they are striving toward a successful grade or score on the challenge test, not

necessarily focused on whether they know the content of the course. Student 3 (nullified): “I think my score will be better than the mean score, but not as high as the best score.” This student’s answer indicates a somewhat competitive nature consistent with a performance goal orientation. Similar statements were made by other students: Student 49 (control): “Average, I hope I passed,” Student 60 (nullified): “Not as well as I would have liked to do.”

Other students’ comments seemed to be more consistent with performance avoidance or overall avoidance goal postures; providing a rationale or making excuses for their poor performance on the chemistry challenge test as seen in the content analysis. Student 21 (nullified) “Because of lack of study of chemistry & review-wise I don’t feel I did so great; Student 29 (stereotype threat) “I forgot all the material that I have learned in chem 121.” Each of these students offered excuses for why they may not have performed well or as well as they should have on the exam which is more consistent with a performance avoidance goal orientation; a posture trying to avoid failure or embarrassment.

Open-Ended Question 3

Question 3 asked participants “Do you think you did as well as other participants? If you feel you did better or worse than others on the testing portion, would you please explain?” Like Question 2 above, this open-ended question had elements that might provide information about the stereotype threat conditions as well as the participants’ achievement goal orientations. However it adds the element of comparing their performance to other participants and may call to mind a performance goal orientation. Student responses were very similar to their responses to Question 2 above. Seventeen

students (36%) felt their performance was equal to or the same as others and 19 (40%) felt their performance was worse than others on the test. Only three participants (5%) felt their performance was above average or better than the others in the group. The remaining eight participants did not know how to rate their performance or stated that they purposely did not compare themselves to the others. This last group's data was not included in the analyses that follow.

As with Question 2, there was no significant difference in students' answers to this question among the experimental conditions ($\chi^2(4) = 1.10, p = .90$). Differences were found however in their performance on the chemistry challenge test based on their answers to this question. Students who stated that they performed worse than their counterparts had a mean of 9.1 correct answers which is below the overall test mean of 10.2 correct answers. Those who thought they did as well as the other students had a mean correct answer score of 10.1; essentially the same as the overall mean. Participants who felt they performed better than their fellow students on the chemistry challenge test were above the overall mean with an average score for this group of 16.3 correct answers. A Kendall tau correlation analysis did not show a significant correlation between student performance on the chemistry challenge test and their answers to this question ($\tau = .24, p = .080$). However graphing the mean chemistry test values with the answers to this question did show a positive trend (see Figure 2). There were no significant correlations with achievement goal orientations among the different responses to this question.

Content analysis of the explanations for their performance on the chemistry test again revealed examples similar to those seen with open-ended Question 2 (see Table

14). Recall that the difference between Question 2 and Question 3 was that open-ended Question 3 asked participants to specifically compare their performance to others in the research study. More students in the stereotype threat group offered excuses as to why their performance was not exemplary or as good as their fellow participants. Many of the comments were like those in Question 2 reflecting a performance and/or performance avoidance orientation while about one-third of the responses (30%) could not be classified into a goal orientation. One student (Student 44) in the stereotype threat condition who displayed a performance orientation (grade focused) stated: “I think I did as well as other participants. I don’t think I aced the test but I think I got at least at 75% (I hope).” An example of performance avoidance goal orientation was seen in another student in the stereotype threat condition: Student 47 (stereotype)”I think I did worse because they all finished before me. I hope I didn’t flunk the test.” It is interesting to find that a student is focused on not failing the challenge test when this is not part of their course grade.

However, there were two students whose comments stood out as being mastery goal oriented. Both students were actually in the control condition. Student 1 (control): “I’m not quite sure as to how I did. When I take a test, I usually don’t concern myself with my surrounding and try to stay as focused as possible. I believe I stayed very focused.” Student 40 (control): “I really have no idea if I did better or worse than others and that generally does not concern me for test.” These students did not want to make a comparison of their performance to others in the study. They focused on their individual achievement and the content. Looking at these two students’ individual goal orientations

both Student 1 and Student 40 had the highest goal orientation scores for overall mastery goal with equal scores for mastery approach and mastery avoidance.

Open-Ended Question 4

Question 4 asked participants “Do you think that most people believe women can do as well as men on science-based tests? Can you provide a reason/rationale for your opinion?” This question was developed to explore whether or not students were aware of the negative stereotype about women’s abilities in mathematics of science and whether they believed the stereotype was prevalent in society. Recall that participants were not initially informed that the study concerned the negative stereotype about women and mathematics ability or science achievement. Their awareness of the stereotype is critical for the inducement of stereotype threat which may in turn impact their achievement score on the chemistry challenge exam (Aronson et al., 2002; Beilock, Rydell, & McConnell, 2007; Chalabaev, Stone, Sarrazin, & Croizet, 2008). As with the previous open-ended questions their awareness may also impact their achievement goal orientation.

Twenty-eight students (61%) agreed that people in general believed that women were just as capable as men on science-based testing while 18 students (39%) felt most people still believed women were not as good in the sciences as men. One student did not answer. Again, there was no significant difference in students’ answers to this question among the experimental conditions ($\chi^2(2) = .58, p = .75$). Those who agreed that the general public thought men and women were equals in science capability had only a slightly higher chemistry challenge test mean ($M = 10.1$) than those who did not agree ($M = 9.7$); this difference was not statistically significant. A Spearman correlation analysis found no significant correlations between experimental conditions, participant

responses to Question 4, participants' chemistry test scores or the achievement goal orientations.

Content analysis of the comments made by students for this question showed that their reasons behind their belief about society's views were essentially the same among the three experimental conditions (see Table 15). However what was different was the tone of their response. The majority of participants in the stereotype threat condition included more negative words and phrases related to their opinions while the control and nullified condition responses were much more positive in tone. Participants in the stereotype threat groups were more likely to describe society's views as slow to change and stated that this research project was proof that it was still a problem. Whereas the students in the control and nullified conditions were more likely to express that although it may have been a problem in the past, it was less of a problem now. They expressed a view that things were progressing toward equality.

Students were often very passionate in their comments on this question (Yes/No agree the public says men/women are equal). Sometimes they underlined, put words in capital letters or added exclamation marks to their sentences. Their degree of passion seemed to suggest a long-term struggle with the topic, as if they have encountered this before and have prepared answers for this many times. Some even indicated past experiences with the stereotype. Of the 15 students in the control group, 6 participants stated that the stereotype against women still existed in the public. Student 31 (control): "Many people still have it in the back of their minds that women are supposed to be homemakers and have kids. They haven't completely caught up to where reality is now." Similarly 7 of 14 in the stereotype threat group felt the stereotype existed.

Student 26 (stereotype): “Women don’t seem as interested in science. There are more men’s names associated with the more memorable discoveries in science that also dates back to the times and how unacceptable it was for women to be leaders.” Interestingly only 4 of the 16 students in the nullified condition felt the stereotype still existed in the general public but the comments in this group were very impassioned about the stereotype in society. Here is an example:

I think there still exists in our society some propensity for people (including women!!!) to believe that, generally speaking, women’s brains are somehow “wired” differently by our hormones and chromosomes. Women who happen to enjoy and excel in science are seen as EXCEPTIONS to the rule. I think the stereotype of women’s intellectual inferiority is as old as ancient history, literally. Somehow over the ages, women gained a reputation for being emotional and irrational, attributes that are incompatible with objective observation and logical reasoning. To reinforce this negative stereotype, there have been studies loosely cited in the popular press detailing the “differences” between women’s brains and men’s brains. It is unfortunate that such studies get misconstrued or posted as truth without any critical examination as to their research methods or statistical interpretation. Long after the authors have been forgotten, any ill-conceived conclusions still persist. There are also very subtle sexist attitudes that come out of people as good-natured jokes and such. NOT FUNNY! Student 3 (nullified)

Each experimental condition had students that agreed or disagreed with the original statement, “Do you think that most people believe women can do as well as men on science-based tests? Can you provide a reason/rationale for your opinion?” Almost 40% of the participants believe there is a bias against women’s mathematics and science abilities within society. The awareness of the stereotype among all the conditions may have been a factor in reducing the ability to detect the impact on participants’ achievement scores. Stereotype awareness and the potential for implicit induction of stereotype threat in the control group may have been a factor in my inability to detect a differential impact among the groups on achievement to support Research Question 1. If there was an implicit induction of stereotype threat the scores on the chemistry challenge test in the control condition would also have been impacted. This might have generated a lower mean score for the control group reducing the difference between the control and stereotype threat conditions. However, an implicit induction would not necessarily have reduced the potential nullified effect since that comparison was between the stereotype threat condition and the nullified condition. Since I did not find a stereotype threat effect between the stereotype threat condition and the nullified condition but I did find significant results among all three conditions on the achievement goal questionnaire, activation of implicit stereotype threat is probably not a viable explanation.

Open-Ended Question 5

The final open-ended question asked these women about their personal beliefs concerning the abilities of women and men in mathematics and science; “What do you believe? Why?” This question was developed to investigate their personal beliefs about the stereotype; whether they endorsed the stereotype themselves. The vast

majority of respondents (76%) stated that they believe women and men were equally capable of success in mathematics or science-based courses and careers. Two (4%) even stated that they thought women were better than men in science and mathematics. However, four participants (9%) stated that they believed men were better than women in mathematics and science. Five student responses were not clear as to what they actually believed (mixed or conditional beliefs) and two students did not respond at all. These last seven students were not included in the analysis. No significant correlations were found between participant responses and the chemistry challenge test score and a chi-square analysis of independence showed no significant differences between answers to Question 5 and experimental conditions ($\chi^2(4) = 1.71, p = .79$). However a significant Kendall tau correlation was found between participants' answers to Question 5 and the approach goal orientation ($\tau = .28, p = .035$).

Content analysis of the students' explanations or rationale for their personal belief about the abilities of women in science or mathematics showed that participants in the control and nullified conditions expressed that men's and women's potential was equal but that ability was also based on effort, preparation or educational background, and interest (see Table 16). As with open-ended Question 4, the tone was much more positive in the control and nullified conditions compared to the stereotype threat condition. Students in the stereotype threat condition were more likely to describe their struggles with gender bias rather than portray the situation as getting better with time. Students in the nullified and control groups described the current situation as getting better or progressing toward equality. They were also more likely to say that effort and hard work were a more important factor than gender for success.

Many students talked about their personal experiences that either supported their belief that women were equally capable of mathematics and science achievement or personal experiences that led them to believe that men were inherently better in these subjects. One of the students in the control condition seemed to sum up many of the other students' thoughts in a very short statement: Student 29 (control): "I think people don't separate the fact that more men are in the science field versus women can do as well as men on science-based tests." Students expressed the ability of women was one thing but it was another discussion altogether whether or not they chose to be in science careers. They were aware that historically there were more men than women in mathematics or science-based careers and that in some fields of study men outnumber women even today. However they were quick to separate this disparity in numbers from actual ability.

Student 3, in the nullified condition, is an example of someone who attributes the differences to interest and opportunity:

I believe that just about any person, regardless of sex, can excel on science-based tests if they have a genuine interest in the subject matter as well as the time, patience and opportunity to learn the material well. I believe this because it has been my personal experience that this is the case.

Student 35 from the stereotype threat condition stated that women were just as capable but there are reasons why they may not choose careers in the sciences.

I believe women are just as much capable if not more so than men to do well in math/science. There are two reasons I believe that women don't

choose these fields as often as men do. 1) I feel that little boys are encouraged more than girls to do well-both by parents and teachers (subconsciously) 2) I feel that women are more social and creative than men, so they choose careers that pertain to these characteristics. I also think this is brought on by society as well.

Summary

In this study I was not able to demonstrate a stereotype threat effect that would reveal a negative impact on women's challenge test scores, which I hypothesized, would occur for Research Question 1. Nor was I able to demonstrate an increase in mean test scores in the nullification condition for Research Question 2. A number of factors may have contributed to the lack of significant results. Several possible explanations or limitations of the study will be discussed in Chapter Five. Findings for Research Question 3, however, indicated that despite the lack of significant effect on the chemistry challenge test achievement scores, students in the stereotype threat condition were more likely to adopt a performance avoidance goal orientation than their counterparts in the control/implicit or nullified experimental condition, and in many cases were also more likely to have an overall performance and/or overall avoidance goal orientation. They also adopted this performance avoidance goal orientation even though the majority expressed a belief in the equality of men and women in mathematics and science.

Students' responses to the post-hoc open-ended questionnaire revealed that the majority of participants (89%) were aware of the negative stereotype concerning women's lesser abilities in mathematics and science from a historical perspective and almost 40% felt that the belief was still prevalent in society today. Although there were

no significant differences among the experimental conditions for goal orientation subscales in the open-ended questions, there were patterns in students' responses that indicated they may be influenced by a stereotype threat even without associated confirmation through challenge test results. Specifically students' responses to open-ended Question 2 indicated positive correlations with performance avoidance, performance approach and overall performance goal orientations which supported the results for Research Question 3 where significant results were found for these goals on the AGQ. There were also trends in their responses to open-ended Questions 2 and 3 that related to their chemistry challenge test scores. In Chapter Five I discuss the findings of this study and relate them to the relevant literature and research questions.

CHAPTER 5

DISCUSSION

In this chapter I summarize the findings of the study and relate them to the specific research questions. I then discuss the concept of stereotype threat, its potential effects on student achievement as well as the potential impact on student goal orientation. The discussion focuses on the impact that stereotype threat can have on student behaviors and the implications for education as it pertains to teaching women in science, student achievement and standardized testing measurements. The final portion of this chapter provides a discussion of some potential limitations of this study as well as suggestions for future research investigations.

Summary of the Findings

Findings of this study suggest that women in a science-based major such as chemistry may not be overtly susceptible to the effects of stereotype threat as had been demonstrated in the previous literature with women in introductory college psychology courses (Good et al., 2008; Pronin et al., 2004; Smith & White, 2002; Spencer et al., 1999). Although I hypothesized that the experimental conditions in this study would create a stereotype threat effect on the participants' performance, the women in this study did not exhibit a significant decrease in their achievement scores on a chemistry challenge test when placed in a stereotype threat condition nor did they demonstrate a significant elevation of achievement scores when placed in a nullified stereotype threat condition.

However, in spite of the lack of demonstrable impact on their chemistry challenge test outcome scores there were significant differences in their achievement goal

orientations. As I had hypothesized, women in the stereotype threat condition expressed higher levels of performance avoidance goal orientation than women in the control group. Women in the nullified condition exhibited even lower levels of performance avoidance goal orientation than the control condition. These findings seem to indicate that stereotype threat and the counter effect of nullification still exerted some impact on these women even if it was not seen through the challenge test results. The measurement process for the chemistry challenge test may not have been appropriate or may not have been sensitive enough to reveal the effect for a variety of potential reasons.

Adoptions of certain achievement goal orientations, like performance avoidance, have been found in previous research studies with women in stereotype threat conditions (Brodish, 2008; Chalabaev et al., 2008; Smith, 2006; Smith et al., 2007). Performance avoidance goals in particular are associated with lower levels of learning and poorer performance or achievement on outcome assessment measures (Elliot & Moller, 2003). The open-ended questionnaire applied at the end of the study also revealed an impact on participants' thoughts and awareness of the stereotype concerning women's performance outcome. Participants' responses to the open-ended questionnaire showed correlations and patterns consistent with certain achievement goal orientations (performance avoidance), consistent with the achievement goal questionnaire results for Research Question 3. In the following section I discuss the specific research questions and hypotheses along with a rationale for why the hypotheses were or were not met by the results of the study.

Research Questions 1 and 2

One of the purposes of this research study was to test a stereotype threat effect in a different demographic of women and in a subject domain related to mathematics but yet not mathematics, i.e., chemistry. Most research studies to date have used students enrolled in introductory psychology courses as their participants. Although the investigators used the students' SAT or ACT scores as a covariate in their data analyses, their populations were a mixture of individuals enrolled in a wide range of college majors. By focusing my study on women students who are enrolled in a basic science course, I hoped to investigate the potential stereotype threat effect specifically on women who have selected college majors with a mathematics and science emphasis. Alongside this was the goal of investigating women and stereotype threat effects applied specifically to the chemistry domain. Similar to the domain of computer science, inorganic freshman chemistry courses typically depend a great deal on mathematics skills and testing involves mathematics-based relationships and calculations. By selecting participants enrolled in a freshman chemistry course I investigated whether stereotype threat effects on women extend into the domain of chemistry.

Research Questions 1 and 2 were focused on an attempt to recreate the impact of stereotype threat on women's achievement in the subject domain of chemistry. Unfortunately the results did not show either a significant effect on the students' chemistry test scores in the stereotype threat condition or an improvement in achievement scores by nullifying the effect. It is somewhat expected that it would be difficult to demonstrate a nullification effect if the corresponding stereotype threat effect was not generated. To examine why I did not find a stereotype threat effect on the participants'

achievement scores, I have to consider the factors that have previously been shown to be associated with expression of a stereotype threat effect in women in the literature. There are two likely reasons why I was not able to demonstrate a stereotype threat effect. The first is that these women are indeed not susceptible to the impact of stereotype threat. All of the affective factors involved in susceptibility to stereotype threat, individually or collectively, may in turn be responsible for this group's apparent resistance to the threat condition. A future study using the MSLQ survey might be helpful in identifying additional affective factors involved in generating a stereotype threat effect. The second is that they are susceptible to the effects of stereotype threat but the measure I chose to demonstrate the effect, a chemistry challenge exam derived from GRE[®] and online chemistry exams, was inappropriate or ineffectual. Revising the exam might be helpful but the primary issue with the challenge test seemed to be insufficient time to complete the test appropriately. Using the same exam with a 90 minute instead of 30 minute time limit or reducing the number of questions to fit a 30 minute time frame would be a suggestion for a future direction with this study.

Stereotype threat has been demonstrated in a variety of situations including academic and non-academic environments and for a variety of target groups and subject domains. For women, the typical stereotype involves society's view that women do not perform as well as men in mathematics and science domains. The proposed reasons for this statistical difference have ranged from genetic or innate factors to factors derived from our society, classroom environments and culture. Researchers have consistently demonstrated the impact of stereotype threat on women in the mathematics domain and at least one study has shown that this concept crosses over into the domain of computer

science (Hackett, 1985; Inzlicht & Ben-Zeev, 2003; Keller, 2002; Kiefer & Sekaquaptewa, 2006, 2007; Kramer & Lehman, 1990; Murphy et al., 2007; Pronin et al., 2004; Quinn & Spencer, 2001; Schmader et al., 2004; Smith et al., 2005; Smith & White, 2002; Spencer et al., 1999; J. Steele et al., 2002).

Another aspect of this population may be related to their coping skills and self-efficacy. Women with a strong sense of coping skills (learning strategies) and perceived self-efficacy may be able to continue engagement through intrinsic reward mechanisms in spite of a stereotype threat condition (Linnenbrink & Pintrich, 2002, 2003). In another study, Pronin et al. (2004) surveyed a group of women who had successfully taken a large number of mathematics classes and found that these women rejected characteristics in their self-identity that would be considered as typically associated with the negative feminine stereotype of women (e.g., flirtatiousness, stay-at-home mom).

Women who have chosen a mathematics or science based major in college have probably had multiple background courses and have obviously have had considerable success in these domains. As a result, they most likely have abilities, strategies and coping mechanisms that have allowed them to build confidence and self-efficacy. These behaviors may provide a sense of immunity from the societal stereotype against women. Although society may believe the stereotype, because of their personal abilities and strategies the stereotype does not necessarily apply to them. Their continued successes may have created more self-confidence and self-reliance, somewhat insulating them from some of the social pressures that may impact other women in science majors.

Finally, a recent study by Wout et al. (2009) demonstrated that the individuals who are targets of the stereotype must not only be aware of the possibility of a negative

stereotype about their group in the situation at hand but they must also decide that there is a probability that the stereotype threat will occur in that situation. Even if the stereotype exists and is possible, if the conditions or situation do not lead to a probability of it being a factor in interactions with others in the environment, the target individual does not attend to it. For this particular study, the women may have been aware of a stereotype threat but since they were assured that the exam would have no impact on their course grade, they may not have attended to the concept in enough depth for the effect to be detected. A few of their comments in open-ended Question 1 specifically stated that this portion of the instructions allowed them to relax. Because they also may have high levels of self-efficacy and resilience in this domain, they may not consider the threat a valid concern. Most of the responses to open-ended Question 1 stated that they did not think the test instructions impacted their performance on the test and that may be true to some extent. But it is also possible that they may not be able to admit the impact or they might not be consciously aware of the impact.

In addition to the issues of educational background, coping skills, and probability of impact, the achievement measure itself and the test instructions creating the experimental conditions may be factors that did not allow expression or measurement of a stereotype threat effect. Participants were given a written description which portrayed the chemistry test in one of three ways. Condition 1 (implicit) only gave directions for taking the test. Condition 2 (explicit STE) described the test as having consistently shown a performance bias against women while Condition 3 (nullified STE) described the test as never having shown gender bias in previous situations. However with this particular population the instructions may not have been sufficient to cause an effect.

It is also possible that the testing environment was not sufficiently threatening to impart an effect. Participants in this study were women only rather than a mixture of male and female students. Although in some women only studies a stereotype threat was induced, these studies involved students enrolled in introductory psychology courses. Since the women in this study were from science-based college majors, they may have needed an additional stress on their performance to induce a stereotype threat. Stereotype threat for women in mathematics and science concerns knowledge of the gap between performance outcomes for men and women. Even with an awareness of the stereotype in the general public, if there are no men present in the testing room, participants may not have considered the stereotype relevant for this situation. As a result the threat was not induced per se and their scores were not affected. A similar issue can be raised because the researcher was a female scientist and therefore a compatriot rather than someone who might critically evaluate their performance.

Another concern involves the development of the chemistry challenge test itself. GRE[®] source questions were determined to be sufficiently challenging to elicit underperformance in women when also placed within a stereotype threat condition for the study of the effect on mathematics (Inzlicht & Ben-Zeev, 2000, 2003; Kiefer & Sekaquaptewa, 2006, 2007). However, for the subject domain of chemistry the questions from the GRE[®] standardized exams may have been too difficult for the introductory level student. The overall mean score on the exam was only 37% with a significant positive skew indicating that the exam was very difficult. The Difficulty Index for the questions ranged from 10.53% to 86.84% ($M = 38.4\%$, $SD = 22.48\%$) indicating that questions displayed a wide range of difficulty but the mean index indicated moderate difficulty.

In summary, I hypothesized that I would be able to generate a stereotype threat effect in college women majoring in sciences through a chemistry domain challenge exam. Unfortunately I was unable to demonstrate a significant difference in the participants' achievement scores based on their experimental conditions. The significant findings for this research question provide some evidence that a stereotype effect was generated, but not detected, by the chemistry challenge exam used for Research Questions 1 and 2. I will now discuss the findings for Research Question 3.

Research Question 3

The third goal of this research study was to investigate the effect of stereotype threat on women's achievement goal orientation. In a similar study, Smith (2006) found that women in a stereotype threat condition were more likely to endorse performance-avoidance goals instead of performance-approach or mastery goals compared to their non-stereotype threatened counterparts. In this study I hypothesized participants who were placed in the stereotype threat condition would be more likely to adopt performance avoidance goal orientations. This in fact was the result from this study. Women in the stereotype threat group exhibited significantly higher levels of performance avoidance goal orientation than those in the stereotype nullified group. Although the differences for the control group were not significant compared to the other groups, levels of performance avoidance goal orientation in the control group were intermediate between the stereotype threat and stereotype nullified groups. Participants also demonstrated higher levels of both overall performance goal orientation and the overall avoidance valence. This is somewhat expected due to the design of the Achievement Goal Questionnaire (AGQ) as questions for these subscales overlap. Although there was no

demonstration of significant mastery goal orientation from the AGQ, this result needs to be interpreted with some caution. Recall that the survey questions on the achievement goal questionnaire that were related to the subscales of mastery approach and mastery avoidance had reliability coefficients at levels less than .70; the usual minimum level required for reliability.

Let us first briefly review the achievement goals and how they impact learning and assessments. Students with mastery and/or performance approach goal orientations are driven toward success and although performance approach goal orientation is not optimal, striving for grades does often lead to high levels of learning (Elliot & Church, 1997). Performance orientation is thought to increase a student's intrinsic motivation if they perform well, but may decrease their motivation when they perform poorly. It is subject to external rewards and therefore somewhat fragile as a motivational tool. Students with performance-avoidance goal orientations are concerned with preventing failure at all costs. As a result they are not focused on learning but rather on preventing embarrassment, ultimately to the detriment of actually learning the course material (Elliot & Moller, 2003).

Performance avoidance goals are associated with students whose purpose is to avoid poor performance or to avoid failure or embarrassment. By focusing on these negative factors they actually inhibit full attention to the task at hand, spend more time checking and double-checking answers all of which ultimately decreases learning or outcome achievement (Smith, 2004). In 2004 Smith proposed the Stereotyped Task Engagement Process (STEP) model to show how stereotype threat induction--the prediction or possibility of failure--might activate adoption of a performance-avoidance

goal orientation in target individuals (C. M. Steele & Aronson, 1995). In the STEP model, Smith proposed that characteristics of the individual together with a situation of stereotype threat could induce the adoption of a performance avoidance goal orientation in the participant. Performance avoidance goals in turn may generate self-regulating strategies which could have positive or negative outcomes. These self-regulating strategies may include positive task behaviors such as additional effort or negative task behaviors, such as a feeling of anxiety, and result in an overall negative experience with the original situation. While positive task behaviors tend to result in higher learning and achievement outcomes, negative task behaviors tend to undermine both learning and outcomes. A negative personal experience can contribute to further negative or counter-productive behaviors (avoidance) and may result in additional negative experiences with repeated exposure, ultimately resulting in diminished performance outcomes. The students in this study adopted performance avoidance goals when placed in the stereotype threat condition even though they did not show any detrimental effect on their chemistry challenge test scores. We might interpret this to mean that the stereotype threat effect was in fact triggered in these students but they were able to overcome the effect for the chemistry challenge exam through coping mechanisms or defense strategies. It is also quite possible that the chemistry challenge exam was not able to detect the effect. To further explore the actual thoughts of the participants about their experiences during the research session and their individual beliefs about the negative stereotype about women in mathematics and science, an open-ended questionnaire was administered to volunteers. The results of the post-hoc questionnaire are discussed in the next section.

Post-Hoc Open-Ended Questionnaire

Following completion of the required portion of the research study participants were asked to volunteer to complete an open-ended questionnaire. Recall that the purpose of the questionnaire was to ask about the possible impact of the challenge exam instructions on their performance on the exam as well as their feelings about women's abilities in mathematics and science and their opinions about the general public's perceptions about women in mathematics and science. I wanted to see if there were common threads or contrasting ideas between participants in the three research conditions which may help explain their achievement outcomes or goal orientations.

Participants' answers to these questions were not statistically different based on their experimental condition: control/implicit, stereotype threat, or nullified. Nor were there any significant correlations with chemistry challenge test results. However there were significant correlations between two of the question's answer sets and some of the AGQ subscales. The vast majority of participants (94%) stated in response to open-ended Question 1 that the instructions did not affect their performance and their outcome scores on the exam by experimental condition indicate that this is correct. However, a significant difference was found among the conditions for the Achievement Goal Questionnaire suggesting that some impact may have been present. Participants may not have wanted to admit that the statements made an impact on their thoughts or the effect was subliminal. Alternatively, participants may have used nullification strategies so that their test performance was not affected, the effect on their performance may have been subliminal in nature.

A content analysis of the explanations participants provided as a rationale or in support of their responses to the open-ended questionnaire showed that individuals in the stereotype threat condition used more phrases related to excuses for their performance on chemistry challenge exam than participants in the control or nullified conditions. Participants in the stereotype threat condition also used words or phrases that could be considered more negative in tone than those in the other conditions. Recall that results of Research Question 3 showed participants in the stereotype threat condition adopted significantly higher levels of performance avoidance goals compared to the participants in the nullified condition. Individuals who have adopted a performance avoidance goal orientation are more focused on prevention of failure and avoiding personal embarrassment. The participants' statements in the open-ended questionnaire suggest that that even though students in the stereotype threat group did not show a significant impact on their chemistry challenge test scores, their comments on the open-ended questionnaire also supported a performance avoidance goal orientation.

What is also apparent from this opened-ended question survey is that participants are aware of the negative stereotype concerning women's abilities in science and mathematics. Awareness has been consistently shown to be a contributing factor in the development of a stereotype threat effect on achievement for the targeted group. The opened-ended questionnaire allowed me to see what some of their thoughts were during and after the research session and that there may be some impact on their emotions and thoughts.

Limitations of the Study

One of the limitations of this study may have been the selection of questions used in the chemistry challenge test. The chemistry challenge test did not detect a stereotype or nullification effect; however impact of the effect was seen through participants' achievement goal orientation. Because the effect was present in the AGQ results, it is possible that the chemistry challenge test might have been inadequate. The average performance was low overall ($M = 38\%$) and several students commented on the difficulty of the test at the end of the session and stated their frustration with questions during the open-ended questionnaire portion of the study. However analysis of the test scores displayed a normal distribution and there was sufficient room for lower scores on the test. I chose relevant test questions from the GRE[®] and from an online standardized test question set for general chemistry. I selected these resources because existing research used mathematics questions from the GRE[®] for the women and mathematics studies. Both testing sets are developed for students who have completed their undergraduate education; not for those who are just starting. The content of the questions was reviewed by one of the course instructors, however in retrospect the rationale for using mathematics questions from these sources may be more reasonable than for the domain of chemistry. By the time students reach college they have participated in a number of different mathematics courses covering multiple topics. Most students have only had one year of high school chemistry prior to enrolling in this level of chemistry at college. They therefore may not have had sufficient background or practice for the question set selected. It might have been valuable to select questions that addressed foundational concepts used within general chemistry directly from the course testing

materials. In addition, since our university typically consists of non-traditional students many of them had a gap in timing between semester 1 and semester 2 of this course series. Some of the participants had some of the semester 1 concepts 2-3 years prior to this research session creating an information disparity in the group. Since the test questions contained material from both the first and second semesters, this added to the difficulty for some students.

A second limitation also related to the achievement measurement process may have been the time limit set for the chemistry challenge test. Most students did not finish the test in the 30 minutes allotted. Although this was a tactic of the research project it may have also compromised the results not allowing for full diversification of test scores so that an effect could be detected. The 30 minute time allotment may have been too short for 28 questions that often involved mathematics calculations or use of chemical formulas. In retrospect, teachers from these courses consulted after the study was completed, stated that 60-90 minutes would have been more acceptable as a time limit for the question set involved. This means that the vast majority of students could not have finished the test appropriately and results may not truly reflect these students' abilities. In the open-ended questionnaire several students commented that they felt rushed, skipped questions, guessed, etc. due to the time constraints. The test results should therefore be interpreted with caution concerning the presence or absence of a stereotype threat effect.

Another aspect of this research that may have complicated the findings on the chemistry challenge test is that most studies in the literature have used SAT/ACT scores as a covariate. As discussed earlier, UNLV does not require SAT/ACT scores as part of the university application process. Many participants had no scores to report and many

of those who did report scores reported their total scores instead of their mathematics subscale score. Regardless I was unable to use this factor as a covariate which may have provided an opportunity to clarify the results and reveal an actual stereotype threat effect.

The final limitation of this study may have been in the selection of women who have chosen mathematics and/or science based majors as participants. Although one of the goals of the study was to specifically look at this type of population, it would have perhaps been efficacious to also assess related coping skills and issues of self-efficacy; mechanisms that may moderate the generation of a stereotype threat effect. A future study which also used the Motivated Strategies for Learning Questionnaire (MSLQ) developed by Pintrich et al. might reveal information related to other affective aspects of students' motivation and learning strategies (Duncan & McKeachie, 2005; Linnenbrink & Pintrich, 2002; Pintrich & De Groot, 1990). The MSLQ has been used in other studies to reveal how students approach and strategize through classroom tasks. As such it could provide additional information about the affective impacts on student performance during a stereotype threat situation.

Future Research

The results of this study and the need to open more opportunities for women in science and mathematics based careers are the driving forces behind the need for more research in this area. Since the initial article on stereotype threat by Steele and Aronson (C. M. Steele & Aronson, 1995), multiple studies have shown the outcome of stereotype threat but there is still a lot of investigation needed to discern just how stereotype threat impacts individuals and how we might overcome the effect in the classroom. In general

more research is needed to examine the cognitive and affective domain aspects that lead to a stereotype threat effect.

There is a need to investigate the impact of stereotype threat on women in different demographic groups. Instead of exploring stereotype threat effects in a study comparing men and women in mathematics, it would be of interest to perform a study comparing women in non-science majors with women in science majors. This type of study might show differences in women who might be more or less susceptible to the impact of stereotype threat. Another analysis that is suggested by the result of this study is to repeat this study with measurements that would identify women's coping strategies, levels of self-efficacy and self-esteem, and effort. As noted earlier in discussion of the open-ended questions, several of the women commented that they ignored the negative stereotype image concerning women in science or applied extra effort to overcome the stereotype. This leads to a suggested future study involving a scaled questionnaire concerning their awareness of the stereotype in the past and in the present as well as whether they had directly or indirectly encountered the stereotype in the classroom from teachers or peers. The survey might also include questions concerning the impact the stereotype has had on them in their course performance, choice of college major and selection of a career in science.

Some of the limitations of this study also suggest additional studies to refine and clarify the findings. Development of a different chemistry challenge test that is derived directly from course materials might be appropriate. I would also like to reexamine the questions in the original test and perhaps refine which questions are used in the study, i.e., specifically select questions with moderate difficulty index ratings. A pilot study

letting all students take as much time as they want, measuring the time they took, and then perhaps setting the time limit such that 80% of the average students would have been able to complete the test.

Another research project might use non-survey instruments to measure individuals' physiological reactions to the stereotype threat conditions. Factors such as blood pressure, heart rate, and skin conductance might avoid the potential problems associated with individuals failing to admit or report their actual thoughts and feelings or of subconscious impacts which may indirectly impact participants involved in the study.

The participants' responses to the open-ended questionnaire were provocative enough to suggest that a study focusing on a qualitative analysis of women's perceptions during a stereotype threat situation would be of interest. Instead of an open-ended questionnaire, an actual one-on-one interview with participants perhaps including video recording to look at body language, which may reflect anxiety or nervousness, and other observational aspects of behavior would be useful.

General Discussion and Implications for Educational Practice

The impacts of stereotype threat have been demonstrated in both academic and non-academic environments, different target populations including those based on race/ethnicity or gender, and in different physical settings. At the same time several studies have also demonstrated the ability to mollify the impact of stereotype threat on student achievement through relatively simple environmental manipulations (Spencer et al., 1999).

A meta-analysis of the existing stereotype threat literature representing 39 studies in five countries and involving over 18,000 students found that performance measures

underestimated the true potential of targeted minorities (ethnic, women) in part perhaps due to the effects of stereotype threat (Walton & Spencer, 2009). They estimated that the SAT underestimated women's mathematics scores by 19-21 points. When the average gender gap according to the College Board is only 34 points, the implications for women in high stakes performance testing are unsettling. Because Western society is entrenched with standardized testing for selection and advancement in almost all venues, it is essential to provide a level playing field and equitable access for all individuals. The impact on student learning and achievement are a critical impediment to the academic success of targeted groups.

According to the Committee on Science, Engineering and Public Policy (COSEPUP) report concerning women in science and engineering careers, the number of women seeking study and careers in science and engineering is increasing; however, the pipeline to career advancement still needs a tremendous amount of improvement (*Beyond Bias and Barriers*, 2007). The committee found that women are as fully capable and interested as men in science careers but that they are "lost at every educational transition."

It is not lack of talent, but unintentional biases and outmoded institutional structures that are hindering the access and advancement of women.

Neither our academic institutions nor our nation can afford such underuse of precious human capital in science and engineering. The time to take action is now. . . For women to participate to their full potential across all science and engineering fields, they must see a career path that allows

them to reach their full intellectual potential. Much remains to be done to achieve that goal. (*Beyond Bias and Barriers*, 2007) page 1

What is shown in this dissertation study is that stereotype threat may not only affect student achievement outcomes but may also impact students' goal orientations. The negative impact on their achievement goal orientations may cause them to more often adopt performance avoidance goals and may undermine achievement in other domains. It may also reduce their desire to stay in an environment or weaken their desire to go into related careers. What is needed is a mechanism to minimize the effect of stereotype threat. This is especially important in light of the findings of the COSEPUP. Extending the policies related to sexual harassment, cultural sensitivity to include concepts of stereotype threat is essential. Often instructors are not aware of the impact of their classroom design or how small statements meant to encourage may in fact do just the opposite (*Beyond Bias and Barriers*, 2007).

It begins with instructional design and teacher education about the impact of small but meaningful statements made in the classroom. Information concerning the concept of stereotype threat and its implications to many student groups needs to be included in curriculum instruction at all levels. Women need to be given the tools to cope with the environment which may cause detrimental achievement effects. Bear in mind that the stereotype threat does not need to be explicit or overt to be felt consciously or to cause a reaction in the targeted individual. However as suggested by this study some women who have chosen a science based major in college may have developed coping skills and learning strategies that alleviate the potential impact of stereotype threat. For those

women and other target groups who have not developed the necessary strategies to cope with for stereotype threat, it is important not only to change the environment in the classroom, but to also prepare these individuals to deal with the environment which may provide the threatening conditions.

TABLES

Table 1

2 x 2 Model of Achievement Goals

	Mastery	Performance
	<u>Mastery Approach</u>	<u>Performance Approach</u>
Approach	pursuit of learning mastery of information	need to do better than others in grades/rewards
	<u>Mastery Avoidance</u>	<u>Performance Avoidance</u>
Avoidance	avoid misunderstandings perfectionist	preventing failure and/or embarrassment

Table 2

Outline of Research Proposal

Phase of Experiment		Activity		
Phase 1 ~10 minutes				
Informed Consent	√	√	√	√
Math/Chem Domain ID	√	√	√	√
Survey				
Phase 2 ~ 40 minutes				
Condition	Intervention	IMPLICIT	EXPLICIT	NULLIFIED
		No instructions	Told test has	Told test has
		given other than	previously shown	not shown any
		to complete the	gender bias against	gender bias
		test	women	against women
Chemistry Achievement	√	√	√	√
Test				
Motivational/Goal Survey	√	√	√	√
Demographic Survey	√	√	√	√
• SAT/ACT-self-report				
• College major & class				
standing				
• Highest college math				
course & grade				
• Race/Ethnicity				

- Age

Phase 3 ~ 10 minutes

Debriefing	√	√	√
Post-Hoc Questionnaire	√	√	√

Table 3

Participant Demographic Means, SD, Skewness, Kurtosis, and ANOVA F Values

Variable	Condition	N	Mean	SD	Skew	Kurtosis	Between Groups	
							F	Sig.
Age	Control	20	21.55	4.42				
	Stereotype	20	22.40	4.48				
	Nullified	21	22.29	5.42				
	Total	61	22.08	4.74	1.30	0.62	0.19	.831
Grade Point Average	Control	20	3.31	0.43				
	Stereotype	20	3.40	0.45				
	Nullified	21	3.62	0.41				
	Total	61	3.38	0.43	-0.35	-0.49	0.33	.723
Chem DIM ^(a)	Control	20	25.95	5.35				
	Stereotype	20	27.05	4.38				
	Nullified	21	28.52	4.04				
	Total	61	27.19	4.66	-0.54	0.02	1.61	.209
Math DIM ^(a)	Control	20	26.55	6.74				
	Stereotype	20	28.40	6.57				
	Nullified	21	31.29	4.82				
	Total	61	28.79	6.30	-0.18	-0.94	3.16	.051

^(a) DIM - Domain Identification Measure

Table 4

Descriptive Statistics for the Domain Identification Measure (DIM)

	Chemistry	Mathematics
	Identification ^(a)	Identification ^(b)
Mean	27.19	28.79
Standard Deviation	4.66	6.30
Skewness	-0.54	-0.18
SE Skewness	0.31	0.31
Kurtosis	0.16	-0.94
SE Kurtosis	0.61	0.61
Cronbach Alpha ^(c)	0.90	0.93
Cronbach Alpha ^(d)	0.78	0.83
Cronbach Alpha ^(e)	0.83	0.89

Notes:

- a. Chemistry Domain Identification included Questions 1.1, 1.3, 1.4, 1.6, 2.2, 2.6, and 3.2. Question 1.6 was reverse-scored prior to analysis.
- b. Mathematics Domain Identification included Questions 1.2, 1.5, 1.7, 1.8, 2.1, 2.3, 2.4, 2.5 and 3.1. Question 1.8 was reverse-scored prior to analysis.
- c. English and Mathematics domains (Smith et al., 2005)
- d. Computer Science and Mathematics domains (Smith, 2004, p. 194)
- e. Chemistry and Mathematics domains – results from this study

Table 5

Achievement Goal Orientation Subscale Means, SD, Skewness, Kurtosis and Reliability

Goal Orientation	Condition	Mean	SD	Skewness	Kurtosis	Reliability
Mastery Approach	Control	13.05	1.50			
	Stereotype	13.20	2.02			
	Nullified	13.71	1.38			
	Total	13.33	1.65	-0.76	0.18	0.61
Mastery Avoidance	Control	11.35	2.68			
	Stereotype	12.00	2.64			
	Nullified	10.33	3.29			
	Total	11.21	2.93	-0.69	-0.09	0.63
Performance Approach	Control	10.85	3.38			
	Stereotype	12.10	2.55			
	Nullified	10.29	2.95			
	Total	11.07	3.03	-0.40	-0.89	0.77
Performance Avoidance	Control	10.40	3.47			
	Stereotype	12.30	2.54			
	Nullified	8.48	3.34			
	Total	10.36	3.47	-0.38	-0.75	0.79
Mastery	Control	24.40	3.57			
	Stereotype	25.20	3.75			

	Nullified	24.05	3.81			
	Total	24.45	3.69	-0.19	-0.60	0.62
Performance	Control	21.25	6.38			
	Stereotype	24.40	4.30			
	Nullified	18.77	5.50			
	Total	21.43	5.86	-0.35	-0.78	0.84
Approach	Control	23.90	4.39			
	Stereotype	25.30	3.60			
	Nullified	24.00	3.59			
	Total	24.49	3.86	-0.07	-0.96	0.71
Avoidance	Control	21.50	5.05			
	Stereotype	24.55	4.15			
	Nullified	18.81	4.50			
	Total	21.57	5.09	-0.07	-0.96	0.71

Table 6

Levene's Test for Homogeneity of Variance on Chemistry Challenge Exam and Achievement Goals by Condition

Outcome Variable	<i>F</i> (2, 58)	Sig.
Chemistry Test Scores	1.85	.166
Mastery Approach Goal	1.18	.315
Mastery Avoidance Goal	1.39	.257
Performance Approach Goal	1.01	.370
Performance Avoidance Goal	1.13	.329
Overall Mastery Goal	0.06	.942
Overall Performance Goal	2.05	.138
Overall Approach Goal	0.42	.656
Overall Avoidance Goal	0.41	.664

Table 7

Spearman's Rho Correlations for Demographic Factors, Math DIM, Chem DIM, and Chemistry Challenge Test (N = 61)

Variables	1	2	3	4	5	6	7	8
1. Age	---							
2. GPA	N/A	----						
3. College Major	-.28*	-.10	----					
4. Class Standing	.70**	-.15	-.60**	----				
5. Highest Math Course	-.35**	.24	.10	-.33**	----			
6. Math DIM	N/A	N/A	-.11	-.11	.50**	----		
7. Chem DIM	N/A	N/A	.33**	-.36**	.28*	N/A	----	
8. Chem Test Scores	N/A	N/A	-.18	-.05	.194	N/A	N/A	----

* $p < .05$.

** $p < .01$.

Table 8

Pearson Product Moment Correlations for Demographic Factors, Math DIM, Chem DIM, and Chemistry Challenge Test (N = 61)

Variables	1	2	3	4	5
1. Age	---				
2. GPA	-.05	---			
3. Math DIM	-.09	.37**	---		
4. Chem DIM	-.30*	.19	.36**	---	
5. Chem Test	-.06	.47**	.25	.28*	---

* $p < .05$
 ** $p < .01$

Table 9

Analysis of Variance for the Achievement Goal Questionnaire-Revised

		Sum of Squares	Mean Square	<i>F</i> (2,58)	Sig.
Mastery Approach	Between Groups	5.01	2.50	0.92	.406
	Within Groups	158.44	2.73		
	Total	163.44			
Mastery Avoidance	Between Groups	29.01	14.51	1.73	.186
	Within Groups	485.22	8.37		
	Total	514.23			
Performance Approach	Between Groups	35.10	17.56	1.98	.148
	Within Groups	514.64	8.87		
	Total	549.74			
Performance Avoidance	Between Groups	149.83	74.91	7.57**	.001
	Within Groups	574.24	9.90		
	Total	724.07			
Mastery	Between Groups	14.19	7.09	0.51	.601
	Within Groups	800.95	13.81		
	Total	815.15			
Performance	Between Groups	326.56	163.28	5.47**	.007
	Within Groups	1730.36	29.83		
	Total	2056.92			

Approach	Between Groups	24.56	12.28	0.82	.446
	Within Groups	870.00	15.00		
	Total	894.56			
Avoidance	Between Groups	337.73	168.87	8.05**	.001
	Within Groups	1217.19	20.99		
	Total	1554.92			

** $p < 0.01$

Table 10

Post-Hoc Tukey HSD Pairwise Comparisons for Significant Achievement Goal

Questionnaire Subscales

Dependent Variable	(A) GROUP NUMBER	(B) GROUP NUMBER	Mean Difference (A-B)	SE	Sig.	η^2
Performance Avoidance Subscale	Control	Stereotype	-1.90	0.99	.145	
		Nullified	1.92	0.98	.132	
	Stereotype	Nullified	3.82**	0.98	.001	0.21
Performance Subscale	Control	Stereotype	-3.15	1.73	.171	
		Nullified	2.49	1.71	.319	
	Stereotype	Nullified	5.64**	1.71	.005	0.16
Avoidance Subscale	Control	Stereotype	-3.05	1.45	.098	
		Nullified	2.69	1.43	.154	
	Stereotype	Nullified	5.74**	1.43	.001	0.22

** $p < .01$

Table 11

Post-Hoc Open-Ended Question Coding and Frequencies (N = 47)

Interview Question	Coding Rubric	Frequency
Question 1: Did the test instructions affect your ability to do well on this test? If the instructions did affect you, what was different and why?	Yes	3
	No	44
Question 2: How do you think you did on the testing portion of the study?	Poorly	19
	Okay-adequate	21
	Well	2
	Did not say/unclear	5
Question 3: Do you think you did as well as other participants? If you feel you did better or worse than others on the testing portion, would you please explain?	Worse than others	19
	Same as others	17
	Better than others	3
	Did not say/unclear	8
Question 4: Do you think that most people believe women can do as well as men on	Yes	28

science-based tests?

No 18

Question 5: What do you believe? Why?

Men are better than
women. 4

Women and men are
the same. 34

Women are better than
men. 2

Did not say/unclear 5

Table 12

Inter-rater Percent Agreement and Cohen's Kappa Values for Content Analysis of Open-Ended Questions 2-5

Open-Ended Question	% Agreement	Cohen's κ
2	77	.70
3	81	.69
4	90	.87
5	80	.70

Table 13

Content Analysis Tally for Open-Ended Question 2

		Experimental Condition		
		Control	Stereotype	Nullified
Why?	forgot material	4	5	
	not yet covered material in class	1	8	1
	do not test well in chem		2	3
	long time since 121	1	3	3
	need to review & practice	2	1	4
	skipped a lot		1	
	guessed		2	
	needed more time			2
Positive	well			
	okay			
	better than most		1	
	pretty good	1		
Negative	very bad	1	2	
	horrible		1	
	not so good	1	2	
	not as well as I would like	1		2
	not very well	2	1	

Table 14

Content Analysis Tally for Open-Ended Question 3

		Experimental Condition		
		Control	Stereotype	Nullified
Why?	didn't compare to self to others	2		
	forgot material	3	3	
	not yet covered material in class		2	
	do not test well in chem	1	1	
	time since 121		1	2
	didn't understand some questions	1		
	did the best that I could	1		
	others left earlier		1	
	need to review & practice	1	2	2
	not very good in chem		1	1
	not interested in chem			1
	skipped a lot		1	
	needed more time			2
Positive	well			1
	okay		1	
	better than most	2		
Negative	very bad	1		
	horrible			

not so good

not as well as I would like

Table 15

Content Analysis Tally for Open-Ended Question 4

		Experimental Condition		
		Control	Stereotype	Nullified
Why?	brains wired differently	1	2	1
	equal ability	2	1	2
	earlier experiences		2	1
	personal success/experience	2		2
	male dominated fields	2	1	3
	historically men better but not now	2	3	3
	seen data/stats		2	2
	more men in fields		1	
	this research project means still not equal		2	
	numbers in field is not ability	1		
	gender roles	1	1	2
	society pressures	1	1	2
	effort or hard work	1	1	
	passion		1	
	depends on your ability not gender	1	1	2
Tone	Positive	9	5	12
	Negative	4	9	3

Table 16

Content Analysis Tally for Open-Ended Question 5

		Experimental Condition		
		Control	Stereotype	Nullified
Why?	brains wired differently		1	1
	equal ability	4	2	1
	earlier experiences	1	2	
	personal success/experience	2	1	1
	male dominated fields	1		1
	historically men better but not now	1		2
	more men in fields		2	1
	this research project means still not equal		1	1
	numbers in field is not ability		1	1
	gender roles		2	1
	society pressures		2	1
	discouraged		1	1
	emotional vs. rational		1	1
	effort or hard work	2	1	6
	preparation/background	1	1	2
	passion/interest	2	1	1
	depends on your ability not gender	3		1
Tone	Positive	10	6	12
	Negative	5	8	2

FIGURES

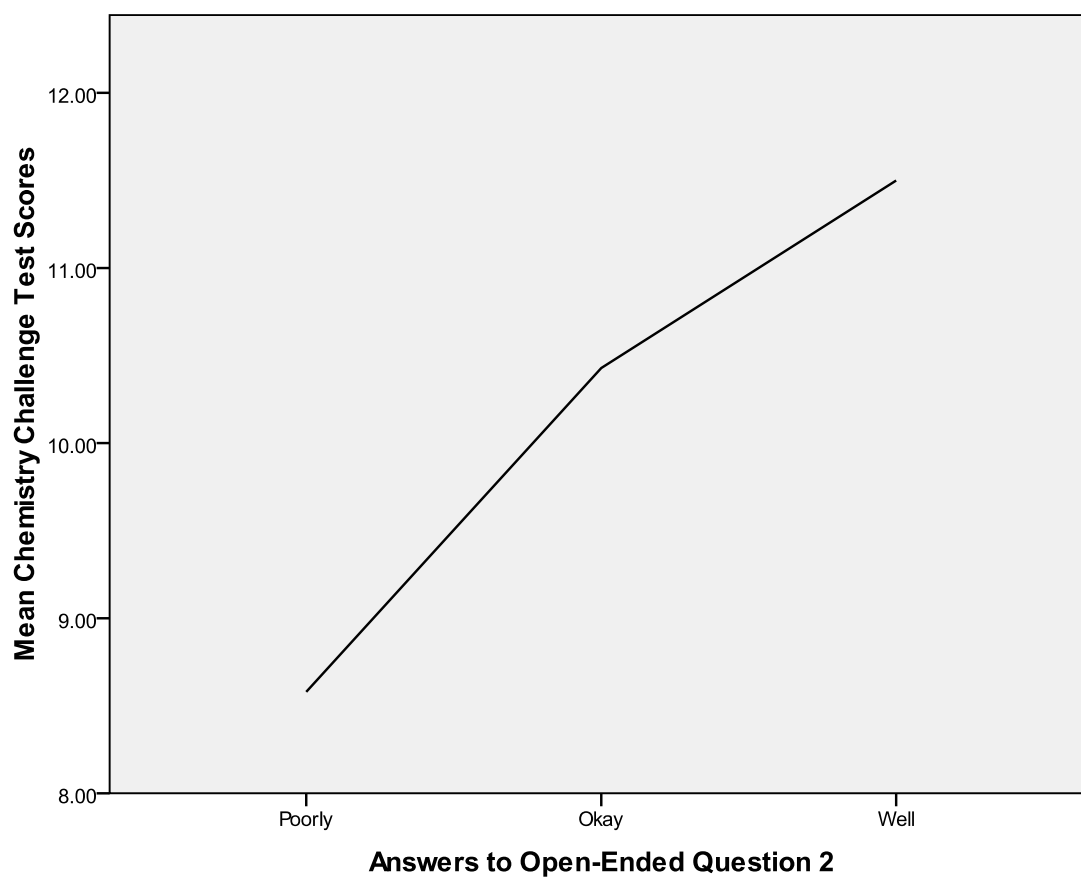


Figure 1

Open-Ended Question 2 Answers Compared to Mean Chemistry Challenge Test Scores

Legend: Even though there was not a significant difference in mean chemistry test scores between students' answers to Post-Hoc Question 2, a positive trend in means could be seen.

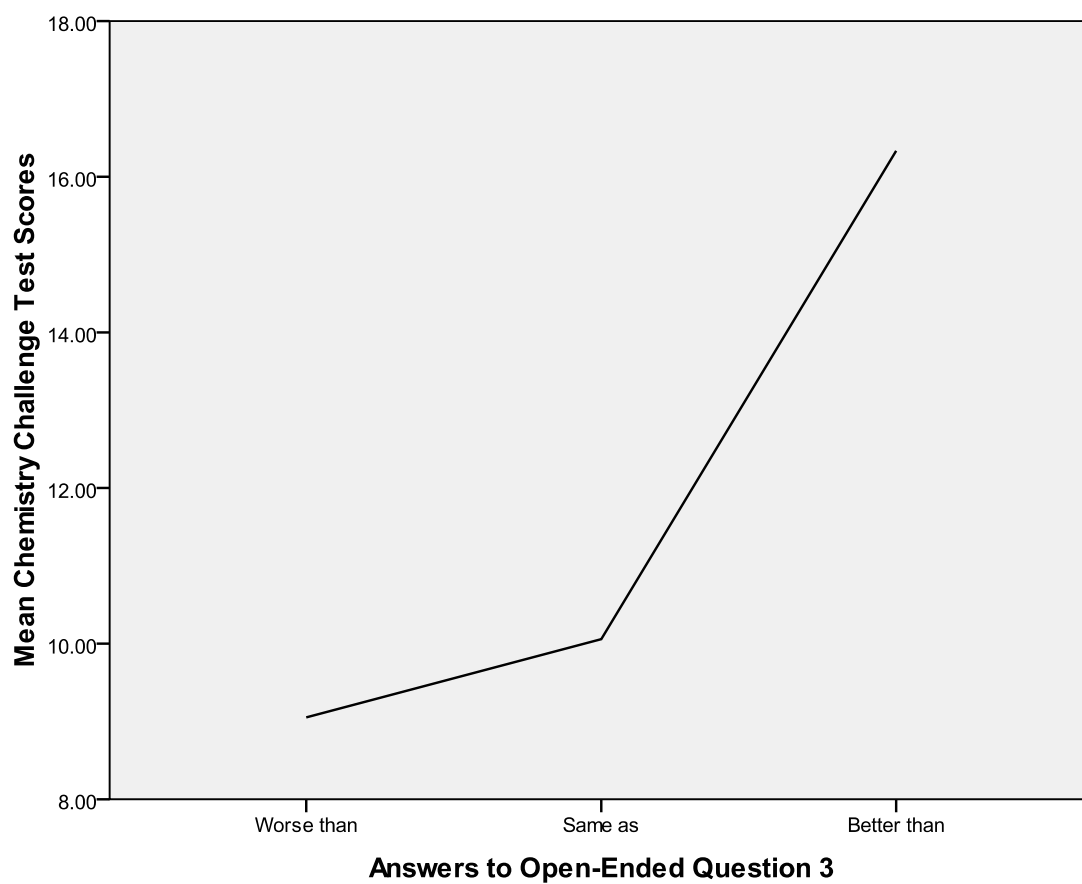


Figure 2

Open-Ended Question 3 Answers Compared to Mean Chemistry Challenge Test Scores

Legend: Similar to the trend for Question 2, a positive trend can be seen between mean chemistry test scores and answers to Open-Ended Question 3.

APPENDICES

Appendix A: IRB Approval Forms



Social/Behavioral IRB – Expedited Review Approval Notice

NOTICE TO ALL RESEARCHERS:

Please be aware that a protocol violation (e.g., failure to submit a modification for any change) of an IRB approved protocol may result in mandatory remedial education, additional audits, re-consenting subjects, researcher probation suspension of any research protocol at issue, suspension of additional existing research protocols, invalidation of all research conducted under the research protocol at issue, and further appropriate consequences as determined by the IRB and the Institutional Officer.

DATE: April 22, 2009
TO: Dr. Michael Nussbaum, Educational Psychology
FROM: Office for the Protection of Research Subjects
RE: Notification of IRB Action by Dr. Paul Jones, Co-Chair
Protocol Title: **Stereotype threat's effect on women's achievement in chemistry: The interaction of achievement goal orientation for women in science and allied health science majors**
Protocol #: 0902-3020

This memorandum is notification that the project referenced above has been reviewed by the UNLV Social/Behavioral Institutional Review Board (IRB) as indicated in Federal regulatory statutes 45 CFR 46. The protocol has been reviewed and approved.

The protocol is approved for a period of one year from the date of IRB approval. The expiration date of this protocol is April 21, 2010. Work on the project may begin as soon as you receive written notification from the Office for the Protection of Research Subjects (OPRS).

PLEASE NOTE:

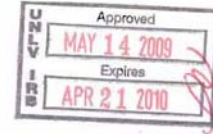
Attached to this approval notice is the **official Informed Consent/Assent (IC/IA) Form** for this study. The IC/IA contains an official approval stamp. Only copies of this official IC/IA form may be used when obtaining consent. Please keep the original for your records.

Should there be *any* change to the protocol, it will be necessary to submit a **Modification Form** through OPRS. No changes may be made to the existing protocol until modifications have been approved by the IRB.

Should the use of human subjects described in this protocol continue beyond April 21, 2010, it would be necessary to submit a **Continuing Review Request Form** 60 days before the expiration date.

If you have questions or require any assistance, please contact the Office for the Protection of Research Subjects at OPRSHumanSubjects@unlv.edu or call 895-2794.

Office for the Protection of Research Subjects
4505 Maryland Parkway • Box 451047 • Las Vegas, Nevada 89154-1047
(702) 895-2794 • FAX: (702) 895-0805



Social/Behavioral IRB – Expedited Review Modification Approved

NOTICE TO ALL RESEARCHERS:

Please be aware that a protocol violation (e.g., failure to submit a modification for any change) of an IRB approved protocol may result in mandatory remedial education, additional audits, re-consenting subjects, researcher probation suspension of any research protocol at issue, suspension of additional existing research protocols, invalidation of all research conducted under the research protocol at issue, and further appropriate consequences as determined by the IRB and the Institutional Officer.

DATE: May 19, 2009
TO: Dr. Michael Nussbaum, Educational Psychology
FROM: Office for the Protection of Research Subjects
RE: Notification of IRB Action by Dr. J. Michael Stitt, Chair *msl*
Protocol Title: **Stereotype threat's effect on women's achievement in chemistry: The interaction of achievement goal orientation for women in science and allied health science majors**
Protocol #: 0902-3020

The modification of the protocol named above has been reviewed and approved.

Modifications reviewed for this action include:

- Procedures are changed to include completion of the Supplemental Compensation form for UNLV student employees and International Students to meet IRS requirements.

This IRB action will not reset your expiration date for this protocol. The current expiration date for this protocol is April 21, 2010.

Should there be *any* change to the protocol, it will be necessary to submit a **Modification Form** through OPRS. No changes may be made to the existing protocol until modifications have been approved by the IRB.

Should the use of human subjects described in this protocol continue beyond April 21, 2010, it would be necessary to submit a **Continuing Review Request Form** 60 days before the expiration date.

If you have questions or require any assistance, please contact the Office for the Protection of Research Subjects at OPRSHumanSubjects@unlv.edu or call 895-2794.

Office for the Protection of Research Subjects
4505 Maryland Parkway • Box 451047 • Las Vegas, Nevada 89154-1047



Appendix B: Recruitment Letter/Email

WOMEN IN SCIENCE RESEARCH STUDY!

Would you like to participate in a research study to help us learn more about motivation and women in science?

I am doing a research study for my doctoral dissertation focusing on motivation and women who are taking science courses. Women who are enrolled in CHEM 121 and/or 122 are optimal participants for this study as you are just beginning your college careers. I could really use your help.



Purpose of the study

The purpose of this study is to investigate if women enrolled in a basic science course which requires a strong math foundation such as freshman inorganic chemistry (CHEM 121/122) show similar achievement in chemistry and similar patterns of motivational achievement goal orientations as those seen in current research across the nation?

Motivational and achievement goals are perspectives that students have in their engagement with task performances. Students bring to the activity, lesson, or classroom, different goals which may result in different outcomes. Motivation can be used to describe an individual's perspective in a wide variety of activities from athletics and sports to business and leadership, academics, arts, and music, etc. The goals that individuals have provide a foundation for their learning experience or activity.

In this study I want to investigate how women define their motivation goal orientations; what motivates them to learn subjects in school – particularly college chemistry. Studying motivation and achievement goals may provide insight to help recruit more women into science-oriented majors and retain them in science careers.

Research Study Procedure

If you are interested in participating, you will be asked to come a session where you will fill out a set of questionnaires, as well as take a short chemistry test. The test is aligned with the subjects taught in college chemistry. Although we want you to do your best on the chemistry test, your score will not impact any of your classes at UNLV nor will any of your information be given to anyone else on campus.

The questionnaires should take about 30 minutes to complete while the chemistry exam should take about 30 minutes. Most students finish in less than 45 minutes. None of your personal information will be published or disclosed other than through group statistics.

After completion of the study you will receive compensation for your time in the form of a gift card to a local coffee shop or the UNLV Bookstore.

If you are interested in being a participant or if you have any questions, please contact me.

Title of Study: Motivational/Achievement Goals and Chemistry Achievement in Women

Investigator(s): Janice M. Conway-Klaassen, Dr. E. Michael Nussbaum

Contact Phone Number: 702-895-1315, 702-895-2665

Email: janice.klaassen@unlv.edu , nussbaum@unlv.nevada.edu

Sessions: Call or email to sign up for one of these sessions - (directions will be posted to rooms)

Monday July 13th **10am – 11:00am BHS 210 OR 1:00 – 2:00pm BHS 134**

Thursday July 23rd **10am – 11:00am BHS 134 OR 1:00 – 2:00pm BHS 134**

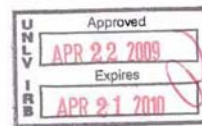
Friday July 24th **10am – 11:00am BHS 210 OR 1:00 – 2:00pm BHS 130**

Please contact me by email to let me know when you will attend – or just show up!

Thanks !!

Appendix C: Informed Consent Form

RECEIVED
MAY 05 2009



INFORMED CONSENT

Department of Educational Psychology

TITLE OF STUDY: Motivational/Achievement Goals and Chemistry Achievement in Women

INVESTIGATOR(S): Janice M. Conway-Klaassen, E. Michael Nussbaum

CONTACT PHONE NUMBER: 702-895-1315; 702-895-0665

Purpose of the Study

You are invited to participate in a research study. The purpose of this study is: To investigate if women enrolled in a basic science course which requires a strong math foundation such as freshman inorganic chemistry (CHEM 121/122) show similar achievement in chemistry and similar motivational/achievement goal orientations as those seen in current research across the nation.

Motivational and achievement goals are perspectives that students have in their engagement with task performances. Students bring to the activity, lesson, or classroom, different goals which may result in different outcomes. Motivation can be used to describe an individual's perspective in a wide variety of activities from athletics and sports to business and leadership, academics, arts, and music, etc. The goals that individuals have provide a foundation for their learning experience or activity.

Participants

You are being asked to participate in the study because you are enrolled in an inorganic chemistry course (CHEM 121/122) at UNLV.

Procedures

If you volunteer to participate in this study, you will be asked to do the following: Fill out a series of questionnaires (30 minutes) and take a short chemistry test (30-60 minutes). In addition, a few volunteers will be asked to participate in a summary interview after completion of the surveys, questionnaires and testing. None of your personal information will be published or disclosed other than through group statistics.

Benefits of Participation

There *may not* be direct benefits to you as a participant in this study. However, we hope to learn about some of the motivational issues facing women in basic science courses.

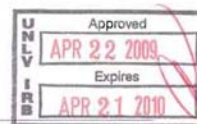
Risks of Participation

There are risks involved in all research studies. This study may include only minimal risks. You may be uncomfortable answering some of the questions in the surveys, however all information will be kept strictly confidential.

Participant Initials _____

RECEIVED

MAY 05 2009



TITLE OF STUDY: Motivational/Achievement Goals and Chemistry Achievement in Women

Cost /Compensation

There will be no financial cost to you to participate in this study. The study will take approximately one and a half (1½) up to a maximum of two (2) hours of your time. You will be compensated for your time in the form of a gift certificate (\$10) to a local coffee shop or bookstore.

Contact Information

If you have any questions or concerns about the study, you may contact Janice M. Conway-Klaassen at (702) 895-1315 or Dr. Michael Nussbaum at (702) 895-2665. For questions regarding the rights of research subjects, any complaints or comments regarding the manner in which the study is being conducted you may contact **the UNLV Office for the Protection of Research Subjects at 702-895-2794.**

Voluntary Participation

Your participation in this study is voluntary. You may refuse to participate in this study or in any part of this study. You may withdraw at any time without prejudice to your relations with the university. You are encouraged to ask questions about this study at the beginning or any time during the research study.

Confidentiality

All information gathered in this study will be kept completely confidential. No reference will be made in written or oral materials that could link you to this study. All records will be stored in a locked facility at UNLV for 3 years after completion of the study. After the storage time the information gathered will be destroyed.

Participant Consent:

I have read the above information and agree to participate in this study. I am at least 18 years of age. A copy of this form has been given to me.

Signature of Participant

Date

Participant Name (Please Print)

Participant Note: Please do not sign this document if the Approval Stamp is missing or is expired.

Participant Initials _____

Appendix D: Domain Identification Survey for Mathematics and Chemistry

The following questions ask about your thoughts about yourself and the subject areas of Chemistry and Math. Remember, there are no right or wrong answers. Just answer as accurately as possible for you.

PART 1

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

- If you strongly agree with the statement, place a √check or “X” in box 5.
- If you strongly disagree with the statement, place a √check or “X” in box 1.
- Otherwise, place a √check or “X” in one box between 1 and 5 that best describes you.

1 Strongly Disagree	2 Disagree	3 Neither Agree or Disagree	4 Agree	5 Strongly Agree
---------------------------	---------------	-----------------------------------	------------	------------------------

	1	2	3	4	5
1. I learn things quickly in Chemistry classes.					
2. Mathematics is one of my best subjects.					
3. Chemistry is one of my best subjects.					
4. I get good grades in Chemistry.					
5. I have always done well in Math.					
6. I'm hopeless in Chemistry classes.					
7. I get good grades in Math					
8. I do badly in tests of Mathematics.					

PART 2

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

- Place a \checkmark or “X” in box 5 if the statement is very much like you.
- Place a \checkmark or “X” in box 1 if the statement is not at all like you.
- Otherwise, place a \checkmark or “X” in one box between 1 and 5 that best describes you.

1 Not at All	2	3 Somewhat	4	5 Very Much
-----------------	---	---------------	---	----------------

	1	2	3	4	5
1. How much do you enjoy Math-related subjects?					
2. How much do you enjoy Chemistry-related subjects?					
3. How likely would you be to take a job in a Math-related field?					
4. How much is Math to the sense of who you are?					
5. How important is it to you to be good at Math?					
6. How important is it to you to be good at Chemistry?					

PART 3

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

- Place a \checkmark or “X” in box 5 if you think you are excellent in this topic compared to other students.
- Place a \checkmark or “X” in box 1 if you think you do poorly in this topic compared to other students.
- Otherwise, place a \checkmark or “X” in one box between 1 and 5 that best describes you.

1 Very Poor	2 Poor	3 About the Same	4 Better than Average	5 Excellent
----------------	-----------	------------------------	-----------------------------	----------------

	1	2	3	4	5
1. Compared to other students, how good are you at Math?					
2. Compared to other students, how good are you at Chemistry?					

Appendix E: Chemistry Challenge Test

Part 1: Questions 1-18 of the Chemistry Challenge exam were selected from the following web site with permission:

<http://antoine.frostburg.edu/chem/senese/101/index.shtml>

The correct answer for each question is indicated by an asterisk (*)

1. To the correct number of significant figures, $(5.0 \times 10^{-5}) \div (2.00 \times 10^{-2})$ is
 - a. 2.50×10^4
 - b. 2.5×10^{-4}
 - c. 2.5×10^{-3} *
 - d. 2.50×10^{-3}
 - e. none of these
2. The density of mercury is 13.6 g/mL. How many pounds does one quart of mercury weigh? (1 pound is 454 g, 4 quarts are 3.7854 liters.)
 - a. $(13.6 \times 454 \times 1000 \times 3.7854)/4$
 - b. $(13.6 \times 1000 \times 3.7854)/(454 \times 4)$ *
 - c. $(13.6 \times 3.7854)/(454 \times 1000 \times 4)$
 - d. $(13.6 \times 1000 \times 4)/(454 \times 3.7854)$
 - e. none of these
3. Which of the following measurements are equivalent?
 - a. 10 micrograms and 0.1 milligrams
 - b. 10 nL and 1000 pL
 - c. 40 km and 40000 cm
 - d. 0.01 mm and 1×10^{-3} cm*
 - e. all of these
4. Which of the following lists of elements contains an alkaline earth metal, a transition metal, and a halogen, respectively?
 - a. Rb, Y, I
 - b. Ba, Fe, Br*
 - c. Sr, Zr, Xe
 - d. K, Ni, O
 - e. none of these
5. The average atomic mass of Cl is 35.453. About 75% of all Cl atoms are ^{35}Cl . If there is only one other common isotope, it is most likely to be
 - a. ^{36}Cl
 - b. ^{37}Cl *
 - c. ^{38}Cl
 - d. $^{35.453}\text{Cl}$
 - e. none of these

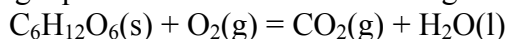
6. Which of the following compounds are correctly named?

- a. $\text{Cu}(\text{HCO}_3)_2$, copper (II) bicarbonate*
- b. $\text{Ba}_3(\text{PO}_4)_2$, tribarium diphosphate
- c. AgNO_3 , argentum nitrate
- d. SrSO_3 , strontium sulfate
- e. FeCO_3 , iron (III) carbonate

7. Cadmium (II) selenide can be used to prepare solutions which have almost any color in the spectrum. If the selenide ion is Se^{2-} , the formula for this compound is

- a. CdSe_2
- b. Cd_2Se
- c. CdSe^*
- d. Cd_2Se_2
- e. Cd-II-Se
- f. none of these

8. The following equation for the combustion of glucose is NOT balanced:



If the equation is balanced with smallest integer coefficients, the coefficient of $\text{O}_2(\text{g})$ is

- a. 6*
- b. 9
- c. 12
- d. 15
- e. 18
- f. none of these

9. Which of the following is the net ionic equation for the reaction between hydrochloric acid and potassium hydroxide?

- a. $\text{HCl}(\text{aq}) + \text{KOH}(\text{aq}) = \text{H}_2\text{O}(\text{l}) + \text{KCl}(\text{aq})$
- b. $\text{K}^+(\text{aq}) + \text{Cl}^-(\text{aq}) = \text{KCl}(\text{aq})$
- c. $\text{K}^+(\text{aq}) + \text{Cl}^-(\text{aq}) = \text{KCl}(\text{s})$
- d. $\text{K}^+(\text{aq}) + \text{Cl}^-(\text{aq}) + \text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) = \text{H}_2\text{O}(\text{l}) + \text{K}^+(\text{aq}) + \text{Cl}^-(\text{aq})$
- e. $\text{H}_3\text{O}^+(\text{aq}) + \text{OH}^-(\text{aq}) = 2 \text{H}_2\text{O}(\text{l})$ *
- f. $\text{HClO}_4(\text{aq}) + \text{KOH}(\text{aq}) = \text{H}_2\text{O}(\text{l}) + \text{KClO}_4(\text{aq})$

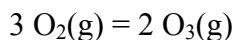
10. Ammonium nitrate is used as a nitrogen fertilizer. What is the percentage of nitrogen by mass in ammonium nitrate? (The atomic weights of N, H, and O are 14.0, 1.0, and 16.0, respectively.)

- a. 35.4%
- b. 17.5%
- c. 42.9%
- d. 35.0%*
- e. none of these

11. A compound of sulfur and oxygen is 40.1% sulfur by mass. What is the empirical formula for the compound? The atomic weights of S and O are 32.07 and 16.00, respectively.

- a. SO_4
- b. SO_2
- c. S_2O_3
- d. SO_3^*
- e. none of these

12. Oxygen gas is converted to ozone gas by exposure to intense ultraviolet light:



If an ultraviolet source converts oxygen to ozone with a 4% yield, how many grams of oxygen are required to produce 1 gram of ozone? The atomic weight of O is 16.

- a. 1.5 g
- b. 0.04 g
- c. 1 g
- d. 25 g*
- e. 0.06 g

13. When the wavelength of electromagnetic radiation is increased by 10 percent, the frequency of the radiation

- a. increases by 10 percent
- b. decreases to 10/11 its original value*
- c. decreases by 10 percent
- d. is unchanged

14. When the frequency of electromagnetic radiation is increased by 10 percent, the energy of one photon of the radiation

- a. is unchanged
- b. decreases by 10 percent
- c. increases by 10 percent*
- d. decreases to 10/11 its original value

15. The Pauli Exclusion Principle:

- a. states that electrons have wavelike behavior
- b. limits the number of electrons that can occupy an orbital to 2*
- c. says that all electrons in an orbital have the same set of 4 quantum numbers
- d. states that the m_s quantum number must have values of -1/2 or +1/2

16. Which of the following electron transitions in a hydrogen atom results in the greatest release of energy?

- a. $n=3$ to $n=4$
- b. $n=6$ to $n=4^*$
- c. $n=4$ to $n=6$
- d. $n=7$ to $n=5$
- e. $n=1$ to $n=3$

17. Isoelectronic atoms and ions have identical

- a. electron affinity
- b. ionization energy
- c. electron configuration*
- d. radii
- e. effective nuclear charge

18. Effective nuclear charge is

- a. the charge on the nucleus experienced by an electron when the shielding effect of other electrons is accounted for*
- b. the amount of energy required to remove an electron from the valence shell when the atom is in a gaseous state
- c. the energy released when a proton is added to the nucleus
- d. the number of electrons that penetrate the nucleus

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Office of the General Counsel

November 24, 2008

Janice Conway-Klaassen
University of Nevada, Las Vegas
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4505 Maryland Parkway
Las Vegas, NV 89154-3021

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4. You will assume responsibility for the analyses and conclusions of your study and, other than acknowledgment of the source of the questions, you will not use ETS's name in such a way as to imply participation in or responsibility for your research.

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6. Please send a copy of your research results to Lorraine Carmosino, Educational Testing Service, Office of General Counsel, Rosedale Road, Mail Stop 04-C, Princeton, NJ 08541 when available.
7. This Agreement shall be considered null and void if not signed and returned within 30 days of the date of this letter.

If the above arrangements are satisfactory, please sign both copies of this letter, and return one to me at the above listed address.

Sincerely,

Lorraine Carmosino

Lorraine Carmosino
Permissions Administrator

cc: C. Hawkes

ACCEPTED AND AGREED TO:

BY: 

TITLE: *Educational Psychology Graduate Student*

DATE: *11/25/08*

Permission to use Dr. Senese's questions

Frederick Senese
06:04AM

Friday, May 29, 2009

From: "Frederick Senese" <FSenese@frostburg.edu>
To: <janice.klaassen@unlv.edu>

Hi Janice,

Yes, you have my permission to use the questions.

From: janice.klaassen@unlv.edu
Sent: Wed 5/27/2009 1:30 PM
To: Frederick Senese
Subject: Permission to use Questions

Hello Dr. Senese,

I am in process of designing my research for my dissertation study and would like permission to use several of the chemistry questions you have posted on the Internet in my study. The questions would be used as part of a challenge exam for students after being placed in a "text anxiety" situation called stereotype threat. The questions would be published within the dissertation but not in any subsequent journal articles. Proper acknowledgements will be given.

The specific questions involved are:

From Practice Exam IA Questions: 1-6, 10-12, 14-17, 19-20, 23

<http://antoine.frostburg.edu/chem/senese/101/101-sample-exam-1a.shtml>
<<http://antoine.frostburg.edu/chem/senese/101/101-sample-exam-1a.shtml>>

From Practice Exam IIIA Questions: 2, 3, 6, 8-9, 13-15

<http://antoine.frostburg.edu/chem/senese/101/101-sample-exam-3a.shtml>
<<http://antoine.frostburg.edu/chem/senese/101/101-sample-exam-3a.shtml>>

Thank you in advance for this consideration.

Jan K
Janice M. Conway-Klaassen

Appendix G: Achievement Goal Questionnaire-Revised

The following questions ask about your study habits in your chemistry course (CHEM 121/122). Remember, there are no right or wrong answers. Just answer as accurately as possible for you. Use the scale below to answer the questions.

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

- Place a \checkmark or “X” in box 5 if you strongly agree with the statement.
- Place a \checkmark or “X” in box 1 if you strongly disagree with the statement.
- Otherwise, place a \checkmark or “X” in one box between 1 and 5 that best describes you.

1 Strongly Disagree	2	3	4	5 Strongly Agree
---------------------------	---	---	---	------------------------

	1	2	3	4	5
1. My aim is to completely master the material presented in this chemistry class.					
2. I am striving to do well compared to other students.					
3. My goal is to learn as much as possible.					
4. My aim is to perform well relative to other students.					
5. My aim is to avoid learning less than I possibly could.					
6. My goal is to avoid performing poorly compared to others.					
7. I am striving to understand the content of this chemistry course as thoroughly as possible.					
8. My goal is to perform better than the other students.					
9. My goal is to avoid learning less than it is possible to learn.					
10. I am striving to avoid performing worse than others.					
11. I am striving to avoid an incomplete understanding of the course material.					
12. My aim is to avoid doing worse than other students.					

Appendix H: Demographic Survey

For the purposes of our research study we ask that you complete the following brief questionnaire.

- Male ☐ Female ☐
- Age: _____
- Please select the racial category or categories with which you most closely identify.

Check as many as may apply.

☐ Asian or Pacific Islander ☐ Black Non-Hispanic

☐ Hispanic/Latino ☐ Native American or Alaskan Native

☐ Non-Resident Alien ☐ White Non-Hispanic

☐ Other ☐ Do Not Wish to Disclose

- SAT or ACT Math Score: _____
- Current College Major: _____
- Highest Math Course Completed & Grade
 - Course _____ Grade _____
- Current College GPA: _____
- Current Standing at UNLV:
 - ☐ Freshman ☐ Sophomore
 - ☐ Junior ☐ Senior

Appendix I: Stereotype Threat Condition Instructions

DO NOT TURN THIS PAGE UNTIL YOU HAVE READ THESE INSTRUCTIONS!!

PLEASE READ THESE INSTRUCTIONS CAREFULLY, INITIAL BELOW THEN BEGIN

Thank you again for participating in our research project. It is important that I remind you to do your best on this exam as our research depends on our participants doing their best. You can check your score at the end of the exam but please note that your performance on this exam will have no bearing on your current course grade and your scores and answers to all questionnaires will be kept completely confidential.

If you are ready to begin the exam, please INITIAL the place below stating that you have read and understand these instructions. Once you have completed this, turn the page to begin the exam portion of the research study. You will have 20 minutes to complete the test. After you have finished the exam section, please complete the motivational goal survey. Good luck and thanks again for helping with this research study.

I have read and understand the above instructions: _____
Initial here

**DO NOT TURN THIS PAGE UNTIL YOU HAVE READ THESE
INSTRUCTIONS!!**

**PLEASE READ THESE INSTRUCTIONS CAREFULLY, INITIAL BELOW
THEN BEGIN**

Thank you again for participating in our research project. It is important that I remind you to do your best on this exam as our research depends on our participants doing their best. You can check your score at the end of the exam but please note that your performance on this exam will have no bearing on your current course grade and your scores and answers to all questionnaires will be kept completely confidential.

This test has previously shown some gender differences at other universities with most women scoring lower than men, supporting the concept that women do not do as well on chemistry exams as men. Even though we are not evaluating your personal ability on these tasks, we want to ask you to try your best to perform well on these tasks. We would like to see how our university population compares with other universities around the country.

If you are ready to begin the exam, please INITIAL the place below stating that you have read and understand these instructions. Once you have completed this, turn the page to begin the exam portion of the research study. You will have 20 minutes to complete the test. After you have finished the exam section, please complete the motivational goal survey. Good luck and thanks again for helping with this research study.

I have read and understand the above instructions: _____
Initial here

**DO NOT TURN THIS PAGE UNTIL YOU HAVE READ THESE
INSTRUCTIONS!!**

**PLEASE READ THESE INSTRUCTIONS CAREFULLY, INITIAL BELOW
THEN BEGIN**

Thank you again for participating in our research project. It is important that I remind you to do your best on this exam as our research depends on our participants doing their best. You can check your score at the end of the exam but please note that your performance on this exam will have no bearing on your current course grade and your scores and answers to all questionnaires will be kept completely confidential.

Most people find these questions very challenging but this test has never shown any gender bias in performance at other universities with women scoring at the same levels as their male counterparts in all previous testing. Even though we are not evaluating your personal ability on these tasks, we want to ask you to try your best to perform well on these tasks. We would like to see how our university population compares with other universities around the country.

If you are ready to begin the exam, please INITIAL the place below stating that you have read and understand these instructions. Once you have completed this, turn the page to begin the exam portion of the research study. You will have 20 minutes to complete the test. After you have finished the exam section, please complete the motivational goal survey. Good luck and thanks again for helping with this research study.

I have read and understand the above instructions: _____
Initial here

Appendix J: Debriefing Statement



Stereotype threat and student motivation

The information you originally read about the purpose of this study was only partially correct. The study does want to look at student motivational aspects for women in science courses but we also wanted to examine a factor called stereotype threat. This concept was purposely kept out of the description so that you would not be aware that it was involved. Awareness in advance may have altered your responses. It was therefore important for us not to disclose the entire purpose of the study in advance. This debriefing statement will now describe the complete purpose of the research study.

What is stereotype threat and how does it impact performance?

“Stereotype threat is being at risk of confirming, as self-characteristic, a negative stereotype about one's group” (2006). When an individual is placed in a situation or condition where the safety of their personal identity is threatened by negative characteristics of their group identity, they are susceptible to stereotype threat. Stereotype threat effect (STE) is in turn described as the detrimental effect on performance outcomes of any group of individuals when placed in a situation which can activate a negative stereotype about their group and therefore the situation is a threat to their individual identity. Stereotype threat seems to interfere with the individual's ability to demonstrate acquired knowledge resulting in decreased performance outcomes on task assessment or on academic achievement testing when placed in a stereotype threatening environment.

Stereotype threat and its potentially negative impact on individual assessment becomes a significant concern in the arena of academic achievement testing and perceptions of intellectual ability of students. Standardized testing is used extensively throughout American culture for assessment and ranking of individuals from situations as diverse as academic achievement in schools and college admission procedures to workplace hiring methods for employment.

In this study, the stereotype threat was that some women were told in their instructions women do not perform as well as men on this chemistry test. That is not true. These questions were taken from a standardized testing format that has consistently demonstrated a lack of gender bias (Educational Testing Services, Graduate Record Exam GRE®).

By discovering how stereotype threat impacts affective factors which in turn influence learning, we may be able to describe interventions that could minimize stereotype threat's impact on achievement.

Three factors were investigated in this study:

1. Stereotype threat inducement: We were attempting to recreate a negative achievement effect when female students are placed in a situation where societal stereotypes might impede their performance on exams. Many people think that women are less capable in math and many women feel threatened when they are asked to complete a math test or a task related to math skills. This study attempted to discover whether or not stereotype threat could be demonstrated in a math-related topic, such as chemistry.
2. The second factor we investigated in this study was whether or not the effects of stereotype threat could be nullified by stating in advance that the chemistry test had not shown any gender bias in the past. Previous studies with women and math tests have shown this effect. If we can find a mechanism to prevent the effects of stereotype threat we may be able to increase the recruitment and retention of women in math and science careers.
3. The final portion of the study was to see if women demonstrate different motivational goals if they were placed in a stereotype threat condition or a nullified stereotype threat condition compared to women in the control condition. In a similar study, Smith found that women in a stereotype threat condition were more likely to endorse performance-avoidance goals instead of performance-approach or mastery goals compared to women who were not placed in a stereotype threat condition.

Motivational and achievement goals are perspectives that students have in their engagement with task performances. Students bring to the activity, lesson, or classroom, different goals which may result in different outcomes. Motivation can be used to describe an individual's perspective in a wide variety of activities from athletics and sports to business and leadership, academics, arts, and music, etc. The goals that individuals have provide a foundation for their learning experience or activity.

In summary this study attempted to demonstrate the effects of stereotype threat in the math-related subject area of chemistry, using women who are enrolled in a basic science course (science and allied health science majors), across three stereotype threat conditions. At the same time I investigated whether there are significant differences in achievement goal orientation between the stereotype threat conditions.

If after reading the complete nature of this study you no longer wish to participate, please tell Ms. Janice Conway-Klaassen and all of your paperwork will be removed from the study.

If you are interested in learning more about the results of the study, you may contact Ms. Janice Conway-Klaassen, at 895-1315 or via email at janice.klaassen@unlv.edu. We appreciate your contribution to this research.

Appendix K: Post-Hoc Interview Questions

1) Did the test instructions affect your ability to do well on this test? If the instructions did affect you, what was different and why?

2) How do you think you did on the testing portion of the study?

3) Do you think you as well as other participants? If you feel you did better or worse than others on the testing portion, would you please explain?

4) Do you think that most people believe women can do as well as men on science-based tests? Can you provide a reason/rationale for your opinion?

5) What do you believe? Why?

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