ABSTRACT

SCHNEIDER, JENNIFER SHIELDS. Impact of Undergraduates' Stereotypes of Scientists on their Intentions to Pursue a Career in Science. (Under the direction of Mary B. Wyer).

Women remain disproportionately underrepresented in certain science, technology, engineering, and math (STEM) majors and occupations. Stereotypes of scientists may be contributing factors in this phenomenon. However, this relationship has not yet been empirically examined. This is partly because of the dearth of literature addressing the stereotypes of scientists and the absence of measures aimed at capturing more current concepts of science and scientists. This research investigates whether undergraduates' stereotypes of scientists predict their intentions to pursue a career in science. Further, the study examines whether or not STEM academic majors are likely to have intentions of pursuing a science career and whether or not this relationship varies by gender. A sample of 1639 undergraduates, from diverse universities and academic majors, took a ten-minute online survey assessing their stereotypes of science, academic major, and intention of pursuing a science career. Using hierarchical and multiple regression analyses, findings indicated students' agreement with scientists' Professional (e.g. whether scientists are perceived as technically competent and logical) and Interpersonal Competencies (e.g. whether scientists are perceived as cooperative and family oriented) positively predicted their science career intentions. The analysis did not indicate that these relationships vary significantly by gender. Further, a one-way ANOVA found undergraduates with STEM majors had significantly higher agreement with scientists' Interpersonal Competencies than non-STEM majors.

Impact of Undergraduates' Stereotypes of Scientists on their Intentions to Pursue a Career in Science

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A dissertation submitted to the Graduate Faculty of
North Carolina State University
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

Psychology

Raleigh, North Carolina

3/29/2010

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BIOGRAPHY

Jennifer Schneider was born on June 5, 1979 in Rochester, Michigan. After graduating from Troy High School in 1997, she attended Miami University in Oxford, Ohio, graduating in May of 2001 with a bachelor's degree in psychology. From 2001 to 2003 she worked as a project manager in a marketing research firm in Cincinnati, Ohio. In August of 2003, she moved to Raleigh, North Carolina to begin graduate studies in psychology at North Carolina State University. For the first half of her graduate studies, Jennifer worked as a project manager for the National Science Foundation Industry University Cooperative Research Center's Program Evaluation Project under the direction of Dr. Denis O. Gray. She received her master's of science in March of 2007. For the past several years, Jennifer has pursued her doctorate of philosophy while working as a project manager for the National Science Foundation Stereotypes Laboratory under the direction of Dr. Mary Wyer.

ACKNOWLEDGEMENTS

I would like to thank the following people for their help and support that have allowed me to complete this degree:

My advisor and chair, Mary Wyer, gave me guidance and assistance throughout the entire process. Not only was she supportive and wise, but she also provided friendship and much-needed laughs along the way. For helping me through this process, I am eternally grateful to her and will always value her not only as a mentor and teacher, but also as an admirable person and friend.

My committee members, Shevaun Neupert, Denis Gray, & Sylvia Nassar-McMillan, provided helpful guidance and feedback and I was so fortunate to have committee members with such expertise and dedication balanced with openness and kindness. I am truly fortunate to have had the opportunity to learn from such esteemed faculty members and people who I respect deeply.

My mentors, peers, and officemates, Laura, Cassandra, Drew, Diane, Felysha, Anisha, Amy, Lindsey, Andrea, Beth, Deena, and Seth, helped immensely with their mentoring, advice, friendship, and support. Also, my partner, Blayne, and friends, Jennifer, Mara, Anita, kept me sane and were always willing to listen, encourage, or distract when necessary. I would not have made it through graduate school without them and will be forever grateful for their friendship and warmth.

Most importantly, I would like to thank my mom, dad, and brother. I have no words to convey the gratitude I have for all their unconditional love and support. I am so privileged for each day they are in my life.

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INTRODUCTION

Forecasts for U.S. science and engineering employment over the coming decade promise a continued upward trend in the number of jobs available. Science, technology, engineering, and math (STEM) occupations are increasing by a 6.7% annual average growth rate, striking in comparison to the 1.6% annualized rate for the overall labor force, and more than triple the growth rate of other occupations (National Science Board, 2008). STEM employment has expanded by 60% since 1983 (National Science Board, 2008). Further, a quarter (26%) of the current STEM degree holders are nearing retirement age (age 50 or older) (National Science Board, 2008), which will provide even more job opportunities to current STEM students.

Behind this somewhat rosy picture is the specter of concern over the declining number of foreign-born students and the U.S.'s ability to generate candidates to fill these jobs. As of 2000, the U.S. STEM workforce was composed of 18% foreign-born individuals. This percentage has steadily grown since 1980; however, recently the number has declined due to increasingly competitive educational systems in countries such as Germany, France and the UK (National Science Board, 2008). These notable figures should alert us to the potential gap in the number and expertise of available STEM graduates and the growing demand for their services. The U.S. should address this situation as one of its primary responsibilities, with a sense of urgency that ensures universities are producing the talented leaders in science and engineering fields that will sustain our national global competitiveness at the same time as other countries are growing and prospering in STEM development.

In March 2008, Microsoft co-founder Bill Gates, a prominent and widely respected businessman and philanthropist, went in front of Congress to urge the nation to take action in order to address the U.S.'s decreasing global competitiveness and shortage of talent in science and engineering fields. He proposed to remedy this problem through advances in math and science education and immigration policy changes aimed at attracting more foreign workers and international students (MSNBC, 2008). Although immigration barriers to science and engineering labor force growth in the United States are an important issue, Gates overlooked a population closer to home: women. An alternative and pragmatic recommendation would be to focus on recruiting and retaining a diverse portion of the nation's women, encouraging them to pursue STEM majors and occupational fields. The inclusion of greater numbers of women in STEM occupations would expand the hiring pool, boost competition, bring diverse perspectives on issues with a coincident influx of new ideas, and subsequently improve the quality of hires for any given position (Bostic, 1999).

Gender Distribution of STEM Occupations and Academic Majors

Despite the underutilization of women in the nation's talent pool for STEM, the percentage of women receiving STEM bachelor degrees and entering STEM occupations has increased over the years. Women now account for half of all STEM bachelor's degrees and women in nonacademic STEM occupations have grown from representing 12% of nonacademic STEM occupations in 1980 to over a quarter (26%) in 2005 (National Science Board, 2008). However, this is still far from ideal since women are still considerably underrepresented in comparison to their standing as almost half (46%) of the total U.S. labor force (BLS, 2008). Further, this does not necessarily paint an accurate picture of women's representation within STEM since women's representation varies when examining a specific STEM occupational field and/or academic major.

Examining the distribution of STEM occupations in 2006, women were represented well in psychology (65%), biological/medicine sciences (49%), social sciences (46%), and STEM health related occupations (66%) (NSF/SRS, 2009). However, despite being slightly over half (50.8%) of the population (U.S. Census Bureau, 2000), women accounted for only 28% of physical scientists (and only 13.8% of physicists), 26% of computer scientists, 20% of earth scientists/geologists/oceanographers, and 11.5% of employed engineers in 2006 (NSF/SRS, 2009).

A possible explanation for this occupational gender segregation is that the occupational disciplines have yet to catch up with the changing gender dynamics of STEM education. However, although women are earning a growing number of STEM bachelor degrees (National Science Board, 2008), the gender segregation among STEM majors is even more prominent than in occupational gender segregation. Although more women than men are enrolled in college (57%) and earn the majority (58%) of all bachelor's degrees (NCES, 2008), academic majors are still segregated by gender. For instance, women earn less than a quarter of the bachelor's degrees in some STEM fields (NSF/SRS, 2009). In 2006, women accounted for a fifth of the bachelor's degrees in computer science (20%), degrees in physics (21%), and degrees in engineering (20%) (NSF/SRS, 2009). On the other hand, women were well represented in the number of bachelor degrees awarded for psychology (77%), biological sciences (62%), and social sciences (54%) (NSF/SRS, 2009). In order to do a better job of recruiting women in STEM majors and careers, a deeper understanding needs to be achieved as to the reasons why women are disproportionately represented in STEM occupations and undergraduate majors.

Explanations for STEM Gender Segregation

So what accounts for the gender segregation within science occupations and academic majors? The answer is complex and multifaceted. For instance, research has supported explanations that vary, including less academic preparedness (Ethington & Wolfe, 1988; Frehill, 1997; Hartman & Hartman, 2008; Tinto, 1987, 1993), an unwelcoming university climate (Allan & Madden, 2006; Handelsman et al., 2005; Whitt, Edison, Pascarella, Nora, & Terenzini, 1999), feelings of inadequacy (Hartman & Hartman, 2008), lack of encouragement (Hartman & Hartman, 2008), experiences of discrimination and prejudice (Ancis, Sedlacek, & Mohr, 2000; Cabrera, Nora, Terenzini, Pascarella, & Hagedorn, 1999), and lack of interest (Jacobs, Finken, Griffin, & Wright, 1998; Meinster & Rose, 2001; Morgan, Isaac, & Sansone, 2001). Most likely, a variety of interrelated reasons combine to explain gender segregation within science fields. One reason that is thought to be associated with several of these explanations involves societal and individual perceptions, or stereotypes, of scientists and the field of science (Eccles, 1994). Most of the research studies examining explanations for the underrepresentation of women in certain STEM fields presume a stable, coherent, and shared understanding of what a scientist does and what kind of person a scientist is; however, this image is only assumed, and not empirically demonstrated, to be a stable, common image of a scientist across different populations (Jacobs et al., 1998; Meinster & Rose, 2001; Morgan et al. 2001).

The Image of Science and Scientists

Pre-1980s research studies capture the image of a scientist as invariably that of a white male with a lab coat and glasses (Beardslee & O'Dowd, 1961; Chambers, 1983). Mead and Metraux's (1957) study having respondents write an essay describing a scientist found scientists to be perceived as the following:

> The scientist is a man who wears a white coat and works in a laboratory. He is elderly or middle aged and wears glasses. He is small, sometimes small and stout, or tall and thin. He may be bald. He may wear a beard, may be unshaven and unkempt. He may be stooped and tired. He is surrounded by equipment: test tubes, bunsen burners, flasks and bottles, a jungle gym of blown glass tubes and weird machines with dials. The sparkling white laboratory is full of sounds: the bubbling of liquids in test tubes and flasks, the squeaks and squeals of laboratory animals, the muttering voice of the scientist. He spends his days doing experiments. He pours chemicals from one test tube into another. He peers raptly through microscopes. He scans the heavens through a telescope. He experiments with plants and animals, cutting them apart, injecting serum into animals. He writes neatly in black notebooks (Mead & Metraux, 386–387).

Follow-up research expands on the original depiction of a scientist being a man in a lab coat working in a laboratory to include such variations as being white, wearing a bow tie, having wild hairdos, etc. (Chambers, 1983; Rahm & Charbonneau, 1997; Sumrall, 1995; Thomas, Henley, & Snell, 2006). Further, the image of a scientist has included personality and work characteristics that are both positive and negative. Positive stereotypical characteristics associated with scientists include them being dedicated, intelligent, altruistic, and driven; on the other hand, scientists are also described with negative characteristics as being uninteresting, dull, secretive, demanding, dangerous, unsociable, isolated from the world, and working long hours (Chambers, 1983; Lips, 1992; Mead & Metraux, 1957; Rahm & Charbonneau, 1997; Sax, 2001). These images of scientists possibly represent and perpetuate our stereotypes of who can be a scientist and be successful in science and, further, may act as a filter suggesting who is appropriate or best fitted to the occupation.

The field of science is perceived as masculine, hard, complex, demanding, and difficult (Colley, 1995; Hughes, 2002; Lips, 1992). It is not unreasonable to think this traditional image may be changing with the increasingly diverse workforce and expanding cultural influences. For instance, media images from popular TV shows such as NCIS, CSI, and Bones not only depict women working successfully as scientists, but also present scientists as cool, sexy, and young, working in environments other than just laboratories. However, the few research studies examining images of scientists show this stereotype persisting throughout the 1980s, 1990s, and into this decade. The dearth of literature on modern stereotypes of scientists, and the relationship between stereotypes and career choice, makes it difficult to examine and analyze current impressions of scientists and how these stereotypes may impact students' plans to enter STEM fields.

Purpose Statement

It is of timely and critical interest to examine why women, over half in numbers of the prospective labor pool, may or may not choose to pursue a career in science. The purpose of this research is to establish whether stereotypes of scientists are a determining factor in whether a person intends to pursue a career in science. Further, it is critical to examine how undergraduates' academic major is related to future intentions to enter science careers and whether or not this relationship is different for females and males. This research study will explore how undergraduates' stereotypes of scientists and their academic major are related (or not related) to intentions of pursuing a science career.

LITERATURE REVIEW

One of the principal concerns in examining the underrepresentation of women in fields such as engineering and physical science is the decreasing interest and/or intention of pursuing a career in science fields (Meinster & Rose, 2001). Students' perceived "interestingness" of a career is an important factor in predicting one's desire to pursue an occupational field (Jacobs et al., 1998). The career aspiration of an adolescent, which is determined early on, is the strongest predictor of a person's later career (Holland, 1985; Schoon, 2001) and a key predictor in whether a woman chooses to pursue STEM graduate programs (Sax, 1996).

Of substantial import is the fact that interest in science fields is shown to already be diverging by gender in middle school. Females in middle school report more interest in rainbows, healthy eating, AIDS, weather, and animal communication, while males report more engineering and physical science based interests (x-rays, computers, cars, atoms, atomic bombs) (Jones, Howe, & Rua 2000). Further, high school girls expressed interest and likelihood of a career in biology or health science more often than in physical science (e.g. physics) (Jacobs et al., 1998). This trend occurred even when ability was held constant. For example, male high school seniors who were talented in math (scored in the 90th percentile on the math section of the

SAT) were more likely than females who were equally talented in math to indicate a desire to pursue a science field (Matyas & Dix, 1992).

Differences between males and females' interest in science fields and desire to pursue a career in science are illustrated further by a study conducted by Morgan et al. (2001). Undergraduates rated the interestingness of, and likelihood of pursuing a career in physical and mathematical science, among other fields. Results showed males were more likely than females to find physical and mathematical science careers interesting and were significantly more likely than females to indicate they wanted to enter a career in the physical or mathematical sciences. Females were more likely than males were to indicate interest in educational, medical and social service careers. Females also indicated interpersonal work as a career goal more often than males, while male undergraduates rated high pay and status work as career goals more often than females (Morgan et al.).

This lack of interest in science fields is of noteworthy concern since even those with early interest in science may eventually lose interest. This may be particularly true for females. Mau (2003) found eighth grade male students with STEM career aspirations were more likely to enter STEM employment than female students with STEM career aspirations. In order to better understand why women with initial interest in science are not entering STEM careers, the next section will discuss STEM academic majors' relationship to entering a science career.

Academic Major's Impact on Intentions of Pursuing a Science Career

Although it may be implied that academic major is a preliminary gateway to one's future career, there is actually little empirical research to support this direct relationship. The major of an undergraduate has been found to have a significant impact on career opportunities, occupational rewards, job satisfaction, and job stability (Snyder, Dillow, & Hoffman, 2008). It is assumed students who select an academic major in a science discipline chose their major in order to gain a skill set for their future occupation (Shauman, 2006). However, this is not necessarily true. For example, the National Survey of College Graduates found that nearly half (45%) of respondents from a wide range of majors indicated they did not, or only partially, worked in a field related to their academic major (Robst, 2007).

"…[O]ccupational decisions are conditioned on educational decisions and experiences. That is, to some extent the choice of college major structures the career opportunities that will be available to a graduate upon labor market entry" (Shauman, 2006, pp. 581-582). The relationship between major and related career field is furthermore thought to vary by type of academic division. Academic majors that teach general skills (such as liberal arts) do not necessarily predict an occupation in the liberal arts field; however, those academic majors that teach very specific skills (such as skills associated with a computer science major) would be more likely to predict a career in computer science (Robst, 2007; Shauman, 2006). Thus, it is believed that those who chose STEM academic majors, and consequently chose to learn skills very specific to their major, had initial intentions of pursing a career in STEM so they could apply those skills accordingly.

However, one reason to question whether a STEM academic major predicts an undergraduate's career in STEM is the discrepancy between the percentages of women with a STEM academic major and those in a corresponding STEM occupation. Although STEM job opportunities are growing much faster than other job fields, female undergraduate STEM attrition rates from STEM majors to science careers are of particular concern (National Science and Technology Council, 2000). Women obtain half of all STEM bachelor's degrees (National Science Board, 2008), but account for only 26% of STEM occupations (NSF/SRS, 2009), a statistic suggesting women are underrepresented in STEM occupations in relation to the number of bachelor's degrees they are awarded. For instance, women account for 62% of biological science, 21% of physics, and 20% of engineering bachelor degrees, but account for only 49% of biological/medicine science occupations, 13.8% of physicists, and 11.5% of engineers (NSF/SRS, 2009). This inconsistency between academic major and occupational choice suggests that the representation of women in STEM majors is not a reliable predictor of the gender division in STEM occupations.

This statistical discrepancy has been previously explained by using the classic metaphor of a "leaky pipeline," which illustrates the loss of talented women at each stage of STEM education and career advancement (Sonnert & Holton 1995). The percentage of women decreases as the level of education or career prestige increases. Within science occupations, women, regardless whether they have a BA, MS or PhD in a STEM field, are twice as likely as men to leave their field (Preston, 2004; Seymour & Hewitt, 1994) (see Ceci, Williams, & Barnett [2009] for a framework discussing why women are underrepresented at the top of math intensive fields).

The gender difference in attrition exists not only in STEM occupations, but also in academic majors. Seymour and Hewitt's (1997) research on academic majors and attrition found female undergraduates were 2.5 times more likely to leave a STEM major than males. This was again confirmed in a research study by Steele, James, and Barnett (2002) who determined women in a predominately male dominated academic major (such as math, science, and engineering) are more likely to contemplate changing their major than females in female dominated majors. Further, Sax (1996) conducted a nine year longitudinal study of college freshmen (1985-1994), the results of which showed males with a bachelor's degree in physical sciences, math, and computer sciences were more likely to enter graduate school than females with degrees in those fields. Women therefore become less and less represented throughout the pipeline's various educational and career stages.

It is thought the relationship between major and occupation may vary by gender. The attrition of women in STEM raises concerns as to why the U.S. is losing more talented women than men who had initial interest in STEM fields (Seymour & Hewitt, 1997). Women are less likely than men to enter STEM careers (Xie & Shauman, 2003) and are more likely to select majors that are traditionally female dominated (Lackland, 2001). The STEM fields where women are well-represented (i.e. biological sciences), are also the fields producing graduates who are less likely to pursue a career in STEM compared to those in physics or engineering fields (male-dominated) (Xie & Shauman, 2003). Further, women continue to be more likely than men to enter stereotypically female jobs, even those with bachelor's degrees in male dominated fields (Shauman, 2006). In college, for example, women tend to choose different subjects than men and even if they chose the same field of study, they enter different types of occupations (Shauman, 2006). These gender differences in academic major may be one factor in the underrepresentation of women in certain STEM occupational fields. However, occupational choice does not take place within a cultural vacuum. Pervasive messages about who can and cannot be scientists, and about the skills needed in scientific occupations, may also guide students' occupational choices.

Perceptions of Scientists

Students' declining interest in science fields, as discussed above, is plausibly related to their perceptions of scientists. Across multiple educational stages, female students were significantly more likely than males to hold a negative perception of science (Catsambis, 1995; Sax, 2001; Weinburgh, 1995). Eighth and ninth grade students were more likely to want to associate with a peer interested in humanities than with a peer interested in science (Hannover & Kessels, 2003), suggesting the existence of negative stereotypes regarding scientists and science. Since stereotypes of scientists are theorized to influence one's career choices (Eccles, 1994), this raises compelling concerns regarding perceptions of science fields and those who work in them. Understanding the current stereotypes of scientists will aid in determining how perceptions vary from population to population and how these stereotypes may be related to subsequent career choice.

Obtaining a clear assessment of the current stereotypes of scientists is actually quite difficult due to the scarcity of literature. A further complication is that there are only a few measurements that are designed to capture these stereotypes: Draw-A-Scientist Test (DAST) (Chambers, 1983), Image of Science and Scientists Scale (ISSS) (Krajkovich & Smith (1982), and Women in Science Scale (WiSS) (Erb & Smith, 1984). These scales were developed several decades ago and will be discussed, along with their strengths and weaknesses, in detail later. As these measures may or may not be accurately capturing contemporary stereotypes there is a need to explore undergraduate stereotypes of scientists using current items and statistical procedures. By extension, the current link between stereotypes and career intentions has yet to be investigated so remains only an assumption.

Impact of Stereotypes on Occupational Choice

> As long as the culture maintains the traditional views of what is appropriate for girls (bread-making, knitting, or sewing) and for boys (mending bicycle tires, changing a fuse, or playing with motors) and conveys the ideas that science is more appropriate for boys than for girls, it is likely that adolescents will bring these values and attitudes to school (Jones et al., 2000, p. 190).

Distinct stereotypes of scientists may be related to one's intentions of pursuing a career in science. Endorsing stereotypes of scientists is thought to limit how a person perceives one's options within science fields. This assumption is based on the growing number of interventions, programs, and fellowships designed to recruit and retain undergraduates in the field (see Marra & Bogue [2004] for a review of literature). One example of such an effort is the National Science Foundation's Research Experiences for Undergraduates (REU) program (NSF REU, 2009). This is an activity aimed at providing undergraduates with research experience by pairing them with a small group (10 people) and sponsoring faculty member to work on a specific research project. The program has grown to include opportunities in 19 STEM fields that are available at many universities across the nation. National Science Foundation's Summer Scholars Internship Program (SSIP) is another example of a program aimed at exposing undergraduates to the diversity within science (ethics, research, education, policies, etc.). This ten-week program aspires to encourage students to pursue either a higher education or career in science (NSF Office of Integrative Activities, 2009).

National Science Foundation alone provides several other programs (NSF, 2009), a sample of which includes: Undergraduate Discoveries of Education (DOE), Cooperative Research Centers (CRCs), Science and Technology (STC) Internship programs, Freshmen Intervention Program (FIP), NSF Course, Curriculum, and Laboratory Instruction (CCLI) Program, ADVANCE, Research Internships of Science of the Environment (RISE) Programs, and the Freshmen Science Undergraduate Laboratory Internship Program (SULI). Also, NSF's Program for Gender Equity funds various K-16 interventions, projects, and fellowships aimed at increasing the number of women in STEM fields (Rosser & Lane, 2002). There is a suggested convergence of opinion based on these growing numbers of programs and internships that there is a benefit to exposing students to the wide array of career options within science fields. It is assumed this exposure erodes students' restrictive stereotypes of scientists and leaves them with an enhanced view of the many career options within science fields.

Occupational choice is theorized to be largely based on one's perceptions of an occupational field, the employees working in that field, and the skills thought to be required (Diekman & Eagly, 2000; Eagly, 1987). Individuals pursue occupations that will fit, or complement, their perceived skills and/or activities. Thus, a career field is thought to be pursued if it is perceived as congruent with an individual's own self-image. Conversely, people avoid fields they perceive as being incongruent with their self-image (McLean & Kalin, 1994).

People's beliefs regarding their skills and personality characteristics have been shown to predict their academic major (Astin, 1993) and shape career ambitions (Astin & Sax, 1996; Morgan et al., 2001; Schoon, 2001). There are several well-known and well-cited career theories that rely on the fit between individuals' self-image and their perceptions of a profession to explain a person's occupational choice. Holland's vocational choice theory (1985) is a well-known theory that matches a person's personality to an occupational environment. This theory asserts that individuals choose occupations where employees are perceived as similar to themselves. This is also true in a college environment. The fit of students with their academic environment predicts their success in that major (Feldman, Smart, & Ethington, 1999). Further, academic environments reward students' abilities and interests that are congruent with their environment (Smart, Feldman, & Ethington, 2000).

Gender differences in career aspirations can be explained by socialization and learned sex-typed values and roles (Eccles, 1994; Jacobs, 1989; Xie & Shauman, 1997). Eccles's (1987/1994) model of occupational sex segregation through socialization also emphasizes how students' perception of their skills predicts their career choice; however, this theory also recognizes gender socialization's role in a career decision. Individuals' perceptions of a field as gendered impacts their perceived ability to achieve in that field. Eccles's model maintains that occupational gender segregation occurs due to males' and females' initial beliefs regarding occupational field characteristics being impacted by gender socialization of expectations, values, and interests. The socialization by gender reinforces stereotypes about gender differences in skills and abilities (Eccles, 1994) and, consequently, impacts one's perceptions of one's own skills and abilities in relation to gender (Correll, 2001, 2004). Since most people are aware of careers considered socially "appropriate" for men (science, engineering, computer programming) and women (helping professions, elementary teaching, nursing) (Morgan et al., 2001), individuals' self-image develops in relation to their gender stereotypes of males' or females' skills or abilities.

Multiple career theories support the notion that occupational choice is largely based on the fit between one's self-perception and one's stereotypes of a career field. Specifically, this has been shown to be true for science careers. For example, students aspiring to have a career in science were more likely than their peers to rate their scientific ability as above average (Schoon, 2001). This is problematic for STEM fields since women have lower self-efficacy in STEM fields at all levels of education and career development (Ethington & Wolfe, 1988; Mau, 2003; also see findings presented above by Beyer, Rynes, Perrault, Hay, & Haller [2003] & Matyas & Dix [1992]). Lent, Brown, and Hackett's (1994) Social-Cognitive Career Theory (SCCT) explains how self-efficacy (in addition to behaviors, outcome expectations, and goals) is a strong predictor of students' career interests (Lent, Larkin, & Brown 1989), career aspirations in science related fields (Lent, Brown, & Larkin, 1986), and even persistence of students in STEM academic majors (Lent, Brown, Schmidt, Brenner, Lyons, & Treistman, 2003). Since women have lower self-efficacy in STEM fields, women are more likely than men to envision a larger discrepancy between the skills they have and the skills that their occupational stereotypes indicate are required to be successful.[1]

Diekman and Eagly's (2000) dynamic social role theory asserts occupational stereotypes are based on gender, which they argue causes a self-selection into occupations with traditional gender roles. These occupational stereotypes are then integrated and interpreted into one's ability to see oneself in that occupation. If women do not have an image of a scientist that is congruent with their own image, they are then less likely to see themselves entering science fields. It is as if the image of a white male wearing glasses and a lab coat is acting as a filter for who may enter the field.

Occupations that are either female or male dominated perpetuate gender typing (Cejka & Eagly, 1999; White et al., 1989). A person that is not of the dominant gender in an occupation will then be less likely to enter that field (Glick, Wilk, & Perreault, 1995). For example, students, especially female students, perceive math as being a masculine field (Hill, Pettus, & Hedin, 1990; Hyde, Fennema, & Lamonm, 1990); thus, females would not be as likely to enter a math-oriented career. Those women who strongly self identify by gender are less likely to enter disciplines perceived as male gendered than those women with more neutral self-identification. This would suggest why females, particularly those with a high female identity, might not enter fields perceived as male dominated, such as engineering.

[1] These career theories would also explain why males are underrepresented in English fields since they rated their self-efficacy lower than females in the school subject English (Matyas & Dix, 1992).

Not only are male or female dominated occupations gender stereotyped, but college students also associate masculine and feminine traits with certain occupations (White & White, 2006). Cejka and Eagly (1999) found respondents perceived being successful in a female dominated occupation required feminine traits and attributes, while being successful in a male dominated occupation required masculine traits. Additionally, occupations considered prestigious were thought to need masculine traits and attributes in order to be successful. This exemplifies how occupations are associated with masculine and feminine traits even beyond the occupational skills required, but also based on the field's perceived prestigious levels and earnings. Stereotypes acquired through multiple and interrelated paths are notoriously difficult to modify (McGlone & Aronson, 2007; Schneider, 2004). The next section will provide a framework that will explain how stereotypes are formed, maintained, tweaked, strengthened, and how they may even change.

A Framework for Understanding Stereotypes: Formation, Maintenance, and Change

In order to examine the major constructs of the proposed study, such as the relationship between stereotypes and a person's intentions of pursuing a career in science, it is of interest to briefly review the literature addressing how stereotypes develop and are maintained. Multiple, interrelated stereotype theories will be presented within a framework that will provide a foundation leading to a deeper understanding of how stereotypes impact a person's decision to enter into a STEM major or career. This framework also demonstrates the convoluted and multifaceted system of stereotype formation and provides a glimpse into how complicated it is to alter or amend a stereotype in order to positively affect one's intention of pursuing a science career.

The following review of major perspectives of stereotype formation and functioning will be presented through a holistic approach to understanding the major constructs of the study using three interrelated conceptual stereotype frameworks: sociocultural, psychodynamic, and cognitive (Ashmore & Del Boca, 1981). Although from the early 1980s, this framework is unique in its ability to look at stereotype factors as complements of one another as opposed to in competition with one another. In each orientation, more modern theories and stereotype factors will be presented to deepen the understanding between stereotypes and the underrepresentation of women in certain STEM fields. Strengths and weaknesses of each alignment will be discussed in order to demonstrate the need to use the three orientations as a complementary and systematic framework to understanding stereotypes.

Sociocultural Orientation

The sociocultural orientation, by far the most dominant in research and the one favored among sociologists, examines stereotypes as consensual beliefs that originate from society (Ashmore & Del Boca, 1981; Hamilton & Sherman, 1994). Through socialization in one's culture, individuals formulate and maintain stereotypes (Hamilton & Sherman, 1994). The norms and roles of the culture dictate group members' behavior and treatment of others, while groups in turn rely on these norms and roles as justification for their actions (Ashmore & Del Boca, 1981). These social norms are learned and reinforced through rewards, punishments, and a series of cultural influences: peer group influence, ethnicity, religion, media, education, etc. (Hamilton & Sherman, 1994). By adhering to what the culture dictates, the stereotype is perpetuated by society and socialization experiences (Ashmore & Del Boca, 1981; Hamilton & Sherman, 1994). This orientation asserts stereotypes are primarily socially learned through culture and group membership, and are then used as a justification for group differences. Two primary theories that support a sociocultural orientation of stereotypes include social role theory and gender schema theory. These theories are particularly relevant for gender stereotypes and are therefore presented in relation to perceptions of male and female stereotypes.

Social Role Theory

One well-cited theory within the sociocultural framework is Eagly's (1987) *social role theory,* which suggests that stereotypes are shaped by the roles people assume in society. The model of social role theory (Eagly, 1987) states that the occupational gender division (Cejka & Eagly, 1999; Glick et al., 1995; Pratto, Stallworth, Sidanius, & Siers, 1997; White & White, 2006) leads to gender stereotypes, which in turn produce gender differences in social behavior (Eagly, 1987). Stereotypes become associated with gender since gender is perceived in relation to the occupational role (Eagly & Steffan, 2000). Thus, the visibility of men and women in gender typical occupations produce gender stereotypes based on their perceived social roles. Individuals then enter these social roles, which are segregated by groups, based on the role's expectations and skills.

In particular, gender stereotypes occur through perceptions that men succeed in roles that typically require skills thought to be agentic (e.g. assertive, independent) and women in roles usually requiring skills considered communal (e.g. nurturing, expressive) (Eagly, 1987). Therefore people associate gender (instead of only the occupation) with the traits and skills needed to pursue certain occupations (Eagly & Steffan, 2000). Consequently, the qualities that are required of a task become stereotypic of women (communal traits) and men (agentic traits) depending on who is seen in the role (Lips, 2005). For example, the scarcity of women visible as mathematicians would explain why women have more negative attitudes about math (Eccles, 1987). In summary, society's division of labor generates stereotypes and the more a culture endorses the segregation of roles (and this can be extended to other entities such as ethnic groups), the more gender stereotypes will influence social expectations and behavior (Eagly, 1987).

The primary strength of social role theory is explaining how gender stereotypes are established and perpetuated. This theory effectively addresses the formation of stereotypes through society's occupational roles and demonstrates how gender stereotypes are continued through their impact on perceived skills and expectations of these roles (Vogel, 2003). However, the theory does not satisfactorily address the circular pattern of the cause and effect of the stereotypes or their accuracy. It is unclear if occupational division by gender is the foundation for gender stereotypes and expectancies or if it could also be the result of stereotypes. One is left to wonder how people are prepared for or recruited into these roles.

Gender Schema Theory

Gender schema theory (Bem, 1983) states that gender stereotypes are a result of gender-schematic processing. The theory combines social learning and cognitive-development theory (Baron & Bryne, 1994; Basow, 1992), which are both rooted in the sociocultural framework based on their reliance on social reinforcements. However, this theory derives from the cognitive orientation as well. Schemas are developed from an early age and proceed to guide the individual's perceptions of these events and their subsequent behavior (Lips, 2005). Since culture emphasizes the importance of differentiating by gender (e.g. bathrooms, food, colors, toys, sports, jobs), children also divide their perceptions accordingly (Bem, 1983). Perceptions are then categorized into schemas according to cultural definitions of gender (Bem, 1983). The strength of an individual's gender schema is determined by the emphasis placed on gender dichotomy during their development. The more an individual's environment emphasizes gender, the more likely they are to organize their schemas by gender and act accordingly (a self-fulfilling prophecy) (Lips, 2005). In summary, gender schema theory implies gender schemas are created through the perceptions and emphasis of societal gender divisions. These schemas can in turn lead to gender stereotypes, gendered behaviors, and gender identity (Bem, 1983).

The gender schema theory primarily supports the sociocultural foundation of stereotyping through emphasis on social learning; however, it also recognizes the importance of cognitive elements in stereotyping. By focusing on gender differences in a child's development and environment, the theory is able to account for individual variation of stereotypes. Despite the theory's strengths, this theory cannot be easily extended to account for stereotype maintenance or change. Particularly, it fails to adequately explain how an individual's social or cultural stereotypes may change throughout the lifespan (Biernat, 1991).

Sociocultural Stereotype Factors Influencing Intentions of a Science Career

There are two main sociocultural orientation stereotype factors that are probable influences on one's intentions of pursuing a science career.

Chilly or Hostile Environment

The first sociocultural orientation stereotype factor that may impact one's intentions of entering a science career is physical environment. Tinto (1997) theorizes that student departure from an academic major is a reflection of that campus community. Undergraduate women are likely to be negatively impacted by their environment by the end of their first year if they are a part of a "chilly" environment (Whitt et al., 1999). The longer women stay in a climate that is "chilly," the stronger the negative impact will be on their personal gains (Whitt et al., 1999). It is estimated that 25% of undergraduate women experience chilly, or unpleasant, environments while in college (Allan & Madden, 2006).

Oswald and Harvey (2001) found that a "hostile" environment could constitute something as small as a posted cartoon depicting traditional gender stereotypes. They examined the impact of stereotype threat and hostile environments on women's math performance. Undergraduate women (n=72) were randomly assigned to be in a hostile environment or non-hostile environment. The hostile environment included a cartoon in the experiment's room (before participants arrived) of a girl struggling to answer an easy math problem, while a boy easily solves a difficult math problem. The non-hostile environment was given the statement "men and women perform equally on this test" during the instructional portion of their test.

Results found the women in the hostile environment condition were less likely to answer math problems (in favor of verbal problems) than those in the non-hostile environment. Further, the females in the hostile condition performed worse on the math problems that they did choose to answer than those females in the control group with no cartoon posted (Oswald & Harvey, 2001).

The likelihood of being in a hostile environment increases for females in male dominated academic areas. This is particularly evident among STEM majors. Undergraduate females in male dominated fields (math, physical science, and engineering) reported higher levels of discrimination, hostility, and feeling threatened than did women in non-male dominated areas or men in either male or female dominated areas (Steele & Barnett, 2002). A "chilly" campus climate that includes discrimination and expectations of failure creates and also fosters support for negative stereotypes or overgeneralizations about a profession and encourages students to avoid academic areas that may be perceived as chilly, such as science fields.

Women entering or in the workforce continue to encounter various levels of chilly environments due to discrimination in hiring practices, opportunities, and evaluations. For instance, male scientists were more likely to be hired (by both men and women employers) than women scientists with identical resumes and job applications (Steinpress, Anders, & Ritzke, 1999). Women encounter further barriers when attempting to utilize opportunities to advance their careers. Wenneras and Wold (2001) examined gender differences in fellowship awards for a prestigious international fellowship program. Findings suggest women had to be 2.5 times more productive to be considered as equally productive to a similarly qualified male.

Even those women who do enter male dominated careers continue to experience a hostile environment. Women in male dominated fields experience harsher evaluations and are held to higher ability standards than men once in the field (Biernet & Kobrynowicz, 1997; Swim, Borgida, Maruyama, & Myers, 1989). Heilman et al. (2004) examined women in male gender-typed jobs and found women who were perceived as successful were significantly more likely to be rated by both men and women as unlikable than men who were perceived similarly successful. Further, if women employees were perceived as being hired to fulfill diversity quotas, they were evaluated much more negatively (Heilman et al.). These discriminatory practices exemplify the chilly or hostile environments women may encounter throughout their education, funding opportunities, job applications, and even performance evaluations.

Peer, Parent, and Teacher Influences

The influence of peers, parents, and teachers is the second source of sociocultural related stereotypes that may impact one's intentions of entering a career in science. First, peers or friends play a role in shaping one's stereotypes. Students adjust their stereotypes in order to conform to the beliefs of their peers (Izumi & Hammonds, 2007; Tan et al., 2001). Therefore, peer groups are likely to have similar stereotypes. If that group is non-supportive, peers can negatively impact an individual's interest in pursuing a science career path (Eisenhart & Holland, 1992).

Even after college, peer influence has been shown to play a role in one's career path. Sax (2001) found peer environment to be a significant predictor of undergraduate female science majors' decision to pursue a science related graduate degree. Positive and/or negative peer interactions and influences about science provoke one's stereotypes to conform more closely to those of one's peers.

In addition to the influence of peers, parents and teachers are influential in students' career decisions. The correlation between parents' perceptions of their child's abilities and their child's later career choice is a well-established finding in the literature (Maple & Stage, 1991; Mau, 2003; Sax, 2001). Since teachers and mothers perceive boys as better at math and girls better at reading (Llummis & Stevenson, 1990) and underestimate girls' and overestimate boys' math and science achievement (Correll 2001, 2004), it is not surprising women are underrepresented in science careers. Parents and teachers are sources of knowledge for students and inevitably have a significant influence on a student's self-image and perceived interests and abilities (Colbeck, Cabrera, & Terenzini, 2000). This stereotype literature has shown how these gendered stereotypes that are passed on to children impact their performance and inevitably their lack of desire to pursue a career that they do not see as congruent with their self-image.

Summary of the Sociocultural Orientation

The sociocultural orientation asserts that stereotypes are largely learned through one's environment and culture. Educational/occupational climate, peers, parents, and teachers account for a substantial part of a person's environment and, according to gender schema theory, stereotypes are socially learned through one's environment, making these factors a major influence on one's beliefs and decisions. The stereotypes and beliefs of one's environment are interrelated with a person's stereotypes and perceptions of gender divisions (e.g. what is appropriate for males vs. what is appropriate for females). Social role theory declares stereotypes, especially occupational stereotypes, are established by whom one sees in certain roles and who is considered as a group member. This perspective then suggests that an occupation's dominance by one gender is almost inevitably linked to stereotypes via environmental influences.

A strength of the sociocultural orientation is the acknowledgement that people are social beings; societal beliefs indisputably shape individual belief systems (Ashmore & Del Boca, 1981). The focus of this orientation is more reliant on one's environmental influences than on the individual, making this a particularly relevant approach when examining widely held stereotypes such as those involved with gender (Schneider, 2004). However, the sociocultural orientation assumes group beliefs will inevitably become individual beliefs, failing to adequately explain how exactly these stereotypes transfer (Ashmore & Del Boca, 1981).

Psychodynamic Orientation

Psychodynamic orientation to stereotypes, the preferred psychological orientation, focuses on intergroup relations, with an emphasis on outcomes (such as prejudice and discrimination). Stereotypes are of a secondary focus and are only relevant since they are associated with the impact on the individual (prejudice and/or personality) (Ashmore & Del Boca, 1981). This orientation derives from Freud's *psychoanalytic theory*, which stresses the importance of child development, and identification with the same sex parent, in the formation of stereotypes (Hamilton & Sherman, 1994; Lips, 1992, 2005). Psychoanalytic theory is based on identity development, which can be amplified in this orientation to encompass how individuals' identity shapes their stereotypes. Although psychoanalytic theory is partly the origin of the psychodynamic framework, it is of more interest to examine how the psychodynamic orientation views stereotypes as meeting personal needs through enhancing one's self-efficacy (achieving status, group belonging) by denigrating others with such defense mechanisms as projection, displacement, and scapegoats (Fein & Spencer, 1997; Hamilton & Sherman, 1994). A theory based on categorization will therefore be introduced instead of focusing on the traditional psychoanalytic theory.

Theory of Categorization

The categorization of groups is grounded in an individual's motivation to achieve or maintain a positive social identity and sense of self (Baron & Bryne, 1994; Schneider, 2004; Tajfel & Forgas, 2000). In order to do this, the individual relies on the categorization, identification, and comparison of groups. First, categories are developed based on a set of beliefs about that category (Schneider, 2004). Next, the identification with one of those categories prompts the creation of an "in-group" and "out-group." After identifying with the in-group, the individual becomes biased in favor of that group. Thus, when the in-groups and out-groups are compared, the individual perceives the in-group and out-group with exaggerated differences (Baron & Bryne, 1994; Haslam, Oakes, Reynolds, & Turner, 1999; Mackie, Hamilton, Susskind, & Rosselli, 1996; Tajfel & Forgas, 2000).

A person's self-efficacy is a factor in whether they perceive themselves as part of the in-group or out-group (Hamilton & Sherman, 1994), implying that there is a desire to view the in-group more favorably in order to view oneself more favorably (Fein & Spencer, 2000). The individual is likely to divide the groups emphasizing extreme contrasts, which causes situational factors that contribute to group differences to be ignored. This implies the individual typically overestimates group differences and underestimate groups' similarities, which is termed a self-serving bias or a fundamental attribution error (Fiske & Taylor, 1984; Pettigrew, 1979). The severe contrast between the in-groups and out-groups is the theory's foundation for stereotype development (Mackie et al., 1996; Macrae, Milne, & Bodenhausen, 1994). Therefore, stereotypes function to maximize one's self-efficacy by providing positive feedback to the self and to one's group and by justifying stereotypes and group divisions; however, as a result, one's self-efficacy would be further negatively impacted in relation to the out-group (Stangor, 1995).

Psychodynamic Stereotype Factors Influencing Intentions of a Science Career

The psychodynamic orientation is closely linked to an individual's self-efficacy in the field. According to the theory of categorization, students' self-efficacy would be an important factor in their choice of career. Female students in their later adolescence years are not as confident as male students in their likelihood of success and their abilities in physical sciences, math, and engineering (Catsambis, 1995; Correll, 2001; Eccles, Barber, Jozefowicz, Malanchuk, & Vida, 1999; Kahle & Rennie, 1993) yet express more self-efficacy in fields such as biological sciences and health (Eccles et al., 1999). Further, high school aged girls who rated themselves as having low competence in math were found to be more likely to select a non-science major than those females who rated themselves competent in math (Seymour & Hewitt, 1997). These findings would imply women's lower self-efficacy in certain fields would cause a perception of physical sciences, math, and engineering careers as the "out-group."

This trend continues even when controlling for ability. For instance, Correll (2001) found male fifth graders with the same math grades and test scores as females, expressed more self-confidence in math. However, this was not found to be true for verbal abilities so males are not just generally rating themselves as more competent than females. Further, Beyer, Rynes, Perrault, Hay, and Haller (2003) examined undergraduates enrolled in either a basic computer science course (primarily for non computer science majors) or a computer science course required for computer science majors (n = 56 [24 females, 32 males]). No significant differences were found between males' and females' quantitative ability, interest in computer science, knowledge of computer science, or attitudes toward computer science courses. Regardless, after controlling for ability, male computer science majors had more confidence than female computer science majors in their computer skills. Even more revealing, women computer science majors had less confidence in their ability than male non-majors. The authors speculate this may discourage women from majoring in computer science and their lack of confidence (despite being just as talented as their male peers) may be the reason women drop out of the computer science field (Beyer et al.).

Self-efficacy is a key psychological factor that helps to explain the current gender gap in certain STEM fields (Correll, 2001; Eccles et al., 1999). The theory of categorization asserts females who have lower self-efficacy than males about their ability in science fields would view science as the "out-group" (Tajfel & Forgas, 2000) and, consequently, not be as likely as males to pursue a science career (Hamilton & Sherman, 1994; Jacobs et al., 1998). This implies female students with low science self-efficacy would then perceive scientists negatively or with exaggerated stereotypes to highlight the differences between science and non-science groups. Thus, a possible gender difference may exist in students' stereotypes of scientists.

Summary of the Psychodynamic Orientation

Overall, the psychodynamic framework is able to account for motivational forces and psychological benefits that lead to the perpetuation of stereotypes. Stereotype development and functioning through the formation and maintenance of categorizations explains the motivation of individuals to form and use stereotypes. Stereotypes can result in diminished self-efficacy or a narrow view of the field of science; psychodynamic orientation asserts that scientists would then be categorized as an "out-group" and not be a likely career profession for those who have low self-efficacy in science fields. The impact of these stereotypes erodes one's confidence further or serves to limit one's career goals due the narrow view of the field. Thus, it is not surprising that females are less likely to want to pursue a career in science than males when they are underrepresented in those fields (Xie & Shauman, 2003). Self-serving motivations cause individuals to enhance their group status in order to intensify their self-efficacy for their in-group, but it also consequently causes diminishing self-efficacy for the perceived out-group. Thus, an individual's tendency to make fundamental attribution errors explains why a disproportionate number of stereotypes are negative (Schneider, 2004). In addition to explaining the reason for stereotyping, the psychodynamic framework is able to relate individuals' perceptions about social groups to their feelings and even behaviors toward these groups.

Despite these strengths, psychodynamic orientation does not provide a full explanation for the social functioning of stereotypes. This orientation ignores perceptual cognitive factors involved in intergroup relations. The development of perceptions of groups is discussed more in terms of groups as objects and it remains unclear why individuals identify with some groups and not others (Taylor, 1981). Further, this framework does not adequately explain the impact of social and cultural forces on stereotypes over time and various environments and even on one's group (Basow, 1992; Bem, 1983).

Cognitive Orientation

A cognitive orientation, the least established stereotype orientation until the past two decades when it has experienced a surge in popularity, takes the position that stereotypes function as cognitive tools that simplify and organize the environment in order to make it more manageable (Ashmore & Del Boca, 1981; Hamilton & Sherman, 1994; Macrae et al., 1994). Advocates of this viewpoint find it unnecessary to differentiate stereotypes from any other cognitive process or structure; however, they do note the increased likelihood of cognitive errors (Ashmore & Del Boca, 1981; Hamilton & Sherman, 1994). These errors occur because of an individual's limited cognitive capacity. A person's cognitive limitations inadvertently cause breakdowns to occur between one's cognition and perception. When this occurs, a systematic bias in the processing of information impacts the formulation of stereotypes and can produce inaccuracies (Ashmore & Del Boca, 1981; Fiske & Taylor, 1984).

A cognitive orientation to stereotyping focuses on the benefits stereotyping can offer to an individual's processing of information. Thus, social and group stereotypes are learned primarily in an attempt to reduce and simplify the amount of data one is receiving (Ashmore & Del Boca, 1981). Ideally, the *naïve scientist theory* should be the primary theory for a cognitive orientation to stereotypes (Fiske & Taylor, 1984). This theory assumes people are motivated to predict and control their environment; as a result, people become "naïve scientists" and slowly and accurately gather all the information needed before forming a logical, causal, and accurate perception. This theory is fatally flawed since there is extensive documentation of individuals having distorted perceptions (Diekman, Eagly, & Kulesa, 2002; Judd & Park, 1993; Stangor, 1995). A more plausible theory of how people make inferences is the *cognitive miser theory* (Fiske & Taylor, 1984).

Cognitive Miser Theory

In the view of the cognitive miser theory, people have limited cognitive capacity and/or are cognitively lazy. Individuals use the least amount of mental effort possible to process information. Thus, the cognitive miser theory focuses on satisfactory and speedy information instead of the accurate and thorough processing that the naïve scientist theory requires. Consequently, cognitive shortcuts such as heuristics and schemas are heavily relied upon to simplify and organize the information into manageable categories (Fiske & Taylor, 1984; Mackie et al., 1996). This theory then implies that people are looking, unconsciously or consciously, to confirm and support the categories they have created (Mackie et al., 1996). According to the cognitive miser theory, stereotype inaccuracies occur because a person is quicker to process information that supports stereotypes than information that does not support the stereotype (Baron & Bryne, 1994; Fiske & Taylor, 1984). This, along with the inadequate shortcuts in processing, may lead to biased processing of social information.

In support of the cognitive miser theory's focus on the utilization of cognitive shortcuts, there are a plethora of theories on cognitive tools that may aid individuals in using and forming stereotypes and also help explain stereotype inaccuracies. Schemas and categorizations were both previously mentioned in theories, but also are applicable in this framework since they serve to aid in cognitive efficiency. For instance, schemas and categorizations of processed information allow for an individual to process stereotypical information quicker than non-stereotypical behavior (Hamilton & Sherman, 1994; Schneider, 2004; Wilder, 1981). Another cognitive tool that also may create stereotypes is illusory correlations which occur when two events are thought to be correlated to a greater extent than they actually are (Baron & Bryne, 1994; Hamilton & Gifford, 1976; Hamilton & Sherman, 1994). This results in individuals overestimating how often the events occur together and often leads to a biased perception of the relationship (Hamilton & Gifford, 1976; Hamilton & Sherman, 1994; Mackie et al., 1996; Macrae et al., 1994). For example, if someone's only exposure to a Latina woman scientist is as a physician, they are likely to overestimate how many Latina women work in medicine and underestimate their representation in other STEM fields. Likewise, if the only exposure one had to a scientist was in media or through personal observation was that of men, one would overestimate how important being male is to being able to be a scientist.

Cognitive Stereotype Factors Influencing Intentions of a Science Career

The cognitive orientation stereotype factor that influences a person's intentions of pursuing a science career is visibility or perception. Students that hold positive perceptions of scientists and engineers are more likely to express intentions of remaining in the STEM fields (Wyer, 2003). However, positive perceptions of scientists and engineers, particularly of women as scientists and engineers, are not abundant due to the lack of role models, mentors, and positive depictions in textbooks (Sax, 2001). Illusory correlations are then likely to occur when an image of a white, male scientist is depicted in the media or when seen occupying a position of high visibility in the profession, as in the previous comment on overestimating the presence of the formerly excluded and invisible Latina scientist. These cognitive errors pose a substantial challenge to modifying perceptions of scientists and engineers once they are created since we cognitively resist stereotype change.

Cognitive theories attempting to challenge this resistance to stereotype change focus on suppression of stereotypes, which has produced mixed results and requires considerable motivation from the individual (Schneider, 2004). This approach raises concerns that attempts at suppression would actually make one more susceptible to endorsing the stereotype due to the fixation on that stereotype (McGlone & Aronson, 2007). One model of stereotype change that focuses on disconfirming evidence is the subtyping model, in which an individual has to observe the disconfirming evidence and consequently creates subgroups of their stereotypes to allow for exceptions. For instance, if one holds the stereotype that women are inferior to men in science fields and then sees a woman with superior math abilities, women in math are then subtyped as an exception to that overarching stereotype (Hamilton & Sherman, 1994). However, this requires consistent disconfirming perceptions and may just create subgroups of stereotypes as opposed to broader generalizations. In this approach, changes in stereotypes are unlikely since challenges to the stereotype are seen as exceptions that prove the rule.

Another more successful cognitive tool for changing perceptions is to bring awareness of inconsistencies through disconfirming evidence to one's beliefs. Rothbart's bookkeeping model (1981) of stereotype change theorizes that change occurs only when the disconfirming evidence outweighs the confirming evidence (Hamilton & Sherman 1994). This is invariably a slow process and relies on the reliability of stable perceptions, which the cognitive miser theory (Fiske & Taylor, 1984) asserts is not always the case (Hamilton & Sherman). Increasing the visibility and number of positive images of women to students could help expand students' perceptions of who is capable of working in STEM fields and who is able to contribute to the profession. This is confirmed after several interventions, designed to provide more positive images of women in science, suggested that these affirming portraits increased students' knowledge about women scientists (Damschen et al., 2005; Wyer, Murphy-Medley, Damschen, Rosenfeld, & Wentworth, 2007). Further, increasing the number and visibility of female role models was shown to broaden perceptions about scientists and engineers (Lockwood, 2006; Powell, 1990; Smith & Erb, 1986; Sumrall, 1995).

Summary of the Cognitive Orientation

Cognitive orientation adequately explains the process of forming stereotypes and the consideration of individual influence (similar to the psychodynamic orientation) through perceptual factors (Ashmore & Del Boca, 1981). The cognitive miser theory conveys the helpfulness of stereotypes as cognitive shortcuts, explaining why stereotypes are maintained (beneficial to the individual) and how they are used (predicting the behavior of others) (Fiske, 1992). The cognitive miser theory further explains how cognitive shortcuts may create stereotypes and how difficult it is to modify a stereotype (Fiske & Taylor, 1984). This organization of information for quicker processing describes how perceptions of scientists (such as those seen on TV, in commercials, the scientific community, textbooks, or role models) are formed based on overgeneralizations or illusory correlations. These perceptions provide individuals with messages regarding who can or cannot enter the field of science and what necessary skills are vital to be successful. These messages can be very limiting to people's perceptions of the options they have if they pursued a career in science.

Cognitive orientation alone cannot adequately explain the development and maintenance of these stereotypes. A major weakness of the cognitive framework is that it does not account for an individual's conscious feelings or motivations about stereotypes (Fiske & Taylor, 1984).

Stereotypes are solely looked at as tools with no regard to their impact or the individual's feelings, interpretations, or perception of the consequence of their stereotypes. The primary flaw of the cognitive orientation, however, is its failure to consider how intergroup relations (psychodynamic) or social forces (sociocultural) can have an impact on a person's stereotypes. For instance, the orientation does not account for how social interpretations have changed from the 1950s (when females were perceived as damsels in distress) and current day (women leaders are perceived as pioneers).

Summary of the Stereotype Orientations' Framework

Although the framework is three decades old, it is a unique way to approach understanding stereotypes and was able to be updated via theories and contemporary research on related stereotype factors within each orientation. The three orientations are able to work in complementary ways and produce a multi-level, ecological framework to understanding stereotype development, maintenance, and change. The framework implies stereotypes are connected to career decisions through sociological environmental factors (such as campus climate and parent and peer influences), individual psychological factors (such as in and out-groups and self-efficacy), and cognitive perceptual factors (such as overgeneralizations and how scientists are portrayed). The sociocultural orientation assists in understanding the impact of social forces on the origins and maintenance of gender and scientist stereotypes (e.g. social roles, social divisions, social reinforcement) and stereotype variation (different schemas). Nevertheless, the sociocultural framework fails to fully consider stereotype inaccuracies, motivation, the individual's role in stereotyping, and the impact of gender stereotypes.

Although both the psychodynamic and cognitive orientations explain the benefits of stereotypes (quicker and easier processing, more positive view of self, etc.), the psychodynamic orientation acknowledges the individual's control over these generalizations. Individuals are participants in stereotype acquisition and are held accountable for their impact in relation to others. For gender stereotypes, this impact is most likely prejudice and discrimination. The psychodynamic orientation is unique in accounting for how the formation of in-groups and out-groups creates group favoritism for the in-groups and negative stereotypes or overgeneralizations for the out-groups.

Whereas the cognitive orientation is the least likely to consider environmental influences on stereotypes, components from this orientation are utilized to explain motivations, inaccuracies, and individual variation. Similar to the psychodynamic approach, the cognitive framework partially defines why people form and rely on gender stereotypes. Cognitive orientation explains how individuals' reliance on cognitive shortcuts (e.g. illusory correlations) can often lead to gender stereotypes (Beyer, 1999; Diekman et al., 2002). Variations in perceptions and schemas of information explain why individuals and groups may have disparate stereotypes. It also may explain why some women enter STEM fields where they are underrepresented while others are not as likely to see the field as a career option due to their perceptions of the skills and/or gender needed to be successful in that career. Within the cognitive orientation, the stereotype factors may provide a partial explanation as to why women STEM majors may be disproportionately seeking a career in STEM in relation to men STEM majors.

All three orientations merged into one theoretical framework provide a multi-level guide to understanding stereotype formation, how they are maintained, and why they are difficult to revise. This framework is crucial when exploring how thoroughly stereotypes are embedded in one's intentions of pursuing science careers. It provides a holistic approach to examining the relationship between stereotypes, one's intentions of pursuing a science career and factors explaining why women may not be as likely to have intentions of pursuing these professions (e.g. hostile environment, peer, parent, and teacher influences, one's self-esteem, biological, and visual/perceptual). This framework further aids in the examination of the factors that may have an impact on academic major's relationship with pursuing STEM fields and why some women who have a STEM major may or may not have intentions of pursuing a science career. These compelling theories assert stereotypes' impact and role on an individual's performance, self-efficacy and, consequently, career intentions (Beyer et al., 2003; Davies, Spencer, Quinn, & Gerhardstein, 2002; Steele, 1997). Stereotype threat theory is presented next in order to provide clarity and empirical research on how stereotypes can alter one's performance and possibly influence a person's intentions to enter a related occupational field.

Stereotype Threat Theory

Stereotype threat theory asserts that negative stereotypes have a detrimental impact on an individual's performance (Steele, 1997). The theory was initially an explanation for the performance gap between African American and European American's academic performance (Spencer, Steele, & Quinn, 1999; Steele & Aronson, 1995). Stereotype threat theory later also became a well-documented explanation for the performance gap between male and female math scores. Furthermore, stereotype threat theory lends credence to the argument that stereotypes are instrumental in the scarcity of women in certain academic STEM fields. The theory suggests stereotypes, and consequently the performances impacted by these stereotypes, adversely influence women's intentions of pursuing STEM majors and careers; women would not be as likely to enter fields where there are known negative stereotypes of women or the stereotypes narrow one's vision of career options in that field. This supports the psychodynamic orientation of the stereotype framework since the negative stereotypes about women being less able than men at science would increase the likelihood of women perceiving science as the out-group (Tajfel & Forgas, 2000). Stereotype threat is empirically demonstrated for women in the context of the generalization that men are better at math than women.

Spencer et al. (1999) conducted two studies with undergraduates enrolled in Introduction to Psychology classes (study 1= 28 men and 28 women; study 2 = 24 men and 30 women). Participants had to have completed at least one semester of calculus (receiving a grade of a "B" or better) and scored in the 85 percentile on the math portion of the SAT or ACT. Further, participants must have strongly agreed (rating of 1-3 on an eleven point scale where 1 is strongly agree and 11 is strongly disagree) to the following two statements: "I am good at math" and "it is important to me that I am good at math." Using a 2x2 research design, both studies had participants complete a computerized test, scored similarly to the GRE, examining gender (male and female) by test difficulty for study 1 (easy or difficult) and test characterization for study 2 (told the test did or did not yield gender differences). The studies measured the performance on the math test and the time spent working on the test.

Results of study 1 found females performed significantly worse than males on the difficult math test, but performed similarly on the easy test. To explain why females underperformed on the difficult test in comparison to men, Study 2 examined whether females were experiencing stereotype threat by telling half the participants that the test yielded gender differences and the second half that it did not yield gender differences. Results showed that when participants were told that there were gender differences in the test scores, males outperformed females; however, when participants were told that the test yielded no gender differences in the test scores, there were no significant differences between genders. These results points toward the significant impact stereotype threat can have on females' math scores.

Similarly, Shih, Pittinsky, and Ambady (1999) conducted a study examining the impact of stereotype threat on gender, also examining a positive stereotype pertaining to ethnicity. The study examined quantitative test scores for three groups of undergraduate Asian-American women: A group whose Asian American-identity was made salient (n = 14), a group whose female-identity was made salient (n = 16), and a control group who had no identity made salient (n = 14). In order to evoke the group's identity, researchers asked respondents to specify their gender (or ethnicity) and take a series of gender (or ethnicity) identity questions before beginning the quantitative test. When undergraduate Asian-American women's ethnicity was made salient (appealing to the stereotype that Asians are good mathematicians) their math scores were superior to Asian-American women whose ethnic identity was not made salient. Conversely, gender identity saliency caused Asian-American women's math scores to be inferior to a group of Asian-American women whose gender identity was not made salient (Shih et al., 1999). Depending on which stereotype was invoked (women are bad at math as the negative stereotype or Asian Americans are good at math as the positive stereotype), the outcome changed.

The negative impacts of stereotypes may have lasting consequences in terms of a student's choice of academic domain. Math avoidance, for instance, may be a key to choice of major. Davies et al. (2002) found that female undergraduates who were subjected to television commercials depicting women in stereotypical roles performed worse on the math questions and were more likely than those who saw neutral stereotypical commercials to choose to answer verbal questions instead of math questions. Furthermore, women exposed to the gender stereotypical commercials expressed less interest in career fields that were susceptible to stereotype threat (math fields) and more interest in career fields that were not subjected to stereotype threat (verbal fields) compared to those women not exposed to stereotypical commercials (Davies et al. 2002). This implies that women who performed worse on math exercises were less likely to want to major in math or enter math fields after watching gender typed commercials.

Stereotype threat was presented to demonstrate how the salience of stereotypes might help explain why women are underrepresented in certain STEM fields. As confirmed above, the literature supports the notion that stereotypes do have a decided impact on individuals' self-perceptions, performance, and consequent choices/paths. However, it is not clear why this may impact some group members while it does not seem to have an impact on others. For example, why do stereotypes impact some women to such an extent that they avoid academic fields/careers where they are fearful of failure, while other women seem unaffected by the stereotype and go on to succeed in those fields/careers? This may be at least partially answered by examining what moderates the relationship between stereotypes and the impact on a person's performance or career choice.

Moderators of Stereotype Threat

There are several moderating variables that have been found to explain why some groups are impacted by stereotype threat and others are not. For instance, these moderators may lend an explanation as to why some women pursue male dominated STEM fields, while others do not. First, stereotype threat is more likely to occur if the individual feels the stereotype is self-relevant (Aronson et al., 1999; Schmader, 2001; Steele & Aronson, 1995). Since most individuals are usually aware of common stereotypes (Devine & Elliot, 1995), a stereotype is thought to become salient to an individual if there is a strong association with a person's group being stereotyped (Kiefer & Sekaquaptewa, 2007). For example, if a woman has a high gender identity, the woman is more likely to view the negative stereotype of "women being bad at math" more relevant to her than is a woman with low gender identity. The knowledge of the stereotype in relation to one's identity with the stereotyped group is what causes the stereotype to become self-relevant (Kiefer & Sekaquaptewa, 2007).

This effect is demonstrated through Keifer and Sekaquaptewa's (2007) research. The study examined gender identification, math scores, and career goals among female undergraduates enrolled in a calculus course (n=63). Findings supported identification with the stereotyped group as a significant moderator between the stereotype that women are bad at math and a person's performance or career intentions. High gender identification was found to be negatively related to math scores and intentions to enter high-math fields. However, women with low gender identification were more likely to have superior math scores and were more likely to express interest in careers that were math oriented (Kiefer & Sekaquaptewa).

A second moderator is stereotype endorsement. The impact of stereotypes on academic major/occupation is particularly of concern for people who believe the stereotype is true. For instance, Schmader, Johns, and Barquissau (2004) found undergraduate women math majors who believe that math gender differences are legitimate were disproportionately impacted by stereotype threat compared to those who did not subscribe to the stereotype. Further, those women who endorsed the stereotype were less likely to report intentions to continue in a math related field and were more likely to view themselves negatively in terms of their math ability (Schmader et al.) .

In addition to self-relevancy and stereotype endorsement, a third moderator is one's desire to do well at the task. In other words, stereotype threat is more likely to have an effect on an individual who cares about the ability being evaluated (Steele, 1997). This suggests stereotype threat is most likely to impact women who are the most interested and motivated to succeed.

Stereotype Threat Theory Conclusion

It is unsurprising there is a dearth of women who enter and stay in STEM majors and careers given the negative stereotypes they may encounter or endorse. Stereotypes of science are thought to be detrimental to the recruitment and retention efforts in STEM fields by harmfully impacting academic performance and self-perceptions. Consequently, these stereotypes may discourage women from choosing a STEM major and entering and remaining in these fields and encourage the likelihood they perceive STEM as an out-group. Even further, those who do pursue a STEM major may be discouraged from capitalizing on that major by pursuing a STEM career. It is elemental that people would want to pursue academic majors and careers where they have an expectation of success and applied skill as opposed to those where they are likely to experience stereotype threat. If a solution for enhancing the number of women in science fields is to change negative science stereotypes, it is imperative to examine what constitutes a modern image of a scientist and whether these stereotypes are in fact actually a predictor of an undergraduate's decision to pursue a science field.

Measurements of Stereotypes of Science and Scientists

There is a dearth of research on current stereotypes of scientists. Obtaining a better understanding of these stereotypes would provide a further analysis of how scientists and the field of science are perceived. Developing a snapshot of undergraduates' perceptions is essential to discovering whether these stereotypes are in fact related to their intentions or pursuit of an allied career.

The empirical research that has examined stereotypes of scientists was primarily gathered in the 1950s-1980s. These stereotypes are undoubtedly different today due to an increasingly diverse workforce. However, it is not demonstrably evident what are the precise perceptions of a modern day scientist. The image of a white, male scientist with glasses may be an image of the past; on the other hand, it may also have a lingering impact on students' desires to pursue scientific careers. Since the research designed to document the shape and scope of stereotypes about scientists has languished, our current knowledge of stereotypes is outdated and relies heavily on findings from Mead and Metraux (1957) and/or on Chambers' Draw-A-Scientist (1983).

Mead and Metraux

One of the first empirical studies attempting to assess stereotypes of scientists was a qualitative effort that sought to measure students' images of scientists and their attitudes toward science (Mead & Metraux, 1957). Approximately 35,000 high school students were asked to write an essay using one of three forms. The first form asked students to complete the following statement: "When I think of scientists, I think of…" The second form asked boys to write about the kind of scientist they would want to be. Girls were told they could answer that same question or describe the type of scientist they should like to marry. The third form was the same as the second except students were asked what kind of scientist they would NOT like to be (or for girls, not like to marry).

Results showed high school students had a positive image of a scientist. Students perceived scientists as brilliant and dedicated with no regard to money or fame. Their essays implied they appreciated scientists and valued their work since it advanced the nation technologically and leads to medical cures. However, negative images emerged when analyzing attitudes toward becoming a scientist. Some of the negative images included dedicating themselves to a single absorbing purpose, abnormal relationship to money, infrequent feelings of being rewarded, poor family life, or the great responsibility that comes with being a scientist. In particular, females were more likely to indicate they did not want to become a scientist nor did they want their husbands to be a scientist (Mead & Metraux).

This study was commonly used as a foundation for future research on stereotypes of scientists. However, the methodology was severely limited in that it was qualitative data and consequently difficult to draw significant conclusions. Even further, the essay questions used "he" for scientists, which may have impacted female respondents' perceptions of a scientist and likelihood they would indicate they hope to enter a career in science. The measure also was not applicable to children since the task required a respondent to write an essay (Mead & Metraux).

Draw-A-Scientist Test (DAST)

Chambers (1983) *Draw-A-Scientist Test* (DAST) was developed with the purpose of measuring children's (aged 5-11) perceptions of science and images of scientists. The DAST asks children to simply "draw a picture of a scientist." These drawings are then evaluated using seven indicators, which were partially based on Mead and Metraux's (1957) results. The indicators included: the presence in the drawing of a lab coat, eyeglasses, facial hair, symbols of knowledge, symbols of research, technology, and relevant captions. A score (out of 7) is given to a drawing based on the number of indicators included in a drawing. Chambers tested this measure with a sample of children from K-5^{th} grade collected from 1966-1977 (n = 4807).

An analysis of the drawings showed students perceived a scientist as an older man who wears a white coat and glasses and works in a laboratory. When comparing drawings by respondent's grade, the number of indicators represented in the drawings increased by grade level; thus, stereotypical images of scientists as determined by the indicators were the most prevalent for students in fifth grade (Chambers, 1983). Further, a gender bias was prevalent in the drawings. Boys almost never drew female scientists and only .5% of the drawings were of female scientists despite the sample being half (49%) girls.

Sumrall (1995) expanded the DAST by asking respondents to explain their drawing and incorporating gender into the data analysis. The DAST was given to 358 students ranging from first to seventh grade. Interviews helped to further evaluate their self-perceptions and their explanation for their drawing with particular probing on gender when needed.

Similar to the drawings done in the 1960s and 1970s, the majority of drawings were of European-American males as scientists. Eighty-one percent of European-American boys and

53% of European-American girls drew European-American male scientists. However, the percentage of female scientists did increase since Chambers' study (1983). Sumrall (1995) found 40% of European-American girls drew European-American females. When the children were probed for the reasons for drawing the scientist's gender, the most popular explanation respondents gave was it was the same as their own self-image. Other reasons included the need to see more of that particular gender in the science field, their mental image of a scientist, and scientist stereotypes.

Although developed for children, the DAST has rescaled similar stereotypes with undergraduate students (Rahm & Charbonneau, 1997; Thomas et al., 2006). With a small sample, Rahm and Charbonneau (1997) found undergraduate and postgraduate students' (n=46) drawings were similar in stereotype content (number of indicators in drawings) to those by the children sampled in Chambers' (1983) study. They too viewed scientists as having facial hair (58%), unusual hairdos (52%), and wearing lab coats (70%). Looking at gender, almost three-fourths (70%) were of males, while only 16% were of females despite 80% of the sample being female. Only 4% of the drawings were clearly not European American.

Thomas, Henley, and Snell (2006) also conducted a study that used the DAST with an undergraduate sample. The 212 undergraduates (100 males and 112 females) were sampled in either psychology (62%) or computer science classes (38%). Although students represented over 40 different academic majors (63% of majors were science disciplines, 34% were non-scientific disciplines), the study produced results similar to those of elementary aged students (inclusion of a lab coat and eyeglasses [55% and 68.4% of drawings respectively]). The average number of indicators for each drawing was 2.92. The fourth graders in Chambers' (1983) study had an average of 3.05. The majority of respondents (82% of males and 82% of females) drew male scientists and 12.3% of males and 16.1% of females drew female scientists. Over half of the scientists were chemists (55.2%); in addition, biologists (13.7%), psychologists (4.7%), physicists (4.2%), and computer scientists (2.8%) were also represented. These results regarding gender are particularly surprising because almost two-thirds (64%) of respondents were science related majors.

An important strength of the DAST is its simplicity. It is straightforward, requires minimal time, and can be easily replicated. The DAST's external validity is supported through the measure's ability to be applied to a wide range of contexts (classrooms, seminars, workshops), cultures (relevant to all cultures and can then be compared across cultures), and populations (young children who cannot yet read through to adults). Of particular interest is the extension of the DAST for assessment of perceptions of scientists among the undergraduate population (Rahm & Charbonneau, 1997; Thomas et al., 2006). Another advantage to the DAST is the accumulation of data over time. The popular measure has been used for two and a half decades, therefore providing a powerful tool for comparing drawings of scientists over the years, ages, subpopulations, and cultures. Further, the results can be used in the classroom as a valuable educational tool by advancing self-awareness and creating dialogue as to what is an accurate image of a scientist. As mentioned earlier, the DAST is also capable of examining images of scientists in relation to gender of the drawings (Sumrall, 1995; Thomas et al., 2006). However, one weakness of the DAST is that the measure is susceptible to an experimenter bias when interpreting and coding which indicators are present in the drawings (Sumrall, 1995). Poor artistic talent (e.g. stick figures or "abstract" drawings) present little information about a likely more complex image and may not be of help in terms of the drawing's gender (Thomas et al., 2006).

Thomas et al. (2006)'s study on undergraduate students implies that similar stereotypes exist regardless of whether the undergraduate is even a science major. This raises a question as to whether these findings are accurate or whether or not the DAST is sufficiently able to capture images of scientists (Thomas et al.). This finding caused some debate as to the measure's construct validity. Symington and Spurling (1999) also raise concerns regarding the construct validity of the DAST. The measure is thought to capture a more global stereotype of scientists instead of the person's own stereotypes; therefore, it is not adequate for capturing students' multiple perceptions of a scientist (Symington & Spurling, 1990; Thomas et al., 2006). This may be due to the wording of the test (Symington & Spurling). For instance, the measure's instructions ask students to draw a scientist "as best as they can," which may provoke a widely held stereotypical image (Symington & Spurling).

Construct validity may also be vulnerable to the experimental situation and experimenter bias. Thomas et al. (2006) found the gender of the person administering the DAST was significantly related to the gender of most participants' drawings. Of more general concern, but still related to construct validity, is the content of the seven indicators developed by Chambers (1983) using the results of studies in the 1950-60s. A half-century of societal change has dramatically impacted the presence of females in STEM fields; however incomplete that change is, stereotypes of scientist have plausibly changed since that of the cold war era!

Image of Science and Scientists Scale (ISSS)

Another measure that was developed using the results of Mead and Metraux's (1957) study is the *Image of Scientists Scale* (ISSS). Krajkovich and Smith (1982) developed the ISSS for the purposes of measuring students' attitudes toward science. After a pilot test, the resulting measure consisted of forty-eight items (positively and negatively worded) that represented students' images of science and scientists. The measure includes both completion items ("When I think about a scientist, I think of: a person who sits in a laboratory all day") and self-contained items (e.g. "A scientist's work is dangerous"). Items were rated using a six-point Likert scale ranging from "Strongly Disagree" to "Strongly Agree." A total scale score was calculated by summing answers for all 48 items (negative items reverse coded) (Krajkovich & Smith).

The measure was proven to have strong reliability and construct validity. A coefficient alpha of .86 shows the scale has satisfactory reliability (Krajkovich & Smith, 1982). Discriminate validity was established, using the known-groups method, by comparing science honor students in ninth grade (n = 47) to a random sample of ninth graders (n= 204) who were known to have less favorable attitudes of science (Krajkovich & Smith, 1982). Additionally, multiple regression analyses results showed ISSS significantly predicted students' science achievement (assessed by their class grades) above and beyond what IQ (assessed using a version of an academic aptitude test) explained (Krajkovich & Smith, 1982).

Despite the strong reliability and construct validity, Erb (1983) used theoretical and empirical evidence to question whether or not the ISSS has actually two distinct, but related, constructs or subscales: images of science and images of scientists.[2] More advanced scale development procedures would help to determine if this is a one or two factor measure. A confirmatory factor analysis would also be able to provide statistics such as goodness-of-fit indices and help determine if all the items are pertinent.

Since this measure was intended for youth and tested solely on ninth graders (Krajkovich & Smith, 1982), the applicability in other populations is of concern. This limits the measure's external validity, particularly in terms of young populations and undergraduate and adult populations. To address this concern, the instrument's psychometric properties should be reevaluated in a variety of populations using updated statistical procedures, such a confirmatory factor analysis.

Women in Science Scale (WiSS)

Erb and Smith (1984) developed the *Women in Science Scale* (WiSS) in order to examine adolescents' attitudes about women in science occupations. WiSS was developed using a sample of 10-16 year olds (n = 612). The measure includes 27 items on a six-point Likert scale (strongly agree to strongly disagree) that has three dimensions. The first is: women possess characteristics which enable them to be successful in science careers (e.g. "Women can make important scientific discoveries"). The second dimension is: women's roles as mother and wife are compatible with successful science career pursuits (e.g. "A woman's basic responsibility is

[2] However, Krajkovich and Smith (1982) rebut Erb's claim that it may in fact be two factors by emphasizing the measurement is a function of the instrument items and the environment in which it is used. Further, Krajokovich & Smith indicate their scale analysis did not produce two constructs; however, they do speculate whether the dimensionality of the instrument could change depending on intended use. Thus, Krajkovich & Smith stand by their assertion that a total score provides the strongest predictive power if the study's objective is to maximize predictive power. They concede that two subscales, scientist and science, can be used if it is more relevant to study and sample (Erb, 1983).

raising children”). The third dimension is: women and men ought to have equal opportunities to prepare for and pursue science careers (e.g. “Women have less need to study math and science than men do”) (Erb & Smith, 1984).

The WiSS has strong reliability and construct validity for measuring adolescent (aged 10-16) attitudes concerning women in science. Reliability was determined using two forms of reliability testing (internal consistency [Cronbach’s alpha = .92] and test-retest [r = .82]) (Cronbach, 1951). Construct validity was also tested through two methods: known-groups method (discriminate validity test) and intertest correlation (convergent validity test). Using a known group method, WiSS was able to discriminate between girls and boys (who are known to have different attitudes) after controlling for age and the age-sex interaction. Further, an intertest correlation using five measures, including the ISSS, found significant correlation to the WiSS (Smith & Erb, 1986). These multiple analyses support the acceptable reliability and construct validity of WiSS.

Since the studies that have used the WiSS usually treated the results as one factor, there is some debate as to whether or not there are actually three factors in the WiSS. The recent reevaluation of the instrument rectified this problem. Owen, Toepperwein, Pruski, Blalock, Lin, Marshall, and Lichtenstein (2007) reevaluated the WiSS using the more contemporary scale development method of factor analysis. Factor analyses (a combination of exploratory and subsequent confirmatory) found the scale actually had just two dimensions (sexuality and equality) made up of only 14 items instead of the initial three dimensions and 27 items (Owen et al.). This shortened two-factor version of the WiSS adds construct validity. After their reevaluation of the WiSS, Owen et al. recommended using a mean score of the scale for analyses instead of the total score that Erb and Smith (1984) recommend. This permits the results to be evaluated within the context of the original Likert scale (Owen et al.). The reevaluation was also helpful for comparing the attitudes toward women in science in the 1980s to current attitudes. Owen et al.'s findings from the reevaluation indicated females hold more positive attitudes about equality and less sexist attitudes than males. This finding supported (and was actually triple the effect size!) the results of Smith and Erb's study (1986).

Measurement Summary

The DAST, ISSS, and WiSS studies were all developed decades ago with components that originated in the 1950s. Although there is a chance these stereotypes still exist, it is also possible these measures are capturing outdated stereotypes and the DAST and ISSS need to be reevaluated for psychometric properties with contemporary statistical procedures, such as factor analyses. Although these measures help to understand past stereotypes and their historical perspective and can be used as a foundation for examining modern stereotypes, the weaknesses of these measures exemplify the need for research to obtain current reliable results. In sum, there is little to no research that provides support that traditional stereotypes still exist or insight into the contemporary stereotypes of scientists. Further, even if one wanted to capture these stereotypes, the instruments available are not operationalized for contemporary times.

Literature Review Conclusion

With the compelling and immediate need for our nation to compete globally, it is crucial that there is scientific talent available from the brightest and most motivated students from as wide of a pool of candidates as possible (COSEPUP, 2007; National Science Board, 2008). The current underrepresentation of women in STEM fields such as engineering, computer sciences and physical sciences severely and unconscionably handicaps these efforts (Bostic, 1999). There is a general cultural backdrop in which females have traditionally been stereotyped as bad at math and disinterested in scientific discovery (Morgan et al., 2001; Steele, 1997). According to multiple career theories, and the psychological orientation within the stereotype framework, females will avoid fields where they have low self-efficacy and also fields where stereotypes are particularly salient for them (Ashmore & Del Boca, 1981; Lent et al., 1994; McLean & Kalin, 1994). As the stereotype threat literature implied, the knowledge of these stereotypes and having low self-efficacy impacts one's performance and ability to see oneself as successful in that field (Spencer et al., 1999; Steele, 1997). Consequently, the impact of these stereotypes on a woman's ability to see herself as a successful scientist is thought to be at the foundation of why some women are not interested in pursing certain male-dominated STEM careers and why women STEM majors may not seek careers in science as frequently as male STEM majors.

In addition to academic major, one's conception of why a person pursues a science career may be rooted in the multitude of factors encompassed by the stereotype framework (Ashmore & Del Boca, 1981). These factors range from environmental factors (sociocultural orientation), stereotype threat and self-assessment factors that lead one to label oneself as a member of an "out-group" in relation to scientists (psychological orientation), perceptual factors influencing who one sees as being successful in a science career (cognitive orientation), and, unsurprisingly their choice of academic major. The relationship between stereotypes of scientists and intention to pursue a scientific occupation is an oft-asserted one and has not been empirically examined with contemporary stereotypes (Eccles, 1993; Jacobs, 1989; Xie & Shauman, 1997). By uncovering the elements of modern-day stereotypes of scientists and empirically determining current perceptions, this research investigates if stereotypes impact students' potential intentions of pursing science fields and whether the impact varies by gender. In addition, the study explores the relationship between male and females' undergraduate major and their intentions of pursuing a science career.

METHOD

Research Objectives and Hypotheses

This study investigates the relationship between undergraduates' stereotypes of scientists, their academic major, and their intentions to pursue a career in science. It was also designed to determine if these relationships differ for males and females. The hypotheses were developed in relation to the constructs that emerged from the Stereotypes of Scientists' measure; thus, the measure will first be briefly described before presenting the study's research questions.

The measure, Stereotypes of Scientists (SOS) scale, was initially developed, refined, and evaluated initially in a pilot study similar to this research (the scale's psychometric properties are discussed below in the *Measures* section). This study uses the SOS scale in a national sample. The measure is comprised of two dimensions capturing different aspects of one's stereotype of a scientist. The first dimension identifies respondents' perceptions of scientists' Professional Competencies (their ability to do their job and the skills and traits needed in their profession). The second dimension captures respondents' perceptions of scientists' Interpersonal Competencies (their ability to work with others, be social, and have a life outside of their work). A higher score for either of these dimensions represents a stronger agreement with scientists' competencies. The SOS scale is described in much more detail in the measures section; however, the scale's two dimensions, Professional and Interpersonal Competencies, are presented first to allow for easier interpretation of the hypotheses and the following three research questions. First, do undergraduates' stereotypes of scientists (Professional and Interpersonal Competencies) vary by their academic major?

H1a: Undergraduates majoring in fields categorized as science, technology, engineering, and math will agree more with scientists' Professional Competencies (thus, have a lower scientists' Professional Competencies score) than those students with majors in non-STEM fields.

H1b: Undergraduates with majors in science, technology, engineering, and math (STEM) will agree more with scientists' Interpersonal Competencies (thus, have a higher scientists' Interpersonal Competencies score) than those students with majors in non-STEM fields.

Next, what predicts an undergraduate's intentions to pursue a career in science?

H2a. Undergraduates with an academic major in a STEM field will have greater intentions of pursuing a career in science than those students majoring in a non-STEM field.

H2b. The higher an undergraduate student's agreement with scientists' Professional Competencies (thus, the higher their Professional Competencies score), the greater their intentions will be to pursue a career in science.

H2c. The higher an undergraduate student's agreement with scientists' Interpersonal Competencies (thus, the higher their Interpersonal Competencies score), the greater their intentions will be to pursue a career in science.

The third and last research question asks, does gender modify (1) the relationship between undergraduates' stereotypes of scientists and their intentions to pursue a career in science and (2) the relationship between undergraduates' academic major and their intentions to pursue a career in science?

H3a: Females' stereotypes of scientists' Professional Competencies will predict their intentions to pursue a career in science, but males' stereotypes of scientists' Professional Competencies will not predict their intentions to pursue a career in science.

H3b: Females' stereotypes of scientists' Interpersonal Competencies will predict their intentions to pursue a career in science, but males' stereotypes of scientists' Interpersonal Competencies will not predict their intentions to pursue a career in science.

H3c: Academic major will be a stronger predictor for males' intentions to pursue a career in science than females' intentions.

Design

This study is a cross-sectional predictive analysis of classes from universities across the United States. Data were collected from undergraduate classes during the fall semester of 2008 and spring semester of 2009. Faculty members were contacted and asked if they would like their class or classes to be included in the study. Internal Review Board (IRB) permission secured from the cooperating faculty member's university and faculty sent a list of their class's email addresses to the researcher. Faculty members were encouraged to offer extra credit to those students who completed the survey as an incentive for student participation. Faculty members were responsible for choosing a start date, alerting their class to the study, explaining any incentive they are offering students, and letting their class know when to expect an email invitation to the study and from what email address it will be coming.

Undergraduates from a range of universities and courses were surveyed (a total of 7 universities and 30 classes were sampled). Since the intention of the study was to examine whether a science or non-science major predicted science career intentions, science classes were over sampled. Over two-thirds of classes sampled were either classified as Agricultural and Life Science or Physical and Math Science classes. The remaining classes were from Humanities, Social Science, or Engineering departments. No Education courses were sampled. See Table 1 for more information on the universities and courses sampled.

The survey was an 83 question voluntary web-based survey that took approximately ten minutes to complete.[3] The email invitation included a short description of the study, a link to the survey, an expected time to complete the questionnaire, an extra credit incentive (if there was one), and a completion deadline. The email also assured students that their results would be kept confidential and reported only in aggregate. Students had approximately two weeks to complete the survey. A reminder was sent after one week and again on the day the survey was due. Students received an email confirming their completion after they submitted their survey. The only requirement to participate was that students had to be enrolled in a participating faculty member's class.

[3] This study is part of a larger *Careers in Science* survey; thus, only a portion of the questions was used for analysis purposes.

Table 1

Universities and Classes Sampled

Characteristic	Sample
Universities	
North Carolina State Univ. (NCSU)	42.8%
University of Florida (UFL)	15.4%
Washington Univ. in St. Louis (WUSTL)	10.7%
Case Western Reserve Univ. (CASE)	9.3%
Univ. of Massachusetts (UMASS)	9.1%
Pennsylvania State Univ. (PSU)	8.6%
University of Georgia (UGA)	4.1%
Total # of universities =	*7*
Classes	
Physical and Math Science (10 classes)	45.0%
Agricultural and Life Science (13 classes)	29.9%
Humanities (2 classes)	12.1%
Engineering (3 classes)	7.0%
Social Science (2 classes)	6.0%
Total # of classes =	*30*

Participants

Data were collected from 1,640 students. One respondent was not included in the final analysis due to their data potentially being corrupt (e.g. no variance in answers); thus, a total of 1,639 undergraduates were included in the study. The survey had a response rate of 55%; however, the response rates differed depending on whether the participant received extra credit from the instructor for their participation. The average response rate for those classes that offered extra credit was higher (80%) than the average response rate for those classes that did not offer an incentive (34%).

The demographic composition is roughly comparable to the gender and racial/ethnic demographics of the colleges participating in our study. Both females (59%) and males (41%) were well represented. Almost three-fourths of the sample was European-American/White (72%). Other frequently specified ethnicities were Asian/Asian American (13%) and African American/Black (7%). Almost the entire sample was U.S. citizens (95%). Students were well-represented at all educational stages (e.g. 30.8% of students were first year students, 26.2% were in their third year). Also, a wide range of academic majors was sampled. The most frequently specified major was Biology (20%); however, the second and third most frequently specified major only represented 6% or less of the sample (Food Science/Nutrition Science-6% and Biomedical Engineering-5%). Due to this wide range of academic majors, majors were coded into larger academic domains (coding procedures described below in *Measures*). See Table 2 for further characteristics about the sample.

Table 2

Characteristics of Respondents

Characteristic	Sample
Gender	
Female	58.8%
Male	41.2%
Academic Major	
Agricultural & Life Science	47.5%
Engineering	16%
Physical & Math Science	8.6%
Education	7.4%
Humanities	6.5%
Social Science	6.3%
Other	4.3%
Undecided	3.4%
Ethnicity	
European American/Caucasian/White	71.5%
Asian American/Asian	13.4%
African American/Black	6.8%
Latino American/Hispanic	4.1%
Other	4.1%
Declined to respond	.2%
Years at the University	
Less than one year	30.8%
One year to less than 2 years	15.9%
Two years to less than 3 years	17.8%
3 years to less than 4 years	26.2%
4 years to less than 5 years	7.1%
5 or more years	2.2%
Marital status	
Single	94.8%
Engaged	2.7%
Married	2.1%
Divorced/Separated	.4%
Citizenship Status	
U.S. Citizen	95.2%
Non-U.S. Citizen	4.8%
n =	*1639*

Measures

The measures chosen for this study were first developed and tested in a pilot study using undergraduates from a large public Research I institution in the Southeastern U.S. (n=1,106). The measure's psychometric properties from the pilot data were analyzed and a subsequent exploratory factor analysis and reliability analysis helped to refine the measures and finalize the scale's constructs. This current study was part of a larger study designed to test these scales using a national sample (several manuscripts are in process and mentioned below). The full questionnaire and all the items can be found in Appendix A.

<u>Independent Variables</u>

Academic Major: Students were asked to specify their academic department using a drop down list of 37 options. There was also an option to write in an unlisted major. Since one university comprised 43% of the respondents in our sample, academic majors were coded into academic domains primarily based on the colleges of this university. The college groupings in the second largest university (15%) and informed reasoning were used as secondary academic major coding mechanisms to create a smaller number of categories. Majors were coded into the following academic domains:

- Agricultural and Life Science: This category includes majors such as agricultural, biology, botany, food science, horticultural sciences, zoology/animal science, microbiology, nursing, environmental science/technology, health science, wood product, natural resources
- Physical and Math Science: This category includes majors such as chemistry, math, meteorology, statistics, physics

- Engineering: This category includes majors such as aerospace, biological, biomedical, chemical, civil, computer science, electrical, environmental, industrial, materials, mechanical, systems science
- Education: This category includes majors such as elementary, secondary, math/science/technology
- Humanities: This category includes majors such as art, communication, English, history, journalism, philosophy, political science, women's studies
- Social Science: This category includes majors such as anthropology, cognitive/neuroscience, psychology, sociology
- Other: This category includes majors that did not fit in the above categories. For example: Business, design, fashion and textile management, public health, information technology management
- Undecided: Those respondents who have not yet declared a major

Stereotypes of Scientists:[4] The Stereotypes of Scientists (SOS) scale (Wyer, Schneider, Nassar-McMillan, & Oliver-Hoyo, 2010) was used to measure participants' stereotypes of scientists. The development of the twenty-two item SOS scale was, in part, based on the measures from two past studies that aimed at capturing stereotypes of scientists quantitatively: Image of Scientists Scale (ISSS) (Krajkovich & Smith, 1982) and the Women in Science Scale (WiSS) (Erb & Smith, 1984; Owen et al., 2007). In addition, focus group participants also completed the Draw-A-Scientist-Test (DAST) (Chambers, 1983) and pilot data discussions

[4] Interpersonal and Professional Competencies will be used primarily as independent variables (Research questions 2 & 3); however, the two variables will be used as a dependent variable for the first research question.

helped in the measure's development. The measure is a two-factor scale (Wyer et al., 2010). The first construct, Professional Competencies, consists of thirteen items (Cronbach's Alpha [Cronbach, 1951] = .84). An example item from this scale is: "When I think about scientists, I think that they are: Technically competent." The second construct, Interpersonal Competencies, consists of nine items (Cronbach's Alpha [Cronbach, 1951] = .77) (Wyer et al., 2001). An example of an item on this scale is: "When I think about scientists, I think that they: Maintain friendships with colleagues in other departments." Students were asked to rate their agreement on all twenty-two items. The response scale has a six-point Likert scale (1 = "Strongly Disagree" to 6 = "Strongly Agree," no neutral point). For more information on the development of this scale and details on the psychometric properties, see Wyer et al. (2010).

The psychometric properties of the SOS scale had yet to be tested since the pilot study's development of the scale. Thus, before running a confirmatory factor analysis on the measure, an exploratory factor analysis was conducted to ensure all the items were loading on the correct factor and not loading on more than one factor. Before beginning the factor analysis, the three negatively worded items (e.g. Insecure) were reverse coded and the items were tested to ensure there was enough common variance to conduct a factor analysis. The Bartlett's Test of Sphericity (χ_2 [231] = 9462.14, $p < .001$) and the Kaiser-Meyer-Oklin measure of sampling adequacy (KMO = .85) indicated the 22 SOS items had adequate common variance for factor analysis (Tabachnick & Fidell, 2001).

A principal axis factor analysis with a promax rotation was run on the 22 items (Costello & Osborne, 2005). Generally, the results of the principal axis factor analysis supported the results of the pilot version of the SOS scale (see Table 3). However, there were a few items that were exceptions based on their factor loadings. Factor loadings, which are similar to correlation coefficients, measure the relationship between a factor and the variable (Field, 2005; Tabachnick & Fidell, 2001). Thus, factor loadings were looked to as guidelines to ensure the items and the factor had a strong relationship and that relationship was unique to just one of the factors in the scale. Although Tabachnick and Fidell (2000) recommend a loading cutoff of .32 (which is 10% overlapping variance), a more rigorous cutoff of .40 was enforced per the initial scale development loading cutoffs (Wyer et al., 2010). Three items were removed from the Professional Competencies factor. "Self-confident" and "Competent" were both removed since they did not load clearly on the Professional Competencies factor alone. The third item, "Competitive", was removed due to a low loading of .32 (10% overlapping variance) (see Table 4).

Table 3

Preliminary Exploratory Factor Analysis Results for Stereotypes of Scientists

Item	Factor Loading: Professional Competencies	Factor Loading: Interpersonal Competencies	Communalities
21. Especially intelligent	**.68**	-.11	.43
20. Able to learn to use new equipment quickly	**.67**	-.06	.42
19. Highly focused	**.65**	-.04	.41
14. Technically competent	**.61**	.09	.42
22. Logical	**.60**	-.08	.33
12. Work oriented	**.53**	.10	.34
6. Are the ones who know how equipment works	**.48**	-.01	.23
7. Are careful with expensive instruments	**.48**	.04	.25
15. Competent	.47	.32	.42
11. Independent	**.44**	-.15	.17
3. Know a lot about the latest discoveries	**.41**	.09	.20
9. Competitive	.32	-.03	.10
16. Self-confident	.25	.33	.22
4. Do not have a lot of friends*	-.27	**.70**	.44
2. Maintain friendships with colleagues in other departments	-.12	**.55**	.29
1. Have fun with colleagues at work	-.04	**.55**	.28
13. Family oriented	-.04	**.55**	.29
10. Cooperative	.13	**.52**	.34
5. Are out of touch with what is happening in the world*	-.03	**.52**	.26
18. Collaborative	.15	**.49**	.31
8. Have happy marriages	.04	**.47**	.24
17. Insecure*	.05	**.45**	.22
Eigenvalue	5.09	2.84	
Variance explained	20.08%	9.83%	
Cronbach's Alpha	.82	.77	
Number of items (Total = 22 items)	13	9	

Note. n = 1639; * Items were reverse coded; Correlation of factors = .33

Table 4

Exploratory Factor Analysis Results for Stereotypes of Scientists

Item	Factor Loading: Professional Competencies	Factor Loading: Interpersonal Competencies	Communalities
21. Especially intelligent	**.69**	-.08	.45
20. Able to learn to use new equipment quickly	**.67**	-.03	.44
19. Highly focused	**.65**	-.01	.42
14. Technically competent	**.58**	.10	.37
22. Logical	**.54**	.11	
12. Work oriented	**.57**	-.06	.32
6. Are the ones who know how equipment works	**.49**	.01	.24
7. Are careful with expensive instruments	**.49**	.06	.26
3. Know a lot about the latest discoveries	**.42**	.11	.21
11. Independent	**.40**	-.13	.15
4. Do not have a lot of friends*	-.24	**.69**	.45
2. Maintain friendships with colleagues in other departments	-.01	**.55**	.30
1. Have fun with colleagues at work	-.09	**.55**	.29
13. Family oriented	-.01	**.54**	.29
10. Cooperative	.15	**.52**	.24
5. Are out of touch with what is happening in the world*	-.01	**.51**	.25
18. Collaborative	.17	**.49**	.31
8. Have happy marriages	.08	**.48**	.25
17. Insecure*	.06	**.42**	.19
Eigenvalue	4.42	2.79	
Variance Explained	19.70%	11.17%	
Cronbach's Alpha	.81	.77	
Number of items (Total =19 items)	10	9	

Note. n = 1639; * Items were reverse coded; Correlation of factors = .33

Next, a maximum likelihood confirmatory factor analysis of the remaining 19 items was conducted using AMOS 17.0. A confirmatory factor analysis (CFA) was conducted in addition to the exploratory factor analysis to test whether the actual structure of latent variables and their relationship to one another is significantly different from the measure's proposed model based on theory (Garson, 2010; Henson & Roberts, 2006; Tabachnick & Fidell, 2001). Before looking at the model fit, the loadings were examined again. The loadings of the items in the model indicated one more item (*Independent*) needed to be removed from the Professional Competencies factor (low loading of .36) (see Table 5). Running the model again with the remaining eighteen items confirmed the two factors (nine items each) all had satisfactory loadings. The two factors were only mildly correlated (.28) (see Table 6).

The resulting SOS Scale consisted of two factors: Professional Competencies and Interpersonal Competencies. Professional Competencies explained 20.41% of the variance in students' stereotypes of scientists. The factor's nine items were summed and averaged to give each student a Professional Competencies score (Cronbach's Alpha = .81 [Cronbach, 1951]). The factor's composite mean was 5.03 (*SD* = .52). A high Professional Competencies score would be interpreted as respondents agreeing scientists have abilities, competencies, and skills stereotyped as professional or related to their ability to do their job well (e.g. scientists are "Intelligent" and "Technically competent").

The second factor, Interpersonal Competencies, explained 11.34% of the variance in students' stereotypes of scientists (Cronbach's Alpha = .77 [Cronbach, 1951]). The nine items were also summed and averaged to provide an Interpersonal Competencies score for each student (composite mean = 4.43, *SD* = .58). The interpretation of scientists' Interpersonal Competencies is similar to Professional Competencies. A high score indicates undergraduates agree scientists have social competencies or are able to live a lifestyle that is stereotyped as interpersonal (e.g. scientists are “Family oriented” or scientists “Have fun with colleagues at work”).

Table 5

Preliminary Maximum Likelihood Confirmatory Factor Analysis Results for Stereotypes of Scientists

Item	Factor Loading: Professional Competencies	Factor Loading: Interpersonal Competencies
21. Especially intelligent	**.67**	
20. Able to learn to use new equipment quickly	**.68**	
19. Highly focused	**.65**	
14. Technically competent	**.60**	
22. Logical	**.59**	
12. Work oriented	**.54**	
6. Are the ones who know how equipment works	**.49**	
7. Are careful with expensive instruments	**.49**	
3. Know a lot about the latest discoveries	**.45**	
11. Independent	.36	
4. Do not have a lot of friends*		**.58**
2. Maintain friendships with colleagues in other departments		**.55**
1. Have fun with colleagues at work		**.52**
13. Family oriented		**.55**
10. Cooperative		**.59**
5. Are out of touch with what is happening in the world*		**.49**
18. Collaborative		**.55**
8. Have happy marriages		**.50**
17. Insecure*		**.43**
Number of items (Total =19 items)	**10**	**9**

Note. n = 1639; * Items were reverse coded

Table 6

Maximum Likelihood Confirmatory Factor Analysis Results for Stereotypes of Scientists

Item	Mean	Factor Loading	
		Professional Competencies	Interpersonal Competencies
21. Especially intelligent	4.99	**.68**	
20. Able to learn to use new equipment quickly	4.90	**.68**	
19. Highly focused	5.23	**.64**	
14. Technically competent	5.06	**.60**	
22. Logical	5.09		
12. Work oriented	5.19	**.51**	
6. Are the ones who know how equipment works	4.62	**.49**	
7. Are careful with expensive instruments	5.11	**.50**	
3. Know a lot about the latest discoveries	5.12	**.45**	
4. Do not have a lot of friends*	2.62		**.58**
2. Maintain friendships with colleagues in other departments	4.58		**.55**
1. Have fun with colleagues at work	4.34		**.52**
13. Family oriented	4.09		**.55**
10. Cooperative	4.67		**.59**
5. Are out of touch with what is happening in the world*	2.35		**.49**
18. Collaborative	4.68		**.55**
8. Have happy marriages	4.27		**.50**
17. Insecure*	2.81		**.43**
Scale Mean		**5.03**	**4.43**
Variance explained (Total = %)	**31.75%**	**20.41%**	**11.34%**
Cronbach's Alpha		**0.81**	**0.77**
Number of items (Total =18 items)		**9**	**9**

Note. n = 1639; * Items were reverse coded; however, original mean of item is reported.

When evaluating the measure's adequacy, criteria for goodness-of-fit indices as specified by Drewes (2009) and Hu and Bentler (1999) were employed. The maximum likelihood confirmatory analysis found the Chi-Square was significant, χ_2 (134, N = 1639) = 1574.79, $p <$ .001. The Chi-Square was not thought to be a good measure of fit (the difference between the expected and observed covariance matrixes) since it is likely artificially inflated due to the large sample (Marsh, Balla, McDonald, 1988; Newsom, 2008; Thompson & Daniel, 1996).

The Relative Fit Indices are usually thought to be better measures of fit if the data are normally distributed. A model with relative fit indices of .90 or greater was thought to be a good fit (Drewes, 2009; Hu & Bentler, 1999). The SOS's relative fit indices were slightly below this standard and ranged from .76 - .80 (Normed Fit Index [NFI] = .79, Relative Fit Index [RFI] = .76, Bollen's Incremental Fix Index [IFI] = .80, Tucker-Lewis Index [TLI] = .77, Bentler's Comparative Fit Index [CFI] = .80). However, after conducting a Shapiro-Wilk's test (Shapiro & Wilk, 1965) to examine if the SOS items were normally distributed, it was discovered all 18 items were positively skewed (see Table 7). Therefore, the Relative Fit Indices may also not be a good measure of fit for the SOS scale (Drewes, 2009). Alternatively, Drewes (2009) recommends the Standardized Root Mean Square Residual (SRMR) and Root Mean Square Error of Approximation (RMSEA) as the best indicators of model fit because they are thought to be the most robust to skewed data.

The SRMR was .07 (a good fit is < .08 [Hu & Bentler, 1999]) and Root Mean Square Error of Approximation (RMSEA) was .08 (a good fit is < .1) (Drewes, 2009). Both of these statistics showed the model to be an adequate fit. Thus, an eighteen-item SOS scale was used for this study's analyses (this version was slightly different than the original SOS scale (Wyer et al., 2010) in that the first factor has nine items instead of thirteen items).

Table 7

Descriptive Statistics by Item for the Stereotypes of Scientists (SOS) Scale

Item	Mean	*SD*	Variance	Skewness	Kurtosis	Shaprio Wilk's
Professional Competencies	*5.03*	*.52*	*.27*	*-.59*	*1.20*	*.97**
3. Know a lot about the latest discoveries	5.12	.84	.71	-1.36	3.46	.78*
6. Are the ones who know how equipment works	4.62	.94	.88	-.85	1.32	.86*
7. Are careful with expensive instruments	5.11	.85	.73	-1.10	1.83	.81*
12. Work oriented	5.19	.68	.46	-.73	1.95	.78*
14. Technically competent	5.06	.74	.55	-.84	2.23	.80*
19. Highly focused	5.23	.72	.52	-.93	1.85	.78*
20. Able to learn to use new equipment quickly	4.90	.82	.67	-.66	.83	.84*
21. Especially intelligent	4.99	.89	.80	-.84	.91	.84*
22. Logical	5.09	.84	.71	-1.11	2.04	.81*
Interpersonal Competencies	*4.43*	*.58*	*.34*	*-.54*	*.87*	*.98**
1. Have fun with colleagues at work	4.34	1.00	1.01	-.77	.68	.87*
2. Maintain friendships with colleagues in other departments	4.58	.92	.85	-.95	1.28	.84*
4. Do not have a lot of friends**	2.62	1.10	1.21	-.63	-.14	.89*
5. Are out of touch with what is happening in the world**	2.35	1.17	1.36	-.91	.29	.86*
8. Have happy marriages	4.27	.92	1.21	-.63	-.14	.89*
10. Cooperative	4.67	.86	1.36	-.91	.29	.86*
13. Family oriented	4.09	.90	.81	-.48	.30	.88*
17. Insecure**	2.81	1.02	1.03	-.49	.12	.90*
18. Collaborative	4.68	.83	.69	-.58	.90	.86*

Note. n = 1639; *p < .001; **The original mean (before reverse coding) is reported for the negatively worded items. However, the Interpersonal Competencies composite score was calculated using the items after they were reverse coded.

Moderator

Gender: Students were asked to specify their gender (male = 0, female = 1).

Covariates

- *Ethnicity*: Students were asked to specify their ethnicity. The response choices were based on the categories used by the National Science Foundation (NSF/SRS, 2009): African American/Black, Asian American/Asian, European American/Caucasian/White, Latino American/Hispanic, Native American/Alaskan Native/Pacific Islander, and Other (with a follow up asking to specify their ethnicity).
- *Years as a student*: Participants were asked the number of years they have been a student at their university. Response choices included: Less than one year, one year to less than two years, two years to less than three years, three years to less than four years, four years to less than five years, five years to less than six years, six years to less than seven years, seven years to less than eight years, eight years to less than nine years, nine or more years. Since few people indicated five or more years (2.2%), the last five response choices were collapsed into one category: five or more years.
- *University:* Since 43% of the sample attended the same university (North Carolina State University [NCSU]), students' universities were categorized into a dichotomous variable based on whether they attended this university (NCSU = 0, Other = 1).
- *Citizenship:* Students were asked to specify their citizenship (non-U.S. citizen = 0, U.S. citizen = 1).

Dependent Variable

Intentions of Pursuing a Career in Science: The Career Intentions in Science (CIS) scale (Wyer, Nassar-McMillan, Oliver-Hoyo, & Schneider, 2010) was used to capture undergraduate students' intentions of pursuing a career in science. The CIS is a one-factor measure consisting of twelve items (Cronbach's Alpha = .98) (Cronbach, 1951). Students were asked to rate their likelihood of doing each of the twelve items using a six-point forced choice Likert scale (1 = "Very Unlikely to 6 = "Very Likely," no neutral point). The CIS's development utilized the research of Ellis and Herrman (1983). The CIS included items that stemmed from two dimensions from Ellis and Herrman's research on occupational choice: certainty and duration. The scale's certainty dimension captures students' work goals or ambition. For instance, students are asked "In your future career, how likely is it that you will: Become a scientist." The second dimension, duration, assesses students short or long term plans to be in science. This dimension was captured by including items such as "In your future career, how likely is it that you will: Have a lifelong career in science." In addition, the scale was informed by several other dimensions found in the literature: occupational motivation (Ellis & Herrman), career aspirations and ambition in science (Ellis & Herrman; Schoon, 2001), and self-efficacy in science (McLean & Kalin, 1994; Lent et al., 1994). The instrument's item response choices resulted from measurement research by Marra and Bogue (2004) from their "Assessing Women in Engineering Project." For more information on the development of this scale and further psychometric properties, see Wyer et al. (2010) for the psychometric development of the Career Intentions in Science scale.

Using AMOS 17.0, a maximum likelihood confirmatory factor analysis was conducted on the CIS scale. Since the CIS is only one factor, a CFA was the only factor analysis method employed. A Bartlett's Test of Sphericity (χ_2 [66] = 26,253, $p < .001$) and the Kaiser-Meyer-Oklin measure of sampling adequacy (KMO = .95) ensured the items in the CIS had sufficient common variance for factor analysis (Tabachnick & Fidell, 2001). The factor's loadings (ranging from .88 - .92) confirmed all twelve items should be included in the model and loaded well on one factor. The factor explained over three-fourths (76.56%) of the variance in students' intentions to pursue a science career and had very high factor reliability (Cronbach's Alpha = .98 [Cronbach, 1951]). The twelve items were summed and averaged to create a CIS score for each respondent. The overall CIS scale mean was 4.12 (*SD* = 1.49). A high CIS score would be interpreted as an undergraduate having high intentions of pursuing a career in science, while a low score would indicate a student having low intentions of pursuing a career in science. See Table 8.

When examining how well the observed CIS model fit the proposed CIS model, the same guidelines and fit cutoffs used in the confirmatory factor analysis for the SOS were employed. Similarly to the confirmatory factor analysis on the SOS, the Chi-Square (χ_2 [54, N = 1639] = 346.66, $p < .001$) was significant. Again, this is thought to be because of the large sample size (Newsom, 2008; Thompson & Daniel, 1996). The relative fit indices were between .84 and .87 (Normed Fit Index [NFI] = .87, Relative Fit Index [RFI] = .84, Bollen's Incremental Fix Index [IFI] = .87, Tucker-Lewis Index [TLI] = .84, Bentler's Comparative Fit Index [CFI] = .87). Ideally, the relative fit indices would be greater than .90 (Drewes, 2009; Hu & Bentler, 1999).

However, parallel to the SOS items, the CIS items all had significant Shapiro-Wilk's statistics (Shapiro & Wilk, 1965) and were positively skewed (see Table 9). Therefore, indicators that are more robust to skewed data, such as the Standardized Root Mean Square Residual (SRMR) and the Root Mean Square Error of Approximation (RMSEA), were examined to determine model fit (Drewes, 2009). The SRMR for the CIS model was .04 and the RMSEA was .20 (ideally, these should be under .08 and .10 respectively [Drewes, 2009; Hu & Bentler, 1999]). The SRMR showed the observed CIS model as having a good fit to the theorized model, but the RMSEA did not. Drewes (2009) asserts a high number of items in a factor, such as this twelve CIS items, may hinder the measure's fit indices, which may explain the higher than desired RMSEA statistic. All items had high loadings, the factor had a very high reliability, the SRMR showed a good fit, and the relative fit indices indicated an adequate fit; thus, the original scale (Wyer et al., 2010) was used for analysis purposes.

Table 8

Maximum Likelihood Confirmatory Factor Analysis Results for Career Intentions in Science Scale

Item	Mean	Loadings
48. Get an advanced degree in science	3.98	.92
56. Have a very successful career in science	3.93	.91
55. Have a lifelong career in science	3.98	.91
47. Be a successful scientist	3.78	.88
46. Get experience working as a scientist	4.28	.88
51. Take advanced courses in science	4.52	.88
52. Complete your degree in science	4.50	.88
53. Do advanced research in science	3.84	.88
54. Apply to graduate programs in science	3.89	.88
49. Become a scientist	3.46	.84
45. Get college training in science	4.87	.82
50. Have the ability to become a scientist	4.42	0.81
Scale Mean	**4.12**	
Total variance explained:		**76.56%**
Cronbach's Alpha		**.98**
Number of items		**12**

Note. n = 1639

Table 9

Descriptive Statistics by Item for the Career Intentions in Science (CIS) Scale

Item	Mean	*SD*	Variance	Skewness	Kurtostis	Shaprio Wilk's
CIS	*4.12*	*1.49*	*2.22*	*-.70*	*-.71*	*.90**
45. Get college training in science	4.87	1.49	2.21	-1.28	.53	.75*
46. Get experience working as a scientist	4.28	1.63	2.66	-.66	-.77	.86*
47. Be a successful scientist	3.78	1.60	2.57	-.41	-1.01	.90*
48. Get an advanced degree in science	3.98	1.77	3.13	-.43	-1.19	.87*
49. Become a scientist	3.46	1.67	2.80	-.01	-1.24	.91*
50. Have the ability to become a scientist	4.42	1.49	2.21	-.91	-.09	.85*
51. Take advanced courses in science	4.52	1.66	2.76	-.95	-.37	.81*
52. Complete your degree in science	4.50	1.81	3.26	-.91	-.71	.77*
53. Do advanced research in science	3.84	1.69	2.86	-.37	-1.12	.89*
54. Apply to graduate programs in science	3.89	1.82	3.33	-.33	-1.32	.87*
55. Have a lifelong career in science	3.98	1.81	3.27	-.47	-1.22	.86*
56. Have a very successful career in science	3.93	1.73	2.99	-.50	-1.11	.87*

Note. n = 1639; *p < .001

Data Analyses

Data analyses were conducted using SPSS 15.0 and AMOS 17.0. A statistical significance of $p \leq 0.05$ was used for all analyses. See Table 10 for a summary of the measures.

Before beginning data analysis, the distributions of CIS, Professional Competencies, and Interpersonal Competencies were examined to determine if the variables needed to be transformed. The objective of transformations is to give a skewed variable a normal distribution so the variable would not violate the assumptions of various statistical tests (Erceg-Hurn & Mirosevich, 2008). A Shapiro-Wilk's test (Shapiro & Wilk, 1965) found all three variables were positively skewed, which indicates the data needed to be transformed (see Tables 7 & 9 presented previously).

Multiple methods were employed to attempt to reach normal distributions via transformations. Three types of transformations were conducted on all three outcome composite variables: square root, logarithm, and reciprocal transformations (Field, 2005). Since none of these three methods yielded a normal distribution for the variables, the next step was to transform the individual items of the composite variable and, if still unsuccessful, try transforming the composite variable comprised of all the transformed individual items in the variable. None of these transformation approaches produced normal distributions for the three variables. The failure of transformations to create normally distributed variables is not uncommon (Erceg-Hurn & Mirosevich, 2008). Erceg-Hurn and Mirosevich recommend not transforming variables for this reason, but also because transformations ignore outliers, reduce statistical power, may change the original means' rank order, and create difficulties interpreting the findings. In addition, the analyses used in this study (correlation, t-tests, ANOVAs, regressions, and factor analysis) are all relatively robust against the violations of non-normally distributed data (Garson, 2009; Tabachnick & Fidell, 2001). Thus, it was decided to not transform the variables for the data analysis.

Table 10

Summary of Measures

Variable	Variance Explained	*M*	*SD*	# of Items	Reliability
Stereotypes of Scientists (SOS) (1-Strongly Disagree; 6-Strongly Agree)	31.75%			18	
Professional Competencies	20.41%	5.03	.52	9	.81
Interpersonal Competencies	11.34%	4.43	.58	9	.77
Career Intentions in Science (CIS) (1-Very Unlikely, 6-Very Likely)	76.56%	4.12	1.49	12	.98

Note. n = 1639

RESULTS

The results section is divided into three components: 1) descriptive statistics on the scale items, 2) the results of the three research questions and their relevant hypotheses tests, and 3) exploratory analyses.

Section One: Descriptive Statistics

Before addressing this study's primary research questions, it is of interest to look at the individual items in the measures to explore contemporary stereotypes of scientists and undergraduates' specific intentions for science education and occupational plans. This allows for a more general understanding of the variables before presenting the results of the research questions, which discusses the relationship between variables. Descriptive statistics are provided for the Career Intentions in Science (CIS) scale and for each of the two factors from the Stereotypes of Science (SOS) scale. Descriptive results are presented by the percentage of undergraduates who agreed with the item (answered either "Strongly Agree" or "Agree" for the SOS or "Very Likely" or "Likely" for the CIS) or disagreed with the item (answered either "Strongly Disagree" or "Disagree" for the SOS or "Very Unlikely" or "Unlikely" for the CIS).

<u>Items in the CIS Scale</u>

The CIS items related to pursuing or finishing a science education were the items that students indicated they had the greatest intentions of completing. Undergraduates most frequently responded they were "Very Likely" or "Likely" to (72.3%, 63.5%, and 65.7% respectively). "Get college training in science" (72.3%), "Complete your degree in science" (65.7%), and "Take advanced courses in science" (63.5%). The CIS items affiliated with pursuing a science career or advanced degree were the items students indicated they had the lowest intentions of completing. More than a quarter of undergraduates indicated they were "Very Unlikely" or "Unlikely" to "Become a scientist" (34.3%), "Apply to graduate programs in science" (29%), "Have a lifelong career in science" (27.3%), "Have a very successful career in science" (26.5%), or "Be a successful scientist" (25.9%). See Table 11.

Items in the SOS Scale

Professional Competencies Factor: Undergraduates demonstrated high agreement with many of scientists' Professional Competencies. Over 83% of undergraduates concurred scientists were "Highly focused," "Work oriented," and "Know a lot about the latest discoveries," (87.7%, 88.8%, and 83.7% respectively responded "Strongly Agree" or "Agree"). Few respondents (3% or less) responded "Strongly Disagree" or "Disagree" to any of the items addressing scientists' Professional Competencies. See Table 12.

Interpersonal Competencies Factor: Undergraduates had less item agreement for scientists' Interpersonal Competencies than they did for their perceptions of scientists' Professional Competencies. The substantial majority of respondents indicated they "Strongly Agree" or "Agree" (ranged from 60.7% to 88.8%) to all nine of the scientists' Professional Competencies items, while only four of the nine items in Interpersonal Competencies had 60% or more of respondents indicate they "Strongly Agree" or "Agree" to the item. Further, a one-way ANOVA with the factor composite scores revealed respondents agreed scientists had Professional Competencies (M = 5.03, SD = .52) significantly more than they agreed scientists had Interpersonal Competencies (M = 4.43, SD = .58) (F [28, 1610] = 4.68, p < .001).[5] The most

[5] In order to make meaningful mean comparisons between items, all the items had to be in the same direction. Thus, the Interpersonal Competencies mean score reflects the three negatively worded items after they were reverse coded.

prevalent Interpersonal Competencies scientists were agreed as having included “Collaborative,” “Cooperative,” and “Maintain friendships with colleagues in other departments” (63% of students responded “Strongly Agree” or “Agree” to all three items). Less than half of undergraduates responded “Strongly Agree” or “Agree” that scientists’ “Have fun with colleagues at work” (49.2%), “Have happy marriages (45.8%), or are “Family oriented” (34.1%). See Table 12.

Table 11

Descriptive Statistics by Item for the Career Intentions in Science Scale (CIS) Scale

Item	*M*	*SD*	Percentage who responded "Very Unlikely" (1) or "Unlikely" (2)	Percentage who responded "Very Likely" (6) or "Likely" (5)
CIS	*4.12*	*1.49*		
45. Get college training in science	4.87	1.49	12.1	72.3
46. Get experience working as a scientist	4.28	1.63	19.1	54.0
47. Be a successful scientist	3.78	1.60	25.9	39.4
48. Get an advanced degree in science	3.98	1.77	26.5	48.4
49. Become a scientist	3.46	1.67	34.3	31.7
50. Have the ability to become a scientist	4.42	1.49	14.8	58.3
51. Take advanced courses in science	4.52	1.66	17.4	63.7
52. Complete your degree in science	4.50	1.81	21.9	65.7
53. Do advanced research in science	3.84	1.69	26.4	42.8
54. Apply to graduate programs in science	3.89	1.82	29.0	46.1
55. Have a lifelong career in science	3.98	1.81	27.3	50.9
56. Have a very successful career in science	3.93	1.73	26.5	49.2

Note. n = 1639

Table 12

Descriptive Statistics by Item for the Stereotypes of Scientists (SOS) Scale

Item	*M*	*SD*	Percentage who responded "Strongly Disagree" (1) or "Disagree" (2)	Percentage who responded "Strongly Agree" (6) or "Agree" (5)
Professional Competencies	*5.03*	*.52*		
3. Know a lot about the latest discoveries	5.12	.84	1.6	83.7
6. Are the ones who know how equipment works	4.62	.94	3.2	60.7
7. Are careful with expensive instruments	5.11	.85	1.2	81.7
12. Work oriented	5.19	.68	.2	88.3
14. Technically competent	5.06	.74	.7	82.0
19. Highly focused	5.23	.72	.5	87.7
20. Able to learn to use new equipment quickly	4.90	.82	.7	73.2
21. Especially intelligent	4.99	.89	1.3	74.6
22. Logical	5.09	.84	1.0	82.3
Interpersonal Competencies	*4.43*	*.58*		
1. Have fun with colleagues at work	4.34	1.00	6.2	49.2
2. Maintain friendships with colleagues in other departments	4.58	.92	3.4	62.5
4. Do not have a lot of friends*	2.62	1.10	54.3	1.6
5. Are out of touch with what is happening in the world*	2.35	1.17	65.9	6.7
8. Have happy marriages	4.27	.92	3.7	45.8
10. Cooperative	4.67	.86	1.4	62.6
13. Family oriented	4.09	.90	4.5	34.1
17. Insecure*	2.81	1.02	40.9	6.3
18. Collaborative	4.68	.83	1.1	62.6

Note. n = 1639; *The original mean (before reverse coding) is reported for the negatively worded items. However, the Interpersonal Competencies composite score was calculated using the items after they were reverse coded.

In summary, the descriptive statistics suggest undergraduates may have greater intentions of pursuing a science education and less stated intentions to pursue a science career or higher education. Also, undergraduates' most prevalent stereotypes of scientists included them being highly focused and work oriented. Conversely, they were also perceived as having interpersonal competencies such as being collaborative and cooperative. After exploring the individual scale items, the overall composite scores for the CIS scale and the two factors in the SOS scale are used for the rest of the analyses. Next, the results of the three research questions and their corresponding hypotheses are presented.

Section Two: Hypothesis Testing

Research Question 1: *Do undergraduates' stereotypes of scientists vary by their academic major?*

A one-way ANOVA was used to test the first two hypotheses. The first hypothesis (H1a), *Undergraduates with majors in STEM fields will have a higher scientists' Professional Competencies score than those students with majors in non-STEM fields,* was not supported. There were no significant differences by academic major for Professional Competencies scores ($F[7, 1631] = 1.13$, $p = .35$); thus, undergraduates' stereotypes of scientists' Professional Competencies did not vary by academic major. See Table 13.

However, the second hypothesis (H1b), *Undergraduates majoring in STEM fields will have a higher scientists' Interpersonal Competencies score than those students with majors in non-STEM fields*, was supported. Undergraduates' stereotypes of scientists' Interpersonal Competencies significantly differed by academic major ($F[7, 1631 = 3.74$, $p < .001$). To explore which academic majors' differed, post hoc tests were conducted. Since the number of respondents in each academic major differed, post hoc analysis using the Tukey-Kramer test was conducted (Field, 2005).

The post hoc analysis confirmed the hypothesis. STEM majors had higher scientists' Interpersonal Competencies scores than non-STEM majors. Specifically, undergraduates with an academic major in the Humanities (M = 4.27, SD = .57) had significantly lower scientists' Interpersonal Competencies scores than those students with majors in Agricultural & Life Sciences (M = 4.46, SD = .59), Engineering (M = 4.47, SD = .59), and Physical & Math Sciences (M = 4.52, SD = .51). Also, students with a major categorized as Other (such as business, design, fashion and textile management, parks & recreation management, etc.) had significantly lower scientists' Interpersonal Competencies scores (M = 4.24, SD .66) than those undergraduates majoring in the Physical & Math Sciences (M = 4.52, SD = .51). See Tables 14 & 15.

Table 13

Mean Professional Competencies Scores by Academic Major

	N	Professional Competencies Mean	*SD*
Agricultural & Life Sciences	779	5.04	.51
Engineering	262	5.02	.49
Physical & Math Sciences	141	4.95	.50
Education	122	5.10	.55
Humanities	106	5.01	.55
Social Sciences	10	5.08	.56
Other	71	4.98	.57
Undecided	55	5.07	.50
Total	1639	5.03	.52

Note. There were no significant differences in mean scores between academic majors.

Table 14

Mean Interpersonal Competencies Scores by Academic Major

	N	Interpersonal Competencies Mean	*SD*
Physical & Math Sciences	141	4.52	.51
Engineering	262	4.47	.59
Agricultural & Life Sciences	779	4.46	.59
Social Sciences	103	4.42	.55
Education	122	4.34	.55
Undecided	55	4.34	.48
Humanities	106	4.27	.57
Other	71	4.24	.66
Total (All majors)	1639	4.43	.58

Table 15

Comparison of Academic Majors' Interpersonal Competencies Scores

	Mean Difference	Std. Error	*p*
Agricultural & Life Sciences vs. Engineering	-.02	.04	1.00
Agricultural & Life Sciences vs. Physical & Math Sciences	-.06	.05	.94
Agricultural & Life Sciences vs. Education	.11	.06	.49
Agricultural & Life Sciences vs. Humanities	.19	.06	**.03**
Agricultural & Life Sciences vs. Social Sciences	.03	.06	1.00
Agricultural & Life Sciences vs. Other	.21	.07	.06
Agricultural & Life Sciences vs. Undecided	.12	.08	.84
Engineering vs. Physical & Math Sciences	-.05	.06	1.00
Engineering vs. Education	.13	.06	.46
Engineering vs. Humanities	.21	.07	**.04**
Engineering vs. Social Sciences	.05	.07	1.00
Engineering vs. Other	.23	.08	.06
Engineering vs. Undecided	.13	.09	.78
Physical & Math Sciences vs. Education	.17	.07	.22
Physical & Math Sciences vs. Humanities	.25	.07	**.02**
Physical & Math Sciences vs. Social Sciences	.09	.07	.91
Physical & Math Sciences vs. Other	.27	.08	**.03**
Physical & Math Sciences	.18	.09	.52
Education vs. Humanities	.08	.08	.97
Education vs. Social Sciences	-.08	.08	.97
Education vs. Other	.10	.09	.95
Education vs. Undecided	.00	.09	1.00
Humanities vs. Social Sciences	-.16	.08	.50
Humanities vs. Other	.02	.09	1.00
Humanities vs. Undecided	-.07	.10	.99
Social Sciences vs. Other	.18	.09	.48
Social Sciences vs. Undecided	.08	.10	.99
Other vs. Undecided	-.10	.10	.98

Research Question 2: *What predicts an undergraduate's intentions to pursue a career in science?*

A multiple regression model was conducted to test the second research question's three hypotheses: (H2a) *Undergraduates with an academic major in a STEM field will have greater intentions of pursuing a career in science than those students majoring in a non-STEM field,* (H2b) *The higher an undergraduate student's scientists' Professional Competencies score the greater their intentions will be to pursue a career in science* and (H2c) *The higher an undergraduate student's scientists' Interpersonal Competencies score, the greater their intentions will be to pursue a career in science*.

Before running a regression model to predict CIS, the categorical variables, academic major and ethnicity, were dummy coded. The group that was most represented in their variable was chosen as the baseline group (the reference group that all other groups are compared to via dummy coding). Accordingly, Agricultural & Life Sciences (47.5% of respondents) served as the baseline for academic major and European American/Caucasian/White (71.5% of respondents) was the baseline group for ethnicity.

Only the predictors and covariates that were significantly correlated with CIS would be included in the regression model. Thus, bivariate correlations and one-way ANOVAs were conducted with CIS and the primary predictors (academic major and the two factors from the Stereotypes of Scientists [SOS] scale: Interpersonal Competencies and Professional Competencies) and potential covariates (demographic characteristics: gender, ethnicity, citizenship; student and university characteristics: university and years at the university).[6] The bivariate correlations and one-way ANOVAs confirmed the predictors and all of the potential covariates were significantly correlated with CIS; therefore, all the variables were included in the regression model (see Table 16).

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[6] A one-way ANOVA showed course significantly correlated with CIS ($F[[4, 1634] = 75.79$, $p < .001$); however, course was excluded as a covariate for several reasons. First, courses were included solely based on cooperating faculty. Second, course was not designed to be a variable, resulting in insufficient information to make it a meaningful covariate (course numbers, content, purpose, and requirement are not necessarily consistent when comparing departments or universities).

Table 16

Predictor and Covariate Bivariate Correlations with the Career Intentions in Science (CIS) Scale

Variable	One-Way ANOVA	Pearson's Correlation Coefficient
Professional Competencies		.09**
Interpersonal Competencies		.29**
Gender		-.08**
Citizenship		-.07**
Number of years at university		.06*
University		.06*
Ethnicity	$F(4, 1631) = 9.34, p < .001$**	
African American/Black vs. European/American/White		.01
Asian American/Asian vs. European American/White		.12**
Hispanic vs. European American/White		.04
Other vs. European American/White		.07**
Academic Major	$F(7, 1631) = 162.05, p < .001$**	
Engineering vs. Agricultural & Life Sciences		.13**
Physical & Math Sciences vs. Agricultural & Life Sciences		.12**
Education vs. Agricultural & Life Sciences		-.33**
Humanities vs. Agricultural & Life Sciences		-.35**
Social Sciences vs. Agricultural & Life Sciences		-.10**
Other vs. Agricultural & Life Sciences		-.25**
Undecided vs. Agricultural & Life Sciences		-.16**

Note. n = 1639
** Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

Next, the multiple regression model was conducted in SPSS to predict Career Intentions in Science scores. The regression model was significant (*F* [17, 1621] = 85.40, *p* < .001) and the predictors explained 47% of the variance in undergraduates' CIS scores. All of the primary predictors (academic major and Interpersonal and Professional Competencies scores) were significant predictors.

The first hypothesis, *undergraduates with an academic major in a STEM field will have greater intentions of pursuing a career in science than those students majoring in a non-STEM field,* was confirmed. Students majoring in Agricultural & Life Sciences had CIS scores significantly higher than those students majoring in Education (β = -.40, *p* < .001), Humanities (β = -.40, *p* < .001), Social Sciences (β = -.18, *p* < .001), Other fields not categorized (β = -.31, *p* < 001), and those students who have not decided yet (β = -.22, *p* < .001). In addition, there were also significant differences among STEM majors. Students majoring in Agricultural & Life Sciences had CIS scores significantly higher than those students majoring in Engineering (β = -.05, *p* = .01), but did not significantly differ from the scores of students majoring in Physical & Math Sciences (β = -.01, *p* = .56). See Table 17.

In order to compare other academic major's impact on CIS scores, the regression model was rerun with Physical & Math Sciences as the baseline category for academic major instead of Agricultural & Life Sciences. Similar to Agricultural & Life Sciences, the results showed students majoring in Physical & Math Science also had significantly higher CIS scores than those students majoring in Education (β = -.39, *p* < .001), Humanities (β = -.39, *p* < .001), Social Sciences (β = -.17, *p* < .001), Other majors (β = -.30, *p* < .001), and Undecided majors (β = -.22, *p* < .001). However, unlike when Agricultural & Life Sciences was the baseline comparison group, the CIS scores of students majoring in Physical & Math Sciences did not significantly differ from students majoring in Engineering (β = -.04, $p = .21$) (see Appendix B, Table B1 for the multiple regression conducted with Physical & Math Sciences as the baseline group for academic major).

The results of the multiple regression analysis also confirmed the second and third hypotheses, *the higher an undergraduate student's scientists' Professional and Interpersonal Competencies score the greater their intentions will be to pursue a career in science.* Students with higher scientists' Professional Competencies (β = .05, $p = .02$) and Interpersonal Competencies (β = .21, $p < .001$) scores had significantly higher CIS scores than students with lower scientists' Interpersonal Competencies and Professional Competencies scores. Undergraduates' stereotypes of scientists' Interpersonal Competencies scores was the second strongest predictor of CIS. The strongest predictor was academic major (particularly the difference between Education and Agricultural and Life Sciences (β = -.40, $p < .001$) and Humanities and Agricultural & Life Sciences (β = -.40, $p < .001$) (see Table 17).[7]

In addition to the primary predictors all being significant, three of the five covariates in the model were significant. The strongest covariate of CIS was ethnicity. Asians/Asian Americans (β = .07, $p < .001$) and students with an ethnicity categorized as Other (β = .04, $p = .02$) had significantly higher CIS scores than European American/White undergraduates. Citizenship and University were also significant. Non-U.S. citizens had significantly higher CIS scores than U.S. citizens (β = -.05, $p = .01$) and North Carolina State University students had significantly higher CIS scores than undergraduates from other universities (β = -.04, $p = .04$).

[7] Standardized beta coefficients may produce exaggerated effect sizes (Johnson 2000).

Gender and Years at the university were the two covariates that were not significant. See Table 17.

Regression Diagnostics

Regression diagnostics were conducted to ensure there were no multicollinearity problems between the predictors in the model. First, a correlation matrix was analyzed to ensure the predictors and covariates were distinct from one another. Variables were considered to be too highly correlated if they had a Pearson's correlation coefficient of .80 (Field, 2005). All variables were deemed to have an acceptable correlation since none of the correlations in the matrix had a Pearson's correlation coefficient higher than .30. See Table 18.

Next, collinearly and casewise diagnostics were run. The collinearly diagnostics examined were variances inflation factor (VIF) and tolerance. Although there are no concrete criteria for acceptable tolerance and VIF statistics, variables with a tolerance below .2 (Menard, 1995) and a VIF statistic greater than 4.0 (Garson, 2009) were chosen as cutoffs to indicate potential multicollinearity. The regression diagnostics indicated confirmed all the variables in the regression model had acceptable tolerance statistics (.80 -.97) and VIF statistics (1.03 - 1.25). However, the casewise diagnostics conducted highlighted ten potentially problematic outliers. To test if these ten cases impacted the model, the regression model was rerun without these ten respondents (F[17, 1611] = 97.74, $p < .001$, $R^2 = .51$, Adjusted $R^2 = .50$). The revised model found the same significant predictors as the initial model; thus, the outliers highlighted as potentially problematic were retained.

Table 17

Multiple Regression Model for Career Intentions in Science (CIS) Scale

Variable	*B*	β	*p*
Demographic Characteristics			
Gender (male = 0, female = 1)	-.01	-.01	.81
Citizenship (non-U.S. = 0, U.S. = 1)	-.38	-.05	**.01**
Ethnicity			
African American/Black vs. European/American/White	.18	.03	.09
Asian American/Asian vs. European American/White	.31	.07	< **.01**
Hispanic vs. European American/White	.17	.02	.22
Other vs. European American/White	.32	.04	**.02**
Student and University Characteristics			
Years at University	-.03	-.03	.19
University (NCSU = 0, Other = 1)	-.12	-.04	**.04**
Stereotypes of Science			
Professional Competencies	.13	.05	**.02**
Interpersonal Competencies	.54	.21	< **.01**
Academic Major			
Engineering vs. Agricultural & Life Sciences	-.20	-.05	**.01**
Physical & Math Sciences vs. Agricultural & Life Sciences	-.06	-.01	.56
Education vs. Agricultural & Life Sciences	-2.26	-.40	< **.01**
Humanities vs. Agricultural & Life Sciences	-2.43	-.40	< **.01**
Social Sciences vs. Agricultural & Life Sciences	-1.12	-.18	< **.01**
Other vs. Agricultural & Life Sciences	-2.23	-.31	< **.01**
Undecided vs. Agricultural & Life Sciences)	-1.84	-.22	< **.01**
R2 (and Adjusted R^2)	.47		

Note. n = 1639

Table 18

Bivariate Correlations Between Predictors and Covariates

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.
1. Interpersonal Competencies	--															
2. Professional Competencies	.23**															
3. Gender	-.01	.10**														
4. Citizenship	.05	.02	.03													
5. Number of years at university	-.01	-.05	-.08**	.04												
6. University	.00	-.01	-.04	-.03	.09**											
Ethnicity																
7. African American/Black European American/White	-.09**	.02	.08**	.02	.02	-.10**										
8. Asian American/Asian vs. White	-.02	-.01	-.02	-.29**	-.04	.14**	-.11**									
9. Hispanic vs. /White	.06*	.04	.02	-.08**	.08**	.10**	-.06*	-.08**								
10. Other vs. White	.05*	.02	-.05	-.05*	.00	.04	-.06*	-.08**	-.04							
Academic Major																
11. Engineering vs. Agricultural & Life Sciences	.03	-.01	-.24**	-.03	-.10**	-.12**	.02	.05*	-.07**	.00						
12. Physical & Math Sciences vs. Agr. & Life Sciences	.05	-.05*	-.09**	.00	-.03	-.08**	-.02	-.01	-.05*	.01	-.13**					
13. Education vs. Agr. & Life Sciences	-.04	.03	.04	.02	-.07**	-.06*	.00	-.07**	.02	-.04	-.12**	-.09**				
14. Humanities vs. Agr. & Life Sciences	-.07**	-.01	.11**	.02	-.05*	.07**	.01	-.05	.01	-.03	-.12**	-.08**	-.08**			
15. Social Sciences vs. Agr. & Life Sciences	.00	.02	.09**	.04	-.07**	.15**	.00	-.02	-.03	.05	-.11**	-.08**	-.07**	-.07**		
16. Other vs. Agr. & Life Sciences	-.07**	-.02	.02	-.05*	.02	.02	-.02	.00	-.03	.00	-.09**	-.07**	-.06*	-.06*	-.06*	
17. Undecided vs. Agr. & Life Sciences	-.03	.02	.07**	-.01	-.15**	.00	.02	.00	-.02	.00	-.08**	-.06*	-.05*	-.05*	-.05	-.04

Note: n = 1639

*Correlation is significant at the 0.05 level (2-tailed); ** Correlation is significant at the 0.01 level (2-tailed)

Research Question 3: *Does gender modify (1) the relationship between undergraduates' stereotypes of scientists and their intentions to pursue a career in science and (2) the relationship between undergraduates' academic major and their intentions to pursue a career in science?*

The third research question was answered through three separate hierarchical regression models that tested each of the three hypotheses: (H3a) *Females' stereotypes of scientists' Professional Competencies will predict their intentions to pursue a career in science, but males' stereotypes of scientists' Professional Competencies will not predict their intentions to pursue a career in science,* (H3b) *Females' stereotypes of scientists' Interpersonal Competencies will predict their intentions to pursue a career in science, but males' stereotypes of scientists' Interpersonal Competencies will not predict their intentions to pursue a career in science*, (H3c) *Academic major will be a stronger predictor for males' intentions to pursue a career in science than females' intentions.*

When testing for moderation, centering the continuous predictor variables helps to prevent problems with multicollinearity between the original predictor and the product or interaction term (Aiken & West, 1991). Thus, before the interaction terms were created, the two continuous predictors, Professional Competencies and Interpersonal Competencies, were centered. Subtracting the variable's mean score from respondents' respective score centered the variables and created a new variable mean score of 0 for the continuous predictors.

Interaction terms between the moderating variable, gender, and the predictor also needed to be calculated before the hypotheses could be tested. The interaction terms were created by multiplying gender by each of the three predictors. For the two continuous predictors, the newly centered variables were used to create the interaction term and the centered variables were also used in the regression model. Since the categorical predictor, academic major, was dummy coded, all the levels were multiplied by gender to create seven interaction terms. Thus, interaction terms were created between (H3a) gender and Professional Competencies, (H3b) gender and Interpersonal Competencies, and (H3a) gender and each of the seven levels for academic major.

Next, a separate hierarchical regression was conducted to test each hypothesis. A hierarchical regression model occurs in two steps (or blocks). The first block for each of the regression models was the same and included the significant predictors from the multiple regression conducted to answer the second research question. These predictors included: academic major, Professional Competencies, Interpersonal Competencies, citizenship, university, and ethnicity. Although not a significant predictor, gender was also included since it is the moderating variable being tested. In the second block of each hierarchical regression, the respective hypothesis's interaction term(s) of interest were entered. Therefore, the second block for the first hierarchical regression model included gender, Professional Competencies, and gender x Professional Competencies (testing H3a), while the second regression model included gender, Interpersonal Competencies, and gender x Interpersonal Competencies (testing H3b). The third model's second block included gender, all the academic levels, and the seven interaction terms between gender and each of the academic major levels (testing H3c).

Contrary to the first two hypotheses, the results of the first two hierarchical regression models did not find gender as a significant moderator between undergraduates' stereotypes of scientists' Professional Competencies and their CIS scores or undergraduates' stereotypes of scientists' Interpersonal Competencies and their CIS scores ($\Delta R^2 = .00$, $\beta = .01$, $p = .65$ and $\Delta R^2 = .00$, $\beta = -.03$, $p = .29$ respectively). Thus, males and females did not significantly differ in how their stereotypes of scientists' Professional Competencies or Interpersonal Competencies impacted their intentions to pursue a career in science (see Tables 19 & 20).

Table 19

Hierarchical Regression Model for Gender as a Moderator for Professional Competencies and Career Intentions in Science (CIS) Scale

Variable	*B*	β	*p*
Step 1			
Demographic Characteristics			
Gender (male = 0, female = 1)	-.01	.00	.90
Citizenship (non-U.S. = 0, U.S. = 1)	-.38	-.06	**< .01**
Ethnicity			
African American/Black vs. European/American/White	.18	.03	.10
Asian American/Asian vs. European American/White	.31	.07	**< .01**
Hispanic vs. European American/White	.16	.02	.25
Other vs. European American/White	.33	.04	**.02**
Student and University Characteristics			
University (NCSU = 0, Other = 1)	-.13	-.04	**.03**
Stereotypes of Science			
Professional Competencies	.13	.05	**.02**
Interpersonal Competencies	.54	.21	**< .01**
Academic Major			
Engineering vs. Agricultural & Life Sciences	-.19	-.05	**.02**
Physical & Math Sciences vs. Agricultural & Life Sciences	-.05	-.01	.65
Education vs. Agricultural & Life Sciences	-2.24	-.40	**< .01**
Humanities vs. Agricultural & Life Sciences	-2.41	-.40	**< .01**
Social Sciences vs. Agricultural & Life Sciences	-1.10	-.18	**< .01**
Other vs. Agricultural & Life Sciences	-2.22	-.30	**< .01**
Undecided vs. Agricultural & Life Sciences	-1.80	-.22	**< .01**
R^2 and Adjusted R2	.47		
Step 2			
Gender (male = 0, female = 1)	-.01	.00	.91
Professional Competencies	.11	.04	.19
Gender x Professional Competencies	.05	.01	.65
R^2 and Adjusted R^2	.47		
ΔR^2	.00		.65

Note. n = 1639

Table 20

Hierarchical Regression Model for Gender as a Moderator for Interpersonal Competencies and Career Intentions in Science (CIS) Scale

Variable	*B*	β	*p*
Step 2			
Gender (male = 0, female = 1)	-.01	.00	.92
Interpersonal Competencies	.60	.23	< **.01**
Gender x Interpersonal Competencies	-.10	-0.03	.29
R^2 and Adjusted R2	.47		
ΔR^2	.00		.29

Note. n = 1639

There was some support for the third hypothesis. Gender significantly moderated the relationship between students majoring in Humanities and their CIS scores compared to students majoring in Agricultural and Life Sciences and their CIS scores ($\Delta R^2 = .003$, $\beta = -.09$, $p = .03$). As hypothesized, results revealed males majoring in Humanities (mean CIS score = 2.69, *SD* = 1.69) have significantly higher CIS scores than females in Humanities (mean CIS score = 2.01, *SD* = 1.06), but CIS scores did not vary by gender for students majoring in Agricultural & Life Sciences (males' mean CIS score = 4.69, *SD* = 1.10; females' mean CIS score = 4.74, *SD* = .99). See Figure 1. Despite hypothesizing academic major would be a stronger predictor for males' CIS scores than females' CIS scores, gender was not a significant moderator for the relationship between any of the other levels of academic major and an undergraduate's desire to pursue a career in science (see Table 21).

To further investigate how gender may modify academic major's relationship with intentions to pursue a science career, another hierarchal regression was conducted after changing academic major's baseline from Agricultural & Life Sciences to Physical and Math Sciences. Interaction terms were then created between gender and each academic major compared to the new baseline group of Physical & Math Sciences. Although gender significantly moderated the relationship between Humanities vs. Agricultural & Life Sciences and CIS scores, no interaction terms were significant after changing academic major's base groups (See Appendix B, Table B2 for the hierarchical regression model with Physical & Math Sciences as the baseline group for academic major).

Table 21

Hierarchical Regression Model for Gender as a Moderator for Academic Major and Career Intentions in Science (CIS) Scale

Variable	*B*	β	*p*
Step 2			
Gender (male = 0, female = 1)	.03	.01	.73
Academic Major			
Engineering vs. Agricultural & Life Sciences	-.22	-.05	.04
Physical & Math Sciences vs. Agricultural & Life Sciences	.01	.00	.94
Education vs. Agricultural & Life Sciences	-2.09	-.37	.00
Humanities vs. Agricultural & Life Sciences	-1.94	-.32	.00
Social Sciences vs. Agricultural & Life Sciences	-1.20	-.20	.00
Other vs. Agricultural & Life Sciences	-2.14	-.29	.00
Undecided vs. Agricultural & Life Sciences	-1.79	-.22	.00
Academic Major			
Gender * Engineering vs. Agricultural & Life Sciences	.13	.02	.42
Gender * Physical & Math Sciences vs. Agricultural & Life Sciences	-.12	-.02	.56
Gender * Education vs. Agricultural & Life Sciences	-.23	-.03	.31
Gender * Humanities vs. Agricultural & Life Sciences	-.60	-.09	**.03**
Gender * Social Sciences vs. Agricultural & Life Sciences	.13	.02	.62
Gender * Other vs. Agricultural & Life Sciences	-.14	-.02	.63
Gender * Undecided vs. Agricultural & Life Sciences	-.03	.00	.94
R^2 and Adjusted R2	.47		
ΔR^2	.003		.35

Note. n = 1639

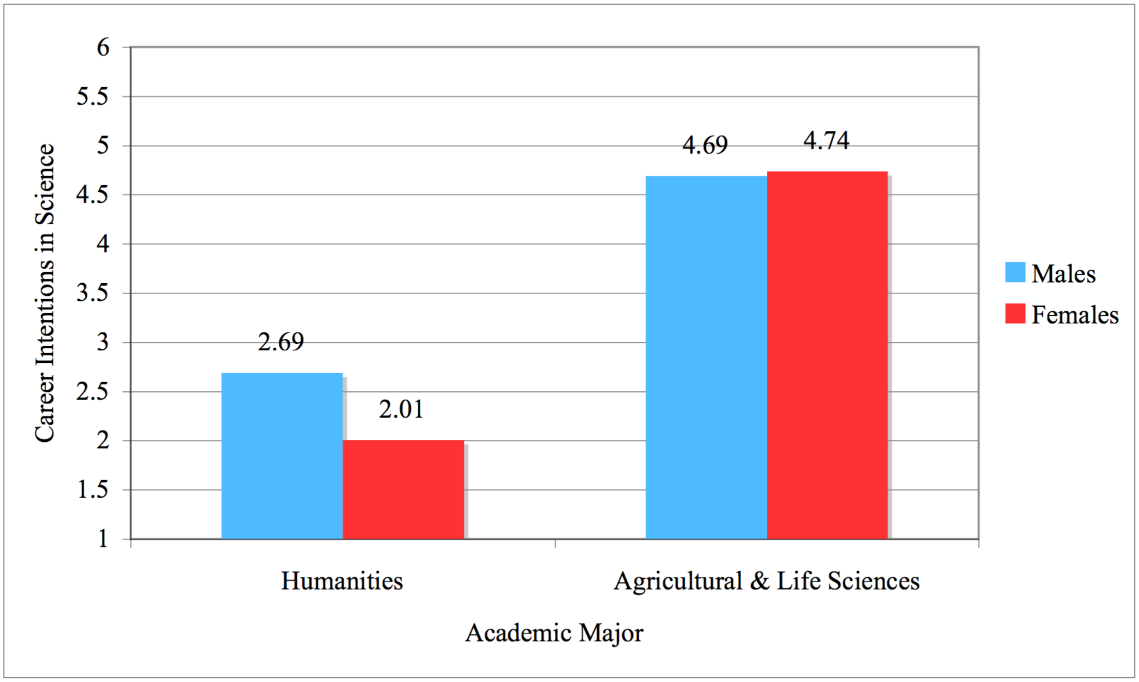

Figure 1. Gender as a Moderator for the Relationship between Humanities vs. Agricultural & Life Sciences and CIS scores (1= "Very Unlikely," 6 = "Very Likely")

Section Three: Exploratory Analyses

As the literature review implies, gender differences may exist between students' stereotypes of scientists (Chambers, 1983; Mead & Metraux, 1957; Owen et al, 2007) and their science career paths (Lackland & De Lisi, 2001; Preston, 2004; Seymour & Hewitt, 1994; Xie & Shauman, 2003). It was further suggested that females' stereotypes of scientists might influence their science career plans to a greater degree than with males (Davies et al., 2002). Contrary to what was hypothesized, gender did not significantly moderate the relationships between the primary predictors and CIS scores. One potential explanation for this lack of significant finding would be the measures are assessing different constructs for males and females (Henson & Roberts, 2006; Tabachnick & Fidell, 2001). An alternative explanation could be that gender differences within individual items are not displayed when looking at the overarching constructs. Therefore, it is of interest to further explore via exploratory analyses if gender's relationships with stereotypes of scientists, or academic major, relate to the intention to pursue a career in science.

The exploratory section is divided into three analyses. The first examines whether the measures (CIS and SOS) were equally fitting for both males and females. The second exploratory analysis tests whether the individual items in the CIS and SOS measures had significant gender differences. Additionally, gender differences among academic majors were explored. The last exploratory analysis recoded academic major into a dichotomous variable that compared STEM majors vs. non-science. Each of the three research question's hypotheses was retested using the recoded academic major variable in order to explore how the categorization of major potentially impacts the results.

Exploratory Analysis #1: Gender Differences in the CIS and SOS Scales

The Career Intentions in Science (CIS) and Stereotypes of Scientists (SOS) scales were tested nationally for the first time in this study. Past research indicates there may be a gender effect in the scale development and the measure's validity for both males and females should be tested (Henson & Roberts, 2006; Kim, 2002; Tabachnick & Fidell, 2001). Finding a gender difference in the measure would suggest males and females differ in which items actually represent their stereotypes or science career intentions. To test each group's theoretical structure, another confirmatory factor analysis (CFA) was conducted with the items from each measure for two groups: males and females. This multi-group CFA for each measure was able to test whether there were significant differences in model fit between males ($n = 459$) and females ($n = 659$).

Career Intentions in Science (CIS) Scale

A multi-group maximum likelihood confirmatory factor analysis tested for gender differences in the model fit of the one factor, twelve-item CIS measure (Marsh, 1987). The CIS's unconstrained two-group model, which freely estimated the male and female factor structures (χ_2 [120]= 3590.65, $p < .001$), significantly differed from the constrained model fit, which constrained the loadings to be equal between male and female groups (χ_2[108]= 3558.18, $p < .001$) (Steinmetz, Schmidt, Tina-Booh, Wieczorek, & Schwartz, 2009). Thus, the multi-group analysis revealed variance of factor measurement by gender, which signifies the CIS theoretical factor structure significantly differs between males and females ($\chi_2\Delta$ [12]= 32.46, $p < .001$, ΔNFI = .001, ΔRFI = –.015, ΔIFI = .001, ΔTLI= -.015, ΔCFI= .00, ΔRMSEA = .01, and ΔSRMR = .00). See Table 22.

Despite not finding measurement invariance by gender, the two models did not appear to vary extensively when examining the model's goodness-of-fit indices or when contrasting item loadings by gender. First, the adequacy of each model is determined by the fit indices (Tabachnick & Fidell, 2001). The unconstrained and constrained models' fit indices were all within .015 of each other's respective fit index (see Table 22). This implies a comparable goodness-of-fit for each model.

Next, the factor structure by gender was compared. The CIS model for males and CIS model for females both had high factor loadings for all twelve items (females factor loadings = .82 - .93; male factor loadings = .80 - .90) and remarkably high overall model reliability (Cronbach's Alpha for males = .97, females = .98 [Cronbach, 1951]). The higher an item's factor loading, the more that item is related to the overall factor (Field, 2005); therefore, the slightly higher loadings for females indicate the model may be a better fit for females than males. However, when comparing individual item loadings between male and female models, all the items' factor loadings had a difference of .04 or less. See Table 23.

These high factor loadings and reliability for males and females and the small differences in factor loadings and fit indices does not appear to support the finding of measurement differences by gender despite the significant difference in Chi-Square between the unconstrained and constrained models. Past research suggests not finding measurement invariance may be a result of the large sample size and potentially indicate the CIS is a better model fit for females than males when it actually may not significantly differ (Bakker, Demerouti, Taris, Schaufeli, & Schreurs, 2003; Newsom, 2008; Thompson & Daniel, 1996).

Table 22

Multi-group Gender Analysis of the CIS Model

	χ2	DF	*P*	NFI	RFI	IFI	TLI	CFI	RMSEA	SRMR
Full Model	3486.66	54	.00	.87	.84	.87	.84	.87	.20	.04
Unconstrained Two-Group Model	3558.18	108	.00	.87	.84	.87	.84	.87	.14	.05
Constrained Two-Group Model	3590.65	120	.00	.86	.85	.87	.86	.87	.13	.05
Model Difference	32.46	12	.00	.001	-.015	.001	-.015	.00	.01	.00

Note. NFI = Non-Normed Fit Index; RFI = Relative Fit Index; IFI = Incremental Fit Index; TLI = Tucker-Lewis Index; CFI = Comparative Fit Index; RMSEA = Root-Mean-Square Error of Approximation; SRMR = Standardized Root Mean Square Residual Root

Table 23

Maximum Likelihood Confirmatory Factor Analysis Results for Career Intentions in Science (CIS) Scale by Gender

Item	Factor Loadings: Total Sample	Factor Loadings: Females	Factor Loadings: Males
45. Get college training in science	.82	.84	.80
46. Get experience working as a scientist	.88	.87	.88
47. Be a successful scientist	.88	.88	.88
48. Get an advanced degree in science	.92	.93	.90
49. Become a scientist	.84	.84	.85
50. Have the ability to become a scientist	.81	.82	.80
51. Take advanced courses in science	.88	.89	.85
52. Complete your degree in science	.88	.89	.86
53. Do advanced research in science	.88	.89	.86
54. Apply to graduate programs in science	.88	.88	.87
55. Have a lifelong career in science	.91	.93	.89
56. Have a very successful career in science	.91	.93	.89
Cronbach's Alpha	.98	.98	.97
CIS Scale Mean	4.12 (*SD*= 1.49)	4.27 (*SD*= 1.40)	4.02 (*SD*=1.54)
N size	1639	964	657

Stereotypes of Scientists (SOS) scale

A second multi-group maximum likelihood CFA tested gender differences in the model fit of the two-factor (nine items each) SOS measure. The results found the unconstrained model (χ_2 [268]= 1752.68, $p < .001$) significantly differed from the constrained model (χ_2[286]= 1800.99, $p < .001$). Therefore, as with the CIS scale, the lack of invariance of factor measurement found across gender indicates the SOS scale significantly differs between males and females ($\chi_2\Delta$ [18] = 48.35, $p < .001$, ΔNFI = .006, ΔRFI = -.01, ΔIFI = .007, ΔTLI= -.01, ΔCFI= .01, ΔRMSEA = .00, and ΔSRMR = .00). See Table 24.

After examining the fit indices between models and factor loadings between males and females, there was mixed evidence for the measure's structure varying by gender. The fit indices between the unconstrained and constrained models did not provide much support for gender differences in the measure since they were all within .01 of each model's respective fit index. However, when comparing the items' factor loadings between male and female factor structures, there was selected evidence that the theoretical factor structure was better for males than it was for females.

For the items in Professional Competencies, factor loadings and reliability appeared to be generally comparable for males and females. Males had item loadings ranging from .48 to .65, while females' item loadings ranged from .40 -.71. Further, both males and females had a Cronbach's Alpha of .81 (Cronbach, 1951) for the Professional Competencies factor. However, when examining the factor structure and reliability in the Interpersonal Competencies by gender, the factor seemed to be a superior fit for males than females.

When comparing the item loadings and overall reliability of the Interpersonal Competencies structure by gender, males had higher overall factor loadings (ranged from .49 - .65) and higher factor reliability (Cronbach's Alpha = .82) than for females' factor structure (loadings ranged from .34-.59; Cronbach's Alpha = .77) (Cronbach, 1951). In particular, the item "Insecure," was a much better representation of males' stereotypes of scientists' Interpersonal Competencies (item loading = .55) than for females (item loading = .34). See Table 25. Thus, unlike the CIS measure where females may have had a slightly better model fit than males, the SOS model was found to have a superior fit for male respondents. This may be particularly relevant, or even isolated to, the gender differences in the Interpersonal Competencies factor.

Table 24

Multi-group Gender Analysis of the SOS Scale

	$\chi 2$	DF	*P*	NFI	RFI	IFI	TLI	CFI	RMSEA	SRMR
Full Model	1574.79	134	.00	.79	.76	.80	.77	80	.08	.07
Unconstrained Two-Group Model	1752.64	268	.00	.77	.74	.80	.77	.80	.06	.07
Constrained Two-Group Model	1800.99	286	.00	.76	.74	.79	.78	.79	.06	.07
Model Difference	48.35	18	.00	.006	-.01	.007	-.01	.01	.00	.00

Note. NFI = Non-Normed Fit Index; RFI = Relative Fit Index; IFI = Incremental Fit Index; TLI = Tucker-Lewis Index; CFI = Comparative Fit Index; RMSEA = Root-Mean-Square Error of Approximation; SRMR = Standardized Root Mean Square Residual Root

Table 25

Maximum-likelihood Confirmatory Factor Analysis Results for Stereotypes of Scientists by Gender

Item	Factor Loadings: Total Sample	Factor Loadings: Females	Factor Loadings: Males
Professional Competencies			
21. Especially intelligent	.68	.70	.64
20. Able to learn to use new equipment quickly	.68	.71	.64
19. Highly focused	.64	.63	.65
14. Technically competent	.60	.59	.63
22. Logical		.60	.58
12. Work oriented	.51	.53	.48
6. Are the ones who know how equipment works	.49	.40	.51
7. Are careful with expensive instruments	.50	.45	.54
3. Know a lot about the latest discoveries	.45	.43	.48
Scale Mean	5.03 (*SD*= .52)	5.04 (*SD*= .45)	4.93 (*SD*= .48)
Cronbach's Alpha	.81	.81	.81
Interpersonal Competencies			
4. Do not have a lot of friends*	.58	.57	.59
2. Maintain friendships with colleagues in other departments	.55	.52	.59
1. Have fun with colleagues at work	.52	.51	.52
13. Family oriented	.55	.59	.49
10. Cooperative	.59	.55	.64
5. Are out of touch with what is happening in the world*	.49	.46	.53
18. Collaborative	.55	.52	.60
8. Have happy marriages	.50	.51	.49
17. Insecure*	.43	.34	.55
Scale Mean	4.43 (*SD* = .58)	4.42 (*SD*= .56)	4.43 (*SD*= .60)
Cronbach's Alpha	.77	.77	.82
Correlation of factors	.28	.23	.36
N size	1639	964	657

Exploratory Analysis #2: Gender Differences in Individual Scale Items and Among Academic Majors

The previous exploratory analysis tested the measure's constructs and model fit by gender. While this analysis is helpful for indicating whether the measures are satisfactory for testing both males and females, it does not specify whether males and females differ in any of the individual items that represent their stereotypes of scientists or their intentions to pursue a science career. For example, males and females may significantly differ in their desire to "Become a scientist;" however, the item may be representing a student's overall science career intentions equally well for males and females. Therefore, it was also of interest to examine if the results of individual scale items differed for males and females in order to understand if males and females specifically differ in some of their stereotypes of scientists. This exploratory analysis examines gender differences for the items in the CIS, items in the SOS, and a student's academic major.

Gender Differences Among the Items in the Career Intentions in Science (CIS) Scale

Before examining the individual items in the CIS, a t-test was conducted to find out whether there were overall gender differences in CIS scores that warranted further investigation. Results found males (M = 4.27, SD = 1.40) had significantly higher CIS scores than females (M = 4.02, SD = 1.54), $t(1530.28) = 3.43$, $p < .001$. The next step was to conduct a multivariate analysis of variance (MANOVA) to test whether gender predicted each of the twelve items in the CIS. In order to reduce the likelihood of making a Type I error, a MANOVA was chosen over twelve individual t-tests (Field, 2005).

Overall, the MANOVA indicated gender was a significant predictor for the twelve CIS items ($F[12, 1626] = 7.02$, $p < .001$). Looking at the individual CIS items, nine of the twelve items significantly differed by gender. Males had significantly higher mean scores than females for all nine of those items. The largest gender discrepancies were for the items: "Have the ability to become a scientist," "Become a scientist," and "Take advanced courses in science" (mean difference between males and females = .44, .38, and .37 respectively). The three items that did not significantly differ between men and women were: "Have a lifelong career in science," "Have a successful career in science," and "Apply to graduate programs in science" (mean difference between males and females = .03, .07, and .16 respectively). See Table 26 for the complete results.

Table 26

Multivariate Analysis of Variance by Gender for Items in the Career Intentions in Science (CIS) Scale

	SS	Mean Square	*F*[a]	*p*	R^2	Male Mean	Female Mean	Mean Difference
45. Get college training in science	12.24	12.24	5.56	**.02**	.003	4.97	4.80	**.25**
46. Get experience working as a scientist	29.59	29.59	11.21	**< .01**	.007	4.44	4.17	**.44**
47. Be a successful scientist	38.45	38.45	15.09	**< .01**	.009	3.96	3.65	**.38**
48. Get an advanced degree in science	21.38	21.38	6.86	**.01**	.004	4.12	3.89	**.37**
49. Become a scientist	56.63	56.63	20.45	**< .01**	.012	3.68	3.30	**.31**
50. Have the ability to become a scientist	78.19	78.19	36.08	**< .01**	.022	4.68	4.24	**.29**
51. Take advanced courses in science	54.38	54.38	19.95	**< .01**	.012	4.74	4.37	**.29**
52. Complete your degree in science	31.86	31.86	9.82	**< .01**	.006	4.67	4.38	**.27**
53. Do advanced research in science	32.88	32.88	11.57	**< .01**	.007	4.01	3.72	**.23**
54. Apply to graduate programs in science	9.50	9.50	2.86	.09	.002	3.98	3.82	**.17**
55. Have a lifelong career in science	0.47	0.47	0.14	.71	.000	4.00	3.96	.16
56. Have a very successful career in science	2.06	2.06	0.69	.41	.000	3.97	3.90	.07

Note. n = 1639 (Females: n = 964, Males: n = 675). *Degrees of freedom = (1, 1637) for all items.

Gender Differences Among the Items in the Stereotypes of Scientists (SOS) Scale

Similar to the CIS scale, t-tests were conducted between gender and the Professional and Interpersonal Competencies composite scores to test for overall gender differences in the constructs. The t-tests revealed females had significantly higher Professional Competencies mean scores (M = 5.04, SD = .45) than males (M = 4.93, SD = .60), t(1637) = -4.03, p < .001. However, there were no significant differences between males' and females' Interpersonal Competencies composite scores (males (M = 4.43, SD = .60; females (M = 4.42, SD = .56), t(2388.51) = .33, p = .74.

A MANOVA was next conducted to examine whether the SOS individual items significantly differed by gender. The analysis included all 22 of the original SOS items since the four items that were removed from the scale may still reveal gender differences of interest. The MANOVA confirmed gender differences existed among the items in the SOS (F[22, 1616] = 5.37, p < .001). Gender differences among individual items are discussed by factor below. See Table 27 for the complete results.

<u>Professional Competencies:</u> Females had significantly stronger agreement than males to the majority of the items in scientists' Professional Competencies (five of the nine items). The items in which males and females had the largest divergence were in perceptions of scientists as "Work oriented," "Are careful with expensive instruments," "Highly focused," "Able to learn new equipment quickly," and "Especially Intelligent (the mean score for at least .12 higher for females than for males for all five items). The competencies with the smallest gender differences (and the four non-significant items) were: "Technically competent," "Competent," "Self-confident," and "Logical" (mean difference between females and males were all less than .08).

Interpersonal Competencies: Although there were no gender differences in students' overall stereotypes of scientists' Interpersonal Competencies, three items significantly differed by gender. Males had a significantly higher mean score than females for two of those three items. Males agreed more often than females that scientists "Have fun with colleagues at work" and "Maintain friendships with colleagues in other departments" (mean difference between males and females = .12 for both items). However, females agreed significantly more than males that scientists were "Family oriented" (mean difference between females and males = .09).

The Four Removed Competencies: As discussed previously in the methods section, there were four original items in the survey that were removed from the SOS scale. Those four competencies were initially included under Professional Competencies: "Competitive," "Independent," "Competent," and "Self-confident." These items were also examined since they may have initially not been considered adequate measurement items because of their severe gender differences (Kim, 2002). This information would help further clarify major differences in perceptions of scientists' attributes.

Two of the four removed items significantly differed. Parallel to the five items in Professional Competencies, females agreed significantly more than males that scientists were "Independent" and "Competitive" (mean difference between females and males = .29 and .15 respectively). Looking at all of the twenty-two original SOS items together, it is noteworthy to point out that males (M = 4.67, SD = .96) and females (M = 4.96, SD = .82) had the largest difference in whether they agreed scientists were "Independent." Males and females did not significantly differ in whether they perceived scientists as being "Competent" or "Self-Confident."

Table 27

Multivariate Analysis of Variance by Gender for the Items in the Stereotypes of Scientists Scale (SOS)

	SS	Mean Square	F^a	*p*	R^2	Male Mean	Female Mean	Mean Difference
Professional Competencies				**< .01**		4.93	5.04	**-.11**
3. Know a lot about the latest discoveries	2.07	2.07	2.91	.09	.002	5.07	5.15	-.08
6. Are the ones who know how equipment works	1.25	1.25	1.42	.23	.001	4.59	4.64	-.05
7. Are careful with expensive instruments	9.89	9.89	13.65	**< .01**	.008	5.01	5.17	**-.16**
12. Work oriented	9.82	9.82	21.85	**< .01**	.013	5.09	5.25	**-.16**
14. Technically competent	.09	0.09	0.17	.68	.00	5.05	5.06	-.01
19. Highly focused	9.84	9.84	18.99	**< .01**	.011	5.14	5.30	**-.16**
20. Able to learn to use new equipment quickly	8.08	8.08	12.17	**< .01**	.007	4.81	4.96	**-.15**
21. Especially intelligent	5.99	5.99	7.57	**.01**	.005	4.92	5.04	**-.12**
22. Logical	1.16	1.16	1.63	.20	.001	5.06	5.12	-.06
Interpersonal Competencies				.74		4.43	4.42	.01
1. Have fun with colleagues at work	5.61	5.61	5.59	**.02**	.003	4.41	4.29	**.12**
2. Maintain friendships with colleagues in other departments	5.59	5.59	6.61	**.01**	.004	4.65	4.53	**.12**
4. Do not have a lot of friends*	.29	0.29	0.24	.63	.00	2.64	2.61	.03
5. Are out of touch with what is happening in the world*	3.18	3.18	2.34	.13	.001	2.41	2.32	.09
8. Have happy marriages	.45	0.45	0.53	.47	.00	4.29	4.26	.03
10. Cooperative	.87	0.87	1.19	.28	.001	4.70	4.65	.05
13. Family oriented	3.75	3.75	4.65	**.03**	.003	4.04	4.13	**-.09**
17. Insecure*	1.71	1.71	1.67	.20	.001	2.85	2.78	.07
18. Collaborative	.91	0.91	1.33	.25	.001	4.71	4.66	.05
The 4 Removed SOS Items								
9. Competitive	9.03	9.03	11.62	**< .01**	.007	4.83	4.98	**-.15**
11. Independent	34.64	34.64	44.84	**< .01**	.027	4.67	4.96	**-.29**
15. Competent	.99	0.99	2.02	.16	.001	5.12	5.17	-.05
16. Self-confident	.83	0.83	1.09	.30	.001	4.66	4.71	-.05

Note. n = 1639 (Females: n = 964, Males: n = 675)
*Items reverse coded. [a] Degrees of freedom = (1, 1637) for all items.

Gender Differences Among Academic Majors

To examine whether gender significantly predicted one's academic major, a multinomial logistic regression was conducted. The model found gender did significantly predict an undergraduate's academic major, $\chi 2$ (7, N = 1639) = 142.49, $p < .001$, Nagelkerke pseudo R^2 = .09. The regression model was rerun with several academic major baseline changes in order to compare for significant gender differences between all levels of academic major. See Table 28 and 29 for the complete results of the comparisons.

The gender differences that emerged among academic majors correspond to national reports detailing if more males or females earn bachelor degrees in various academic majors (NSF/SRS, 2009). For instance, males were significantly more likely than females to have an academic major in Engineering or Physical & Math Sciences than any other major (percentage difference of 37.4% and 12.4% respectively). Specifically, females were more likely than males to have a major in Agricultural & Life Sciences, Education, Humanities, Social Sciences, Other, Undecided or even Physical & Math Sciences compared to an Engineering major, (Odds Ratio = 3.74, 1.74, 4.18, 8.36, 6.85, 3.80, and 7.09, $p < .01$). Females were also significantly more likely to have an Agricultural & Life Sciences, Education, Humanities, Social Sciences, Other, and Undecided major than to have a Physical & Math Sciences major (Odds Ratio = 2.17, 2.43, 4.87, 3.98, 2.21, and 4.12 respectively, $p < .01$).

Significant gender differences also emerged among the academic majors dominated by females. Despite there being more females than males in Agricultural & Life Sciences, females were 2.24 times more likely than males to have a major in Humanities, 1.83 times more likely to have a Social Sciences major, and 1.90 times more likely to have an Undecided major than to have an Agricultural & Life Sciences major. See Table 29.

It was also of interest to test whether there were gender differences when all science, technology, engineering, and math (STEM) majors and non-STEM majors were examined together. Using NSF's classifications as guidance (NSF/SRS, 2009), academic major was recoded as either a STEM major (Agricultural & Life Sciences, Engineering, and Physical & Math Sciences) or a non-STEM major (Education, Humanities, Social Sciences,[8] Other, and Undecided) (STEM = 0, non-STEM = 1). A Chi-Square test was then conducted between gender and the recoded, dichotomous academic major. The results supported the previous finding that gender differences exist between the individual majors. Overall, there were significantly more females than males with a non-STEM major compared to a STEM major (χ_2 [1, N = 1639] = 320.70, $p < .001$).

[8] Respondents with a Social Science major were grouped as having a non-STEM major. This was determined based on the results of the multivariate regression conducted in research question two. Students majoring in Agricultural & Life Sciences had significantly higher science career intentions than students with a Social Science major. Further, there were significantly more men than women in Agricultural & Life Sciences, Engineering, and Physical & Math Sciences when compared to Social Sciences.

Table 28

Percentage of Males and Females by Academic Major

	n	Percentage Female	Percentage Male	Difference in Percentage
Humanities	106	79.2%	20.8%	58.5%
Undecided	55	76.4%	23.6%	52.7%
Social Sciences	103	75.7%	24.3%	51.5%
Education	122	65.6%	34.4%	31.1%
Other	71	63.4%	36.6%	26.8%
Agricultural & Life Sciences	779	63.0%	37.0%	26.1%
Physical & Math Sciences	141	44.0%	56.0%	12.1%
Engineering	262	31.3%	68.7%	37.4%
Total	*1639*	*63.0%*	*37.0%*	*26.1%*

Table 29

Multinomial Regression of Academic Major by Gender (male = 0, female = 1)

	Coefficient	Wald	Odds Ratio	*p*
Agricultural & Life Sciences vs. Education	.11	.29	1.12	.59
Agricultural & Life Sciences vs. Humanities	.81	10.34	2.24	**< .01**
Agricultural & Life Sciences vs. Social Sciences	.60	6.26	1.83	**.01**
Agricultural & Life Sciences vs. Other	.02	.00	1.02	.95
Agricultural & Life Sciences vs. Undecided	.64	3.85	1.90	**.05**
Engineering vs. Agricultural & Life Sciences	1.32	74.88	3.74	**< .01**
Engineering vs. Physical & Math Sciences	.54	6.36	1.72	**.01**
Engineering vs. Education	1.43	37.86	4.18	**< .01**
Engineering vs. Humanities	2.13	60.18	8.38	**< .01**
Engineering vs. Social Sciences	1.92	52.46	6.85	**< .01**
Engineering vs. Other	1.34	22.72	3.80	**< .01**
Engineering vs. Undecided	1.96	32.39	7.09	**< .01**
Physical & Math Sciences vs. Agricultural & Life Sciences	.78	17.55	2.17	**< .01**
Physical & Math Sciences vs. Education	.89	12.08	2.43	**< .01**
Physical & Math Sciences vs. Humanities	1.58	29.06	4.87	**< .01**
Physical & Math Sciences vs. Social Sciences	1.38	23.34	3.98	**< .01**
Physical & Math Sciences vs. Other	.79	6.99	2.21	**.01**
Physical & Math Sciences vs. Undecided	1.42	15.46	4.12	**< .01**
Education vs. Humanities	.70	5.16	2.01	**.02**
Social Sciences vs. Humanities	.20	.37	1.22	.54
Other vs. Humanities	.79	5.30	2.21	**.02**
Undecided vs. Humanities	.17	.18	1.18	.67
Education vs. Social Sciences	.49	2.73	1.64	.10
Social Sciences vs. Other	-.10	.10	.91	.76
Education vs. Undecided	.53	2.04	1.70	.15
Social Sciences vs. Other	-.59	3.06	.56	.08
Social Sciences vs. Undecided	.04	.01	1.04	.93
Other vs. Undecided	.62	2.41	1.87	.12

Note: n = 1639

Exploratory Analysis #3: STEM *Majors vs. Non-*STEM *Majors*

Academic major had a significant relationship with students' stereotypes of scientists' Interpersonal Competencies and was the primary predictor of science career intentions. However, there were significant findings between STEM and non-STEM majors, and even within STEM majors. It was of interest to discover if, or how, these effects would change if STEM majors were combined and compared to non-STEM majors. Therefore, similar to how the National Science Foundation compares students' individual academic majors and categorized into STEM and non-STEM majors (NSF/SRS, 2009), the third exploratory analysis reexamined the three original research questions with academic major recoded into STEM majors & non-STEM. As in the previous exploratory analysis, academic major was categorized as either a STEM (Agricultural & Life Sciences, Physical & Math Sciences, and Engineering = 0) or non-STEM major (Humanities, Social Sciences, Education, Other, and Undecided = 1).

The majority of respondents were categorized as having a STEM major (72.9%, n = 1182), while just over a quarter of respondents had a non-STEM major (27.9%, n = 457). There were about the same number of females and males in STEM majors (females = 54%, males = 46%); however, females constituted almost three-fourths (72%) of non-STEM majors, while just over one quarter (28%) of non-STEM majors were male.

<u>Research Question 1 Rerun:</u> *Do undergraduates' stereotypes of scientists vary by their academic major?*

One-way ANOVA tests originally examined if students' stereotypes of scientists' Professional and Interpersonal Competencies differed between STEM and non-STEM majors. Since academic major is now a dichotomous variable, t-tests were run to test the two hypotheses.

The results did not differ from the original analysis. The first hypothesis, *Undergraduates with majors in STEM fields will have a higher scientists' Professional Competencies score than those students with majors in non-STEM fields,* remained unsupported. Professional Competencies scores did not significantly differ by academic major, $t(768.06) = -.88$, $p = .38$). Science, technology, engineering and math (STEM) majors had a mean Professional Competencies score of 5.03 ($SD = .50$), while non-STEM majors had a score of 5.05 ($SD = .55$). The second hypothesis, *Undergraduates majoring in STEM fields will have a higher scientists' Interpersonal Competencies score than those students with majors in non-STEM fields,* was confirmed again. Interpersonal Competencies scores did significantly differ by academic major, $t(1637) = 4.37$, $p < .001$. Students with STEM majors ($M = 4.67$, $SD = .58$) agreed significantly more often than non-STEM majors ($M = 4.33$, $SD = .57$) that scientists had Interpersonal Competencies.

<u>Research Question 2 Rerun:</u> *What predicts an undergraduate's intentions to pursue a career in science?*

The multiple regression model predicting CIS scores was rerun with the dichotomous academic major variable replacing the dummy coded academic major variables. A bivariate correlation confirmed STEM academic majors were positively and significantly correlated with CIS scores ($r = .61$). Bivariate correlations between academic major (STEM vs. non-STEM) and the other predictors in the model confirmed multicollinearity was not of concern. See Table 30.

Table 30

Research Question 2 Rerun: Predictor and Covariate Correlations with Academic Major STEM vs. Non-STEM

Variable	One-Way ANOVA	Correlation with Academic Major (STEM vs. non-STEM)
Career		- .61**
Professional Competencies		.02
Interpersonal Competencies		- .11**
Gender		.17**
Citizenship		.02
Number of years at university		- .16**
University		.09**
Ethnicity	$F(4, 1631) = 3.16, p = .01$	
African American/Black vs. European/American/White		.00
Asian American/Asian vs. European American/White		- .08**
Hispanic vs. European American/White		- .02
Other vs. European American/White		- .01

Note. n = 1639

** Pearson's correlation coefficient is significant at the 0.01 level (2-tailed)

Next, the multiple regression analysis was rerun. The variables entered were the same as the original analysis except academic major was replaced with the recoded, dichotomous academic major variable. The model was again found to be significant ($F[11, 1627] = 116.268$, p < .001) and explained 44% of the variance in CIS. This regression model explained slightly less variance than the original model explained (47%). There was only one change in whether a variable was a significant or non-significant predictor. University, which was a significant covariate in the original model, became a non-significant predictor of CIS ($\beta = -.05$, p = .43).

The first hypothesis in the second research question, *Undergraduates with an academic major in a STEM field will have greater intentions of pursuing a career in science than those students majoring in a non-STEM field,* was again confirmed. Students majoring in STEM had CIS scores ($M = 4.69$, $SD = 1.05$) significantly higher than those students majoring in non-STEM majors ($M = 2.66$, $SD = 1.45$) ($\beta = -.59$, $p < .001$). The results of the multiple regression also confirmed the second and third hypotheses in the second research question, *The higher an undergraduate student's scientists' Professional and Interpersonal Competencies score the greater their intentions will be to pursue a career in science*. Students with higher Professional Competencies ($\beta = .05$, p = .02) and Interpersonal Competencies ($\beta = .22$, $p < .001$) scores had significantly higher CIS scores than students with lower Interpersonal Competencies and Professional Competencies scores. Consistent with the original model, the two primary predictors of undergraduates' intentions to pursue a career in science were academic major and their stereotypes of scientists' Interpersonal Competencies. See Table 31.

Table 31

Research Question 2 Rerun: Multiple Regression Model for Career Intentions in Science (CIS) Scale with Academic Major STEM vs. non-STEM (STEM=0, non-STEM=1)

Variable	*B*	β	*p*
<u>Demographic Characteristics</u>			
Gender (male = 0, female = 1)	.03	.01	.56
Citizenship (non-U.S. = 0, U.S. = 1)	-.33	-.05	**.01**
Ethnicity			
African American/Black vs. European/American/White	.20	.03	.08
Asian American/Asian vs. European American/White	.32	.07	< **.01**
Hispanic vs. European American/White	.15	.02	.30
Other vs. European American/White	.40	.05	**.01**
<u>Student and University Characteristics</u>			
Years at University	-.03	-.02	.20
University (NCSU = 0, Other = 1)	-.05	-.02	.43
Dichotomous Major (STEM=0; non-STEM=1)	-1.95	-.59	< **.01**
<u>Stereotypes of Science</u>			
Professional Competencies	.13	.05	**.02**
Interpersonal Competencies	.56	.22	< **.01**
R^2	.44		

Note: n = 1639

Research Question 3 Rerun***: Does gender modify (1) the relationship between undergraduates' stereotypes of scientists and their intentions to pursue a career in science and (2) the relationship between undergraduates' academic major and their intentions to pursue a career in science?***

The three hierarchical regression models that tested for a gender moderation between Professional and Interpersonal Competencies and CIS and academic major and CIS were rerun using the dichotomous academic major variable. A new interaction term was created for gender and the recoded academic major variable. The first block in each of the regression models included the same predictors from the original hierarchical regression model except academic major was again replaced with the recoded academic major variable. These predictors included: academic major (STEM vs. non-STEM), Professional Competencies, Interpersonal Competencies, citizenship, university, and ethnicity. Gender was also included since it is the moderating variable being tested. In the second block of each hierarchical regression, the respective interaction terms of interest were entered.

Similar to the exploratory reruns for the first two research questions, the original results of the first two hypotheses did not change. (H3a and H3b) *Females' stereotypes of scientists' Professional Competencies and Interpersonal Competencies will predict their intentions to pursue a career in science, but males' stereotypes of scientists' Professional and Interpersonal Competencies will not predict their intentions to pursue a career in science*, were again not confirmed. Gender remained a non-significant moderator for the relationships between Professional Competencies and CIS scores ($\Delta R^2 = .00$, $\beta = .02$, $p = .40$) and Interpersonal Competencies and CIS scores ($\Delta R^2 = .00$, $\beta = -.03$, $p = .36$). See Table 32 and 33.

The third hypothesis, (H3c) *Academic major will be a stronger predictor for males' intentions to pursue a career in science than females' intentions*, originally was partially supported by the finding that gender significantly moderated the relationship between Humanities (compared to Agricultural & Life Sciences) and undergraduates' intentions to pursue a career in science. However, this hypothesis was not supported after academic major was recoded into non-STEM majors and STEM majors. Gender was not a significant moderator of the relationship between the recoded academic major variable and science career intentions ($\Delta R^2 = .001$, $\beta = -.05$, $p = .18$). See Table 34.

Table 32

Research Question 3 Rerun: Hierarchical Regression Model for Gender as a Moderator for Professional Competencies and Career Intentions in Science (CIS) Scale

Variable	*B*	β	*p*
Step 1			
Demographic Characteristics			
Gender (male = 0, female = 1)	.04	.01	.52
Citizenship (non-U.S. = 0, U.S. = 1)	-.34	-.05	**.01**
Ethnicity			
African American/Black vs. European/American/White	.19	.03	.09
Asian American/Asian vs. European American/White	.32	.07	**< .01**
Hispanic vs. European American/White	.14	.02	.34
Other vs. European American/White	.40	0.05	**.01**
Student and University Characteristics			
University (NCSU = 0, Other = 1)	-.05	-.02	.35
Stereotypes of Science			
Professional Competencies	.14	.05	**.02**
Interpersonal Competencies	.56	.22	**< .01**
Academic Major (STEM = 0, non-STEM = 1)	-1.93	-.58	**< .01**
R^2 and Adjusted R2	.44		
Step 2			
Gender (male = 0, female = 1)	.04	.01	.51
Professional Competencies	.08	.03	.30
Gender x Professional Competencies	.09	.02	.40
R^2 and Adjusted R^2	.44		
ΔR^2	.00		.40

Note. n = 1639

Table 33

Research Question 3 Rerun: Hierarchical Regression Model for Gender as a Moderator for Interpersonal Competencies and Career Intentions in Science (CIS) Scale

Variable	*B*	β	*p*
Step 2			
Gender (male = 0, female = 1)	.04	.01	.54
Interpersonal Competencies	.61	.24	.00
Gender x Interpersonal Competencies	-.09	-.03	.36
R^2 and Adjusted R2	.44		
ΔR^2	.00		.36

Note. n = 1639

Table 34

Research Question 3 Rerun: Hierarchical Regression Model for Gender as a Moderator for Academic Major (STEM vs. non-STEM) and Career Intentions in Science (CIS) Scale

Variable	*B*	β	*p*
Step 2			
Gender (male = 0, female = 1)	.08	.03	.22
Academic Major (STEM =0, non-STEM =1)	-1.81	-.55	.00
Gender x Academic Major	-.18	-.05	.18
R^2 and Adjusted R2	.44		
ΔR^2	.00		.18

Note. n = 1639

DISCUSSION

Stereotypes are cited as a primary factor influencing whether women choose to enter science professions (Astin & Sax, 1996; Davies et al., 2002; Eccles 1987; Schmader et al., 2004; Schoon, 2001; Steele, 1997). Yet, remarkably little is known about the actual impact males' and females' stereotypes of scientists have on their intentions to pursue a science career. Given that the Draw-A-Scientist test (Chambers, 1983), ISSS (Krajkovich & Smith, 1982), and WiSS (Erb & Smith, 1984) are most likely outdated measures, this dearth of research could be attributed to a lack of instruments assessing modern stereotypes of scientists. The development of the Stereotypes of Scientists (SOS) scale now permits an initial look at how contemporary stereotypes of scientists may be impacting undergraduates' science career intentions.

This study investigated three primary research questions and produced three evident conclusions. First, STEM majors agree more than non-STEM majors that scientists have strong Interpersonal Competencies. Second, undergraduates' stereotypes of scientists do impact their intentions to pursue a career in science. This is particularly true for their stereotypes of scientists' Interpersonal Competencies. Third, the impact of a student's stereotypes or academic major on their intentions to pursue a science career did not differ for males and females. The discussion addresses these conclusions in more detail before presenting the study limitations and implications of the findings. Before beginning the discussion of these results, a brief synopsis of the findings from the primary variables' measures and descriptive statistics results will be provided.

Primary Variables and Gender Comparisons

Descriptive statistics for each of the primary variables (scientists' Professional Competencies and Interpersonal Competencies, students' academic major, and science career intentions) are presented to help clarify and describe the variables themselves before discussing their relationships with one another from the hypotheses results. These statistics provide insight into students' specific stereotypes of scientists and science career intentions. Further, examining the items by gender suggested males and females differ in some of their particular stereotypes of scientists or science career intentions.

<u>Stereotypes of Scientists</u>

An evaluation of the Stereotypes of Scientists (SOS) scale confirmed the measure had strong reliability and an overall moderate goodness-of-fit (Drewes, 2009). The SOS scale has a two-factor solution (nine items each): Professional Competencies (Cronbach's Alpha = .81) and Interpersonal Competencies (Cronbach's Alpha = .77) (Cronbach, 1951). The two factors together explained a total of 32% of the variance in students' stereotypes of scientists (Professional Competencies = 20.4% and Interpersonal Competencies = 11.3%).

The most prevalent stereotypes of scientists that emerged from the results of the descriptive statistics were primarily of their Professional Competencies. Undergraduates agreed significantly more to scientists having Professional Competencies than Interpersonal Competencies. Looking at the individual items of the composite scores, there was substantial agreement with all nine items in Professional Competencies. Students agreed scientists had professional competencies such as someone who is highly focused, work oriented, and who knows a lot about the latest discoveries. These stereotypes are similar to Mead and Metraux's

(1957) research that found scientists' positive depictions included them being brilliant, dedicated, having a single absorbing purpose, and working to advance the nation technologically and medically. This implies the image of scientists' professional attributes is typically positive, but may not be all that different from what it was half a century ago.

Despite items in Interpersonal Competencies having more variance and overall less item agreement to the items in Professional Competencies, stereotypes of scientists' Interpersonal Competencies still emerged. In particular, scientists were considered cooperative, collaborative, and able to maintain friendships with colleagues in other departments. Unlike scientists' Professional Competencies, this finding suggests a change from long-established stereotypes of a scientist as isolated, unsociable, secretive and demanding (Lips, 1992; Mead & Metraux, 1957; Sax, 2001). However, while these positive perceptions of scientists' Interpersonal Competencies were all related to their careers, less than half the students were agreed scientists had fun with colleagues at work, were family oriented or had happy marriages. These contemporary stereotypes of scientists' Interpersonal Competencies suggest a more positive view of their ability to work with others and have relationships at work, but were less likely to have a positive of a perception of their personal or home lives.

In past studies, females' perceptions of scientists were more negative than males' perceptions (Catsambis, 1995; Sax, 2001; Weinburgh, 1995). This study both challenges and maintains this finding depending on whether stereotypes of scientists' Professional or Interpersonal Competencies were examined. Although both males and females agreed that scientists had strong Professional Competencies, females had significantly higher Professional Competencies scores. In particular, females agreed more than males that scientists are work oriented, careful with expensive instruments, and highly focused. These are typically positive attributes and goes against previous research that asserts females perceive scientists more negatively than males (Sax, 2001). Looking at the items that were removed from the SOS scale, however, females agreed more than males that scientists were competitive and independent (the largest gender difference in stereotypes was for the perception of a scientist as independent). These two attributes can be thought of as either positive or negative depending on the individual and context.

There were no overall gender differences in students' Interpersonal Competencies composite scores. This is contrary to several research studies that suggest males perceive scientists more positively than females (Catsambis, 1995; Sax, 2001; Weinburgh, 1995). However, a few of the individual items did significantly differ by gender. Males agreed more than females that scientists had fun with colleagues at work and maintained friendships with colleagues in other departments. These item differences support the research asserting females are more likely than males are to perceive scientists as less social (Morgan et al., 2001).

In summary, an assessment of undergraduates' stereotypes of scientists' Professional and Interpersonal Competencies demonstrates that students largely perceive scientists favorably. Results indicate traditional positive perceptions of scientists' Professional Competencies are persisting, exceptionally so for females (Chambers, 1983; Lips, 1992; Mead & Metraux, 1957; Rahm & Charbonneau, 1997; Sax, 2001). Previous perceptions of scientists as isolated may have altered, with both males and females now perceiving them as working well with others in a professional context (Lips, 1992; Mead & Metraux, 1957; Sax, 2001). However, a few gender differences among the individual items in Interpersonal Competencies suggest scientists may still be perceived, especially by females, as having a less than ideal personal or home life (Morgan et al.).

Academic Major

The gender segregation by academic major is well documented (Jacobs, 1989; NSF/SRS, 2009; Seymour & Hewitt, 1997; Steele et al., 2002). Women earn more bachelor's degrees than men in psychology (77% women), biological sciences (62%), and social sciences (54%), but only earn a fifth of the bachelor's degrees awarded in computer sciences (20%), physics (21%), and engineering (20%) (NSF/SRS, 2009). The findings in this study parallel the gender segregation evidenced in past reports. Engineering and Physical & Math Sciences had significantly more males than females (women represented 31% and 44% of the respective major), while Agricultural & Life Sciences, Humanities, Education and Social Sciences were significantly female dominated (women represented 63%, 79%, 66% and 76% of the respective major). Further, when STEM majors were compared to non-STEM majors, there were significantly more males than females with a STEM major. Female undergraduates also had a more traditionally female dominated major, such as Humanities or Social Sciences, significantly more often than the major Agricultural & Life Sciences. This supports research that females choose academic majors that have been traditionally female dominated (Lackland & De Lisi, 2001; Shauman, 2006).

These findings endorse current trends (NSF/SRS, 2009) that females are still not represented proportionately in engineering and physical science and math majors. A wide range of literature suggests this academic major segregation may be explained through multiple and complex factors ranging from academic preparedness, hostile university environment, self-efficacy, role models, discrimination, and interest level (Allan & Madden, 2006; Ethington & Wolfe, 1988; Frehill, 1997; Handelsman et al., 2005; Hartman & Hartman, 2008; Jacobs et al., 1998; Meinster & Rose, 2001; Morgan et al., 2001; Tinto, 1993; Whitt et al., 1999). Students' generalizations of scientists' attributes are theorized to impact many of these factors through negative stereotype formation and maintenance as explained by the theories of the stereotype framework (Ashmore & Del Boca, 1981) and stereotype threat (Davies et al., 2002; Steele, 1997).

Career Intentions in Science

A confirmatory factor analysis of the twelve-item CIS measure showed the CIS to have an adequate model fit (Drewes, 2009; Hu & Bentler, 1999) and strong reliability (Cronbach's Alpha = .98 [Cronbach, 1951]). The CIS explained over three-fourths of (77%) the variance in students' science career intentions and had an overall scale mean score of 4.12 ($SD = 1.49$). Given that almost three-fourths (73%) of respondents in the study had STEM academic majors and STEM majors had significantly greater intentions of pursuing a science career than non-STEM majors, it was surprising that the overall mean score for students' science career intentions was not higher than 4.12.

The "leaky pipeline" metaphor indicates that women graduating with science degrees, regardless of whether they are in a male or female dominated science field, are not as likely as men to pursue a science career (National Science Board, 2008; NSF/SRS, 2009; Shauman, 2006; Sonnert & Holton 1995). Consistent with other research studies (Diekman & Ealgy, 2000; Glick et al., 1995; Lackland & De Lisi, 2001; Xie & Shauman, 2003), findings showed female students (who represented over half [54%] of the STEM majors) had less overall intention of pursuing a science career than did males. Further, males had significantly greater intentions than did females to complete nine of the twelve CIS items (including "Complete your degree in science," "Become a scientist," and "Be a successful scientist"). In addition to males indicating they had greater intentions than females to "Be a successful scientist," males were also significantly more likely than females to indicate they "Have the ability to become a scientist" (the item with the largest gender discrepancy). These gender differences are consistent with research findings that women have lower self-efficacy than males in STEM fields at all levels of education and career development (Beyer et al., 2003; Catsambis, 1995; Correll, 2001; Ethington & Wolfe, 1988; Mau, 2003; Matyas & Dix, 1992).

Next, the results of the research questions provide both empirical support and challenged evidence to previous theories, literature, and findings from research on traditional stereotypes of scientists.

Research Question 1: Do undergraduates' stereotypes of scientists (Professional and Interpersonal Competencies) vary by their academic major?

Students with a non-STEM major are typically thought to be more limited in their exposure and images of scientists than students with STEM majors (Sax, 2001). It was therefore hypothesized that students majoring in a non-STEM field would have less agreement with scientists' Professional and Interpersonal Competencies than those with STEM majors. The results both supported and challenged this hypothesis. The first hypothesis was not supported. There were no significant differences between academic majors' stereotypes of scientists' Professional Competencies. However, the second hypothesis was supported. Results revealed STEM majors perceived scientists as having stronger Interpersonal Competencies than non-

STEM majors. In particular, students majoring in Agricultural & Life Sciences, Engineering, and Physical & Math Sciences agreed that scientists had Interpersonal Competencies significantly more than did those students majoring in Humanities.

These findings imply stereotypes of scientists do vary by major although this difference may be limited to perceptions of scientists' Interpersonal Competencies. Students with a non-STEM major, such as a major in Humanities, view scientists as having fewer Interpersonal Competencies than those students who have a STEM major. This disparity is plausibly due to the limited range of scientists' images that students with non-STEM majors may see compared to the diverse set of characteristics students with STEM majors are likely to encounter (Sax, 2001). If this were the case, exposure to scientists may be a potential change agent for one's stereotypes.

Research Question 2: What predicts an undergraduate's intentions to pursue a career in science?

Recent research suggests that increasing numbers of students choose work in a field unrelated to their academic major (Robst, 2007; Shauman, 2006). This is particularly true for non-STEM majors since their field is thought to teach a general, rather than a specific, skill set (Shauman, 2006). Although academic major may seem like an obvious, principal predictor for career intentions, it was relevant to confirm this relationship and explore which major had the greatest intentions to pursue a career in science. Unsurprisingly, the results did confirm the first hypothesis: undergraduates with an academic major in a STEM field will have greater intentions of pursuing a career in science than those students majoring in a non-STEM field.

Academic major was the strongest and primary predictor for whether a student pursues a career in science. Students with STEM majors had greater intentions of pursuing science careers than those with non-STEM majors. There were significant differences though when comparing career intentions among STEM majors. Students majoring in Agricultural & Life Sciences were significantly more likely than students majoring in Engineering to have intentions of pursuing a science career. This is plausibly due to perceptions of engineering being a separate career field from science. Yet, there were no significant differences in CIS scores between Physical & Math Sciences and students majoring in either Agricultural & Life Sciences or Engineering. These results differ from the results of previous research indicating students in female-dominated science majors (such as Agricultural & Life Sciences) are less likely to pursue a career in science than those in male-dominated fields (such as Physical & Math Sciences) (Xie & Shauman, 2003).

In addition to academic major, there is a plethora of explanations and theories that conjecture why else a person enters an occupation. Several of these theories suggest a student's stereotypes of scientists influence the decision to pursue a career in the profession (Diekman & Ealgy, 2000; Eccles, 1994). The results of this study confirmed this research question's second and third hypothesis: the higher an undergraduate student's agreement with scientists' Professional and Interpersonal Competencies the greater their intentions will be to pursue a career in science. Thus, undergraduates' stereotypes of scientists' prediction of science career intentions lend empirical support to these previous theories.

Specifically, these results revealed students' stereotypes of a scientist's Interpersonal Competencies were a particularly strong predictor of a student's science career intentions and had the largest impact on CIS scores after academic major. This finding implies students may not be as likely to have intentions to pursue a career in science if they hold the traditional stereotype of scientists' Interpersonal Competencies (unsociable, uninteresting, and isolated), but would be more likely to express science career intentions if they see scientists as highly competent interpersonally (Lips, 1992; Mead & Metraux, 1957; Sax, 2001). In addition, these findings also imply the traditional stereotypes of scientists' Professional Competencies (dedicated, intelligent, altruistic, and driven) are positively correlated with science career intentions (Lips, 1992; Mead & Metraux, 1957; Sax, 2001). Thus, one's stereotypes of scientists do impact a student's science career plans even above and beyond their academic major and individual and student characteristics.

Research Question 3: Does gender modify (1) the relationship between undergraduates' stereotypes of scientists and their intentions to pursue a career in science and (2) the relationship between undergraduates' academic major and their intentions to pursue a career in science?

Scant research has examined how gender impacts the relationship between science career intentions and academic major or stereotypes of scientists; however, past research does indicate females hold a more negative perception of scientists and are less likely than males to enter a career in science regardless of their academic major (Catsambis, 1995; Sax, 2001; Weinburgh, 1995; Xie & Shauman, 2003). It was therefore hypothesized that *females' stereotypes of scientists' Professional and Interpersonal Competencies will predict their intentions to pursue a career in science, but males' stereotypes of scientists' Professional and Interpersonal Competencies will not predict their intentions to pursue a career in science*. However, these hypotheses were not supported, instead exhibiting gender as a non-significant moderator of the relationship between one's stereotypes of scientists and their intentions to pursue a career in science. These findings suggest the impact of stereotypes of scientists on a student's intentions to pursue a science career does not differ for females.

This research question's third hypothesis, *academic major will be a stronger predictor for males' intentions to pursue a career in science than females' intentions,* was only partially supported. Results did show males with a major in Humanities had greater science career intentions than females majoring in Humanities; however, males and females majoring in Agricultural & Life Sciences did not significantly differ in their intentions to pursue a science career. Despite this finding, gender did not significantly moderate any other academic majors' relationship with CIS scores and was also a non-significant moderator when comparing Humanities to a baseline of Physical Sciences or STEM majors and non-STEM majors' science career intentions. It was interesting that gender was not a significant moderator for more of the academic majors' relationship with students' career intentions given that previous research highlights the discrepancy between the proportion of women and men who graduate with a STEM major and the lower percentage of women compared to men who pursue STEM careers (COSEPUP, 2007; National Science Board, 2008; Lee, 2008; Sonnert & Holton 1995; Xie & Shauman, 2003).

Overall, this research question helped to clarify whether gender did have a role in these relationships. The finding that males majoring in Humanities have greater intentions of pursuing a career in science than females majoring in Humanities implies there may be some variation by gender in professional choice. However, overall, there is little support that gender impacts an academic major's relationship with science career intentions. Additionally, these results suggest males and females do not differ in how their stereotypes of scientists impact their professional objectives.

After discussing the descriptive statistics and the results of the research questions, it is important to specify limitations of the research to aid in the interpretation and application of the study's findings.

Limitations

Although these results provide valuable research for understanding the relationship between stereotypes of scientists and intentions to pursue a career in science, this study did have a few notable limitations. First, there were limitations with the sample. The study benefited from a large sample consisting of students from diverse demographics; however, the courses sampled relied on the cooperation of instructors and were not from all regions of the United States. Internal Review Board (IRB) permissions were secured from fourteen universities, yet only seven could be sampled. Half of the universities had classroom privacy policies that prevented access to students. Unfortunately many of these universities were located in western regions; thus, the results may be restricted by the disproportionate inclusion of views of students attending universities in eastern or mid-west regions.

This study was designed to parallel the same general terms of earlier scales (Chambers, 1983; Erb & Smith, 1984; Krajkovich & Smith, 1982; Owen et al., 2007), referring to "science" and "scientist" without providing respondents a specified definition. As a consequence, participants' interpretation of "scientist" and "science" was subjective. A respondent's individual definition of scientist, science, or what a career in science implies may vary major-to-major or be influenced by extraneous variables such as personal experiences, encounters with science, scientists, and laboratory environments. As a result, the findings may reflect multiple interpretations of science as a construct. For example, some students majoring in engineering or psychology may perceive their field as a science discipline, while others in the same major may view their field as distinctly separate from science. Additionally, science education majors may categorize their field as a science discipline, while others in the major may consider it education. These discrepancies could impact responses on the measures, potentially altering the stereotypes being assessed and threatening construct validity. A general definition of science in the preface of the instrument may have helped construct validity to ensure a cohesive signification of the terms science and scientist (Shadish, Cook, & Campbell, 2002).

The categorization of academic majors may have also influenced results. Although majors were coded in accordance with the university with the largest number of respondents, academic majors, departments, and colleges all vary university to university. Further, the larger academic major categories forced certain female and male dominated majors to be collapsed into one category. For instance, biomedical engineering (female dominated) and electrical engineering (male dominated) were both categorized as Engineering. Also, Education included both elementary education and math/science/technology education. Ideally, these would be broken out even further; however, the convoluted nature of majors across multiple universities made this process nearly impossible and would have resulted in much smaller sample sizes.

The study could have also potentially benefited by the inclusion of an independent performance measure, such as GPA. This would have provided control for any effect high or low performers were having on the results. Additionally, it would be beneficial to examine if, and how, a performance measure moderated the relationship of students' stereotypes of scientists or academic major and their science career intentions.

The CIS and SOS measures were both recently developed and tested; accordingly, the measures' factor structure and model fit were closely inspected, particularly so by gender. The measures were examined by gender to explore if a measure was more suitable for assessing one gender more than another. The results revealed both measures (CIS and SOS) significantly differed in their model fit by gender. The model differences suggested there is a possibility the CIS items were a significantly better fit for capturing females' science career intentions than males, while the SOS scale, particularly the Interpersonal Competencies factor, may be a significantly better fit for male students than it was for female students. Despite these findings, it is not certain that the measures do in fact differ for males and females.

Several research studies have indicated an increased probability of finding significant differences between model groups when the study has a large sample size and non-normal variable distributions (Bakker et al., 2003; Marsh, Balla, McDonald, 1988; Newsom, 2008; Thompson & Daniel, 1996). This explanation may clarify why males' and females' goodness-of-fit indices (Drewes, 2009; Hu & Bentler, 1999) are so similar for both measures when a significant gender difference between models was found. The CIS measure in particular appears to be an acceptable indicator of both males' and females' science career intentions after both groups' factor structures had strong and similar factor loadings, reliabilities, and variance explained.

In the SOS measure, the gender difference may be specific to one factor, perhaps even attributable to one item. The examination of the Professional Competencies factor loadings, reliabilities, and variance did not indicate significant gender differences in the model. However, the Interpersonal Competencies factor loadings, reliabilities, and variance may suggest the Interpersonal Competencies items are better at assessing males' stereotypes of scientists' Interpersonal Competencies than females' stereotypes. "Insecure" stood out as one item that may not be capturing the same construct as the other Interpersonal Competencies items for females, but does capture the same construct for males. It is inconclusive whether the measures are more appropriate for measuring males' or females' stereotypes or career intentions and the validity of the measures by gender should be examined further. In particular, the SOS scale should be reevaluated for measuring females' stereotypes of scientists when compared to males' after removing the item "Insecure."

Although this research could be strengthened after addressing these concerns, these results provide a strong preliminary foundation for the implications of and future research on undergraduates' stereotypes of scientists' relationship to science career intentions.

Implications and Future Research

Although stereotypes are a frequent variable cited as a factor in career decisions (Astin & Sax, 1996; Davies et al., 2002; Eccles 1987; Schmader et al.; Schoon, 2001), this was one of the first studies to examine the relationship between stereotypes of scientists and career intentions in science and whether this relationship explains why women are less likely than men to pursue science careers (Xie & Shauman, 2003). The results provided empirical evidence that stereotypes of scientists do impact science career intentions, which, until now, was based primarily on assumptions. Findings imply students who have more positive stereotypes of scientists' professional skills (Professional Competencies) and social skills (Interpersonal Competencies) would have greater intentions of pursuing a career in science than those students with negative stereotypes of scientists. Discovering that the second strongest predictor (behind academic major) of science career intentions was whether students perceived scientists as having Interpersonal Competencies suggests that a perception of a scientist lacking in interpersonal skills is a major deterrent to entering a science career.

The importance of students' stereotypes of scientists' Interpersonal Competencies was emphasized further when comparing stereotypes by academic major and gender. Students with STEM majors (who had significantly greater science career intentions than non-STEM majors) agreed more than non-STEM majors that scientists have strong Interpersonal Competencies. Additionally, although the impact of scientist stereotypes on science career intentions did not vary by gender, an examination of the individual Interpersonal Competencies' items suggest males may have (who had significantly greater science career intentions than females) a more positive image of scientists' personal and home lives than did females. This implies the considerable relevance of scientists' Interpersonal Competencies on recruiting, and possibly, retaining students, particularly females, in science occupations.

In view of the fact that this is one of the first empirical studies examining modern stereotypes of scientists, the findings provide a strong foundation for future research studies. After establishing the relationship between students' stereotypes of scientists and science career intentions, it would next be of interest to conduct additional research examining academic major intentions (as opposed to career intentions). Opinions related to Interpersonal Competencies significantly differed between STEM and non-STEM majors, suggesting the value of exploring whether stereotypes of scientists may be a primary predictor of a student's intention to pursue a science major. Additionally, after noting limitations with the potential lack of diversity relative to the interpretation of science and grouping of majors, it would be beneficial to explore whether students' stereotypes of scientists vary by specific academic majors (instead of by general college groupings). Furthermore, conducting a longitudinal study with students would add valuable data for interpreting the long-term impact of the relationship between stereotypes of scientists, academic major, science career intentions and one's actual career path. This further exploration would promote a finer grained analysis of why females remain disproportionately underrepresented within some STEM fields, particularly within engineering disciplines (NSF/SRS, 2009).

Conclusion

Although there are a growing number of women entering STEM academic majors and careers, gender segregation continues to persist within some STEM fields (NSF/SRS, 2009). For America to remain globally competitive in an increasingly science and technology driven society, we must nurture and produce the talent necessary for success. There needs to be a dedicated and focused effort to recruit the country's most able students into STEM fields regardless of gender, and emphasize disciplines in which females are currently underrepresented. There have been multiple efforts at the national level to promote such change in the longstanding underrepresentation of women in certain fields (Mara & Bogue, 2004) with wide ranging research finding a plethora of variables and factors that, when combined and looked at as a multifaceted system, may all help to explain the gender segregation (e.g. Jacobs, Finken, Griffin, & Wright, 1998; Meinster & Rose, 2001; Morgan, Isaac, & Sansone, 2001). Stereotypes and perceptions of scientists and the field of science itself have long been thought to be at the root of many of these interrelated explanations and theories (Ashmore & Del Boca, 1981; Davies et al., 2002; Diekman & Eagly, 2000; Eagly, 1987; McLean & Kalin, 1994; Steele, 1997).

This study empirically investigated stereotypes' relationship with science career intentions and whether this relationship differed by gender. The results provide a contemporary perception of scientists and establish that students' stereotypes of scientists are an important factor for students' intentions of pursuing a science career and that these perceptions have career implications for both men and women. The findings suggest students with positive stereotypes of scientists, primarily in regard to scientists' Interpersonal Competencies, have greater intentions to pursue a science career than students with negative stereotypes of scientists. This highlights how significant the portrayal of science and science professionals is on the developing stereotypes of America's emerging talent.

Although perceptions continue to exist of scientists as unsocial introverts (particularly so for females and non-STEM majors), the overall contemporary stereotypes that emerged denote that both male and female students have a positive, and complex, image of a scientist. This suggests the limited and traditional image of a wild-haired, lab coat wearing white male scientist has changed (Chambers, 1983). By offering a contemporary overview of undergraduates' stereotypes of scientists and establishing that such stereotypes partially explain whether students intend to pursue science careers, this study provides a strong foundation for further research continuing the investigation into the relationships between stereotypes of scientists, academic major, gender, and science careers.

These results should be used to inform programs and interventions aimed at recruiting future scientists. The finding that an image of a scientist lacking in interpersonal skills may be a major deterrent to a student entering a science career substantiates the benefits of negating longstanding unfavorable stereotypes for both men and women. In order to recruit and retain greater numbers of talented people in science careers, STEM interventions and educational programs should address these negative stereotypes by exposing students to the diversity of scientists' attributes and career paths, while also further enhancing the positive stereotypes.

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APPENDICIES

Appendix A

Careers in Science National Survey

Section I

*** A: Please specify the course you are taking this survey for:**

Please write your answer here:

*** B: Please specify your birth year:**

Please write your answer here:

*** C: What is your primary major or area of study?**
Please choose the one that is the closest match to your major.

Please choose *only one* of the following:

- ☐ Agricultural
- ☐ Animal Sciences
- ☐ Anthropology
- ☐ Biochemistry
- ☐ Biomedical Engineering
- ☐ Biology
- ☐ Botany
- ☐ Business and Marketing Education
- ☐ Chemical Engineering
- ☐ Chemistry
- ☐ Civil Engineering
- ☐ Computer Engineering
- ☐ Computer Science
- ☐ Electrical Engineering
- ☐ Elementary Education
- ☐ English
- ☐ General Studies Education
- ☐ Horticultural Science
- ☐ Industrial Engineering
- ☐ Math Education
- ☐ Mathematics
- ☐ Materials Engineering
- ☐ Mechanical Engineering
- ☐ Microbiology
- ☐ Middle Grades Education
- ☐ Natural Resources
- ☐ Philosophy
- ☐ Physics

- ☐ Political Science
- ☐ Psychology
- ☐ Science Education
- ☐ Sociology
- ☐ Statistics
- ☐ Technology Education
- ☐ Zoology
- ☐ Undecided Major
- ☐ Other not listed area of study

C.2: If you selected "Other not listed area of study" above, please specify your primary major or area of sutdy here:

Please write your answer here:

Section II: Observations of Scientists

*** A: We are interested in your observations about scientists, including their motivations, priorities, and the kinds of work they do. Please rate to what extent you agree with the following statements using a scale ranging from "Strongly Disagree" to "Strongly Agree."**

When I think about scientists, I think that they:

Please choose the appropriate response for each item:

	Strongly Disagree	Disagree	Mildly Disagree	Mildly Agree	Agree	Strongly Agree
1. Have fun with colleagues at work	☐	☐	☐	☐	☐	☐
2. Maintain friendships with colleagues in other departments	☐	☐	☐	☐	☐	☐
3. Know a lot about the latest discoveries	☐	☐	☐	☐	☐	☐
4. Do not have a lot of friends	☐	☐	☐	☐	☐	☐
5. Are out of touch with what is happening in the world	☐	☐	☐	☐	☐	☐
6. Are the ones who know how equipment works	☐	☐	☐	☐	☐	☐
7. Are careful with expensive instruments	☐	☐	☐	☐	☐	☐
8. Have happy marriages	☐	☐	☐	☐	☐	☐

*** B: We are interested in your observations about scientists, including their motivations, priorities, and the kinds of work they do. Please rate to what extent you agree with the following statements using a scale ranging from "Strongly Disagree" to "Strongly Agree."**

When I think about scientists, I think that they are:

Please choose the appropriate response for each item:

	Strongly Disagree	Disagree	Mildly Disagree	Mildly Agree	Agree	Strongly Agree
9. Competitive	☐	☐	☐	☐	☐	☐
10. Cooperative	☐	☐	☐	☐	☐	☐
11. Independent	☐	☐	☐	☐	☐	☐
12. Work oriented	☐	☐	☐	☐	☐	☐
13. Family oriented	☐	☐	☐	☐	☐	☐
14. Technically competent	☐	☐	☐	☐	☐	☐
15. Competent	☐	☐	☐	☐	☐	☐
16. Self-confident	☐	☐	☐	☐	☐	☐
17. Insecure	☐	☐	☐	☐	☐	☐
18. Collaborative	☐	☐	☐	☐	☐	☐
19. Highly focused	☐	☐	☐	☐	☐	☐
20. Able to learn to use new equipment quickly	☐	☐	☐	☐	☐	☐
21. Especially intelligent	☐	☐	☐	☐	☐	☐
22. Logical	☐	☐	☐	☐	☐	☐

Section III: Self-Observations

*** C: We are interested in your observations about yourself, including your motivations, priorities and the kinds of work that you like to do. Please rate to what extent you agree with the following statements using a scale ranging from "Strongly Disagree" to "Strongly Agree."**

When I think about myself, I:

Please choose the appropriate response for each item:

	Strongly Disagree	Disagree	Mildly Disagree	Mildly Agree	Agree	Strongly Agree
23. Have fun with colleagues at work	☐	☐	☐	☐	☐	☐
24. Maintain friendships with colleagues in other departments	☐	☐	☐	☐	☐	☐

25. Know a lot about the latest discoveries	☐	☐	☐	☐	☐	☐
26. Do not have a lot of friends	☐	☐	☐	☐	☐	☐
27. Are out of touch with what is happening in the wolrd	☐	☐	☐	☐	☐	☐
28. Know how equipment works	☐	☐	☐	☐	☐	☐
29. Am careful with expensive instruments	☐	☐	☐	☐	☐	☐
30. Will have a happy marriage	☐	☐	☐	☐	☐	☐

*** D: We are interested in your observations about yourself, including your motivations, priorities and the kinds of work that you like to do. Please rate to what extent you agree with the following statements using a scale ranging from "Strongly Disagree" to "Strongly Agree."**

When I think about myself, I am:

Please choose the appropriate response for each item:

	Strongly Disagree	Disagree	Mildly Disagree	Mildly Agree	Agree	Strongly Agree
31. Competitive	☐	☐	☐	☐	☐	☐
32. Cooperative	☐	☐	☐	☐	☐	☐
33. Independent	☐	☐	☐	☐	☐	☐
34. Work oriented	☐	☐	☐	☐	☐	☐
35. Family oriented	☐	☐	☐	☐	☐	☐
36. Technically competent	☐	☐	☐	☐	☐	☐
37. Competent	☐	☐	☐	☐	☐	☐
38. Self-confident	☐	☐	☐	☐	☐	☐
39. Insecure	☐	☐	☐	☐	☐	☐
40. Collaborative	☐	☐	☐	☐	☐	☐
41. Highly focused	☐	☐	☐	☐	☐	☐
42. Able to learn to use new equipment quickly	☐	☐	☐	☐	☐	☐
43. Especially intelligent	☐	☐	☐	☐	☐	☐
44. Logical	☐	☐	☐	☐	☐	☐

Section IV: Career Steps

*** E: In your future career, how likely is it that you will:**

Please choose the appropriate response for each item:

	Very Unlikely	Unlikely	Mildly Unlikely	Mildly Likely	Likely	Very Likely
45. Get college training in science	☐	☐	☐	☐	☐	☐
46. Get experience working as a scientist	☐	☐	☐	☐	☐	☐
47. Be a successful scientist	☐	☐	☐	☐	☐	☐
48. Get an advanced degree in science	☐	☐	☐	☐	☐	☐
49. Become a scientist	☐	☐	☐	☐	☐	☐
50. Have the ability to become a scientist	☐	☐	☐	☐	☐	☐
51. Take advanced courses in science	☐	☐	☐	☐	☐	☐
52. Complete your degree in science	☐	☐	☐	☐	☐	☐
53. Do advanced research in science	☐	☐	☐	☐	☐	☐
54. Apply to graduate programs in science	☐	☐	☐	☐	☐	☐
55. Have a lifelong career in science	☐	☐	☐	☐	☐	☐
56. Have a very successful career in science	☐	☐	☐	☐	☐	☐

Section V: Gender & Ethnicity in Scientific Professions

*** F: We would like to know what you think about men, women and ethnicity in our culture in general, as well as your observations about science professions. Please rate to what extent you agree with the following statements using a scale ranging from "Strongly Disagree" to "Strongly Agree."**

Please choose the appropriate response for each item:

	Strongly Disagree	Disagree	Mildly Disagree	Mildly Agree	Agree	Strongly Agree
57. Women and men should have equally successful	☐	☐	☐	☐	☐	☐

science careers.						
58. Women and men do have equally successful science careers.	☐	☐	☐	☐	☐	☐
59. Women and men should receive equal educational opportunities in science.	☐	☐	☐	☐	☐	☐
60. Women and men do receive equal educational opportunities in science.	☐	☐	☐	☐	☐	☐
61. Women and men should receive equal employment opportunities in science.	☐	☐	☐	☐	☐	☐
62. Women and men do receive equal employment opportunities in science.	☐	☐	☐	☐	☐	☐
63. People of all ethnic groups should have equally successful science careers.	☐	☐	☐	☐	☐	☐
64. People of all ethnic groups do have equally successful science careers.	☐	☐	☐	☐	☐	☐
65. People of all ethnic groups should receive equal educational opportunities in science.	☐	☐	☐	☐	☐	☐
66. People of all ethnic groups do receive equal educational opportunities in science.	☐	☐	☐	☐	☐	☐
67. People of all ethnic groups should receive equal employment opportunities in science.	☐	☐	☐	☐	☐	☐
68. People of all ethnic groups do receive equal employment opportunities in science.	☐	☐	☐	☐	☐	☐
69. In my ethnic group, men and women should have the same educational and employment opportunities in science.	☐	☐	☐	☐	☐	☐

70. In my ethnic group, men and women do have the same educational and employment opportunities in science.	☐	☐	☐	☐	☐	☐

Section VI: Background Information

*** G: We would like to understand more about your background and experiences. Please rate to what extent you agree with the following statements using a scale ranging from "Strongly Disagree" to "Strongly Agree."**

Please choose the appropriate response for each item:

	Strongly Disagree	Disagree	Mildly Disagree	Mildly Agree	Agree	Strongly Agree
71. I am active in organizations or social groups that include mostly members of my own ethnic group.	☐	☐	☐	☐	☐	☐
72. I am comfortable working with people of different ethnic groups.	☐	☐	☐	☐	☐	☐
73. I have friends in my major who are members of my ethnic group.	☐	☐	☐	☐	☐	☐
74. I have family members who are scientists.	☐	☐	☐	☐	☐	☐

*** 75: How many years have you been a student at your university?**

Please choose *only one* of the following:

- ☐ Less than one year
- ☐ One year to less than two years
- ☐ Two years to less than three years
- ☐ Three years to less than four years
- ☐ Four years to less than five years
- ☐ Five years to less than six years
- ☐ Six years to less than seven years
- ☐ Seven years to less than eight years
- ☐ Eight years to less than nine years
- ☐ Nine or more years

*** 76: Please specify your gender:**

Please choose *only one* of the following:

- ☐ Female
- ☐ Male

*** 77: Please specify your ethnicity:**

Please choose *only one* of the following:

- ☐ African American/Black
- ☐ Asian American /Asian
- ☐ European American/Caucasian/White
- ☐ Latino American/Hispanic
- ☐ Native American/Alaskan Native/Pacific Islander
- ☐ Other

77b: If you chose "Other" for your ethnicity, please specify your ethnicity here:

Please write your answer here:

*** 78: Please specify your martial status:**

Please choose *only one* of the following:

- ☐ Single
- ☐ Engaged
- ☐ Married
- ☐ Divorced/Separated
- ☐ Widowed

*** 79: Please specify your citizenship:**

Please choose *only one* of the following:

- ☐ U.S.
- ☐ Non-U.S.

*** 80: Please specify the profession you currently plan on seeking upon graduation:**

Please write your answer here:

Submit Your Survey.
Thank you for completing this survey..

Appendix B

Table B1

Multiple Regression Model for Career Intentions in Science (CIS) Scale with Academic Major Baseline Change to Physical & Math Sciences

Variable	*B*	β	*p*
Demographic Characteristics			
Gender (male = 0, female = 1)	-.01	-.01	.81
Citizenship (non-U.S. = 0, U.S. = 1)	-.38	-.05	**.01**
Ethnicity			
African American/Black vs. European/American/White	.18	.03	.09
Asian American/Asian vs. European American/White	.31	.07	< **.01**
Hispanic vs. European American/White	.17	.02	.22
Other vs. European American/White	.32	.04	**.02**
Student and University Characteristics			
Years at University	-.03	-.03	.19
University (NCSU = 0, Other = 1)	-.12	-.04	**.04**
Stereotypes of Science			
Professional Competencies	.13	.05	**.02**
Interpersonal Competencies	.54	.21	< **.01**
Academic Major			
Agricultural & Life Sciences vs. Physical & Math Sciences	.06	.02	.56
Engineering vs. Physical & Math Sciences	-.14	-.04	.21
Education vs. Physical & Math Sciences	-2.20	-.39	< **.01**
Humanities vs. Physical & Math Sciences	-2.37	-.39	< **.01**
Social Sciences vs. Physical & Math Sciences	-1.06	-.17	< **.01**
Other vs. Physical & Math Sciences	-2.17	-.30	< **.01**
Undecided vs. Physical & Math Sciences	-1.78	-.22	< **.01**
R2 (and Adjusted R^2)	.47		

Note. n = 1639

Table B2

Hierarchical Regression Model for Gender as a Moderator for Academic Major (with Baseline Change to Physical & Math Sciences) and Career Intentions in Science (CIS) Scale

Variable	*B*	β	*p*
Step 2			
Gender (male = 0, female = 1)	-.09	-.03	.63
Academic Major (Physical & Math Sciences baseline)			
Agricultural & Life Sciences vs. Physical & Math Sciences	-.01	.00	.94
Engineering vs. Physical & Math Sciences	-.23	-.06	.12
Education vs. Physical & Math Sciences	-2.10	-.37	**< .01**
Humanities vs. Physical & Math Sciences	-1.95	-.32	**< .01**
Social Sciences vs. Physical & Math Sciences	-1.21	-.20	**< .01**
Other vs. Physical & Math Sciences	-2.15	-.29	**< .01**
Undecided vs. Physical & Math Sciences	-1.80	-.22	**< .01**
Gender x Academic Major (Physical & Math Sciences baseline)			
Gender x Agricultural & Life Sciences vs. Physical & Math Sciences	.12	.04	.56
Gender x Engineering vs. Physical & Math Sciences	.25	.04	.28
Gender x Education vs. Physical & Math Sciences	-.11	-.02	.70
Gender x Humanities vs. Physical & Math Sciences	.25	.04	.42
Gender x Social Sciences vs. Physical & Math Sciences	-.48	-.07	.13
Gender x Other vs. Physical & Math Sciences	-.02	.00	.96
Gender x Undecided vs. Physical & Math Sciences	.09	.01	.82
R^2 and Adjusted R2	.47		
ΔR^2	.003		.35

Note. n = 1639