ABSTRACT

PAXTON, DEBRA ANN. The Impact of Gender on Science Identity Congruence and Intentions to Pursue a STEM Career. (Under the direction of Mary Wyer.)

This thesis research was conducted in partial fulfillment of requirements for the degree of Master of Science in Psychology. This research explored the relationship between science identity congruence and career persistence in science, technology, engineering and mathematics (STEM) through the use of extant data from a national dataset of undergraduate students. The impact of science identity on STEM career persistence, and the role of gender in that relationship, was examined through regression and moderation analyses. Additionally, two methods to calculate identity congruence variables via difference scores were compared. Science identity congruence significantly predicted student intentions to pursue a STEM career, but gender was not a moderator in that relationship. Different methods to calculate identity congruence resulted in significantly different outcomes.
The Impact of Gender on Science Identity Congruence and Intentions to Pursue a STEM Career

by
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DEDICATION

This thesis is dedicated to my parents, whom I love and miss dearly.
BIOGRAPHY

Debra A. Paxton grew up outside of Detroit, MI in a close knit family of four. She was the youngest daughter of Ann and Bill Paxton. Her older sister, Pamela Paxton, is currently a Professor of Sociology at the University of Texas, Austin and has served as inspiration throughout Debra’s life and especially during her graduate studies. Debra earned a Bachelor of Science degree in Psychology and Biology at the University of Michigan before moving to North Carolina in 1997. Her research career began at Duke University Medical Center (DUMC) where she ran research investigations on the impact of pharmacological intervention on substance use. During her tenure at DUMC, an institutional crisis regarding human subjects protections lead her to pursue a position with the DUMC Institutional Review Board. In 2001 she accepted a position in research compliance at North Carolina State University (NCSU). Since then, she has worked as a research ethics officer, with expertise in human subjects protection, research misconduct, and research using human stem cells. She matriculated as a doctoral student in the Psychology program at NCSU in 2009, working under the direction of Mary Wyer and continuing to serve as a research ethics officer.

In 2002, Debra married Adam Dodd of Beckley, West Virginia. They live in Durham, North Carolina with one evil cat and one sweet cat.
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I could not have completed this thesis without the loving support of my family. My husband unconditionally supported my studies, providing encouragement and perspective to help me succeed. As mentioned previously, my sister is a shining star of inspiration and not only served as a role model for me but also provided advice, encouragement and relief throughout my studies.

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Introduction and Literature Review

There is reason to believe that science identity can predict student participation in STEM careers, and that it plays a role in students’ choice of and intention to persist in STEM careers. There is empirical evidence that women experience identity ambiguity and identity conflict when choosing STEM careers, which have been shown to be related to reduced persistence in those careers. However, there is also evidence that this is not the case, given increasing female participation in STEM careers at the national level (National Science Foundation, 2011). Unfortunately, this interesting schism has not been explored because the literature lacks current, validated and reliable measures for science identity and STEM career intentions, and lacks broad, multi-institutional level research that provides a national perspective on the issue. The body of literature examining the impact of gender and science identity on STEM career choices approaches the issue from a variety of theoretical standpoints, using different definitions and measures of identity and commitment. Past research has used several different terms and operationalizations for the concepts under study, including “identity compatibility,” “identity congruence,” and “identity interference,” with each term being evaluated via different measures. Few, if any, of the measures used in the existing literature are valid, reliable or can be standardized across studies and diverse participant groups. Previous research also tends to involve fewer than 400 participants, usually focusing on undergraduate students from only one school or major within a school, such as Engineering or Mathematics. Such narrow samples limit the applicability of findings outside of the research context.
Despite decades of effort to improve gender equity in STEM fields, a disparity in participation persists (Hill, Corbett & Rose, 2010). While more women are pursuing higher education in STEM fields, they remain underrepresented in comparison to men and do not advance into STEM careers at the same rate as men (Hill, Corbett & Rose, 2010; Koebler, 2012). This loss of talented women from STEM disciplines means not only that they are left out of fields that offer professional growth and personal development, but their perspectives, creativity and insight are prevented from contributing to innovation and technological advancement arising from STEM disciplines (Hill, Corbett & Rose, 2010; Kelan, 2009). Thus, the loss of women from STEM career pipelines is an indication of continuing inequality and also represents a loss of intellectual capital. Both of these issues slow the progress of technological innovation and narrow the perspective and usability of innovative products and scientific results (Bernstein & Russo, 2008).

Some have argued that women are not persisting in STEM careers at the same rate as their male counterparts, and that there is a disparity in positions of leadership and prestige in STEM fields between genders because women lose motivation and intention to pursue and persist in STEM careers over time (Bernstein & Russo, 2008; Diekman et al., 2010). Researchers argue that women do not choose to pursue or persist in STEM careers because women consider STEM fields a poor career fit, but studies differ in describing the precise dynamics behind this perception of lack-of-fit. Recent work finds evidence that societal expectations placed on women lead to greater work/life conflict, which then leads women to perceive STEM careers as not matching their personal strengths or lifestyle choices. Due to
stereotypes, prejudices and preconceived notions of what defines a “woman” and what defines a “STEM professional,” women are said to have difficulty developing deep and personal identities as STEM professionals (Diekman et al., 2010). It is argued that this lack of identification as STEM professionals results in women choosing to pursue alternate career choices (Ashforth, Harrison & Corley, 2008; Hill, Corbett & Rose, 2010; Rousseau, 1998).

Others have argued that the traditionally reductionist and competitive nature of STEM disciplines, entrenched androcentric biases, and societal gender role expectations for women result in the disidentification of women from STEM careers (Diekman et al., 2010; Keller, 1982). As minorities in STEM fields, women often experience identity ambiguity or conflict in which they have difficulty perceiving themselves as both STEM professionals and women. This identity ambiguity or identity conflict can lead to lowered perceptions of how well a STEM career “fits” their personal identity (Clair et al., 2012; Settles, 2004).

Several researchers have examined the impact of gender and identity on career trajectories. In 2008, Lester performed qualitative research with women community college faculty and identified a pathway for the development of professional identities and expectations of fit that began early in life and external to the college experience; as the women in Lester’s research grew up they were presented with societal images and stereotypes about scientists and about femininity. Lester illustrated how these “external influences” impacted early career interest. Lester also found that later in life, the college experiences of participants affected their development of professional identity and perceived career fit, that they continued to navigate issues of gender, professional identity and career fit.
throughout their careers, and that their impressions of fit between their identity as women and identity as professionals impacted career choices.

Carlone and Johnson (2007) examined women of color in STEM fields, using identity as a lens through which to assess experiences. They performed ethnographic interviews with 15 women of color pursuing STEM careers through their undergraduate, graduate and STEM career trajectories. They found that identity “fit” was an important aspect of successful STEM careers for women of color, concluding that for the participants in their study, perceived incompatibility between gender and STEM identities had an impact on career trajectory. For those in their study, women who perceived incompatibility between gender and STEM identities were more likely to encounter negative experiences and outcomes during the pursuit of a STEM career, and therefore were more likely to leave the field. Similarly, Carlone and Johnson (2007) found that women who experienced gender and STEM identity congruence were more likely to have positive experiences and positive outcomes in their STEM careers.

There is evidence that patterns of identity, gender and STEM career choice are changing in some STEM fields. Recent national statistics show that more women are becoming involved in the STEM fields of the biological sciences and medicine (National Science Foundation, 2011). These statistics indicate that the participation of women in medical and bioscience careers has increased in relation to men while women’s participation in physical sciences, mathematics, engineering and computer sciences has remained low in relation to men over the past two decades. Interestingly, women are more likely to pursue
doctoral degrees in computer science and engineering than bachelors or masters degrees (National Science Foundation, 2011). According to the American Association of University Women (AAUW) (2010), women earn more bachelor’s degrees in biological sciences than men, and make up more than half of biological professionals. However, in other STEM fields, women are less than one third of STEM professionals (AAUW, 2010).

These statistics may reflect differences across STEM fields which make some STEM fields a better fit for women, or they may reflect changes in women’s attitudes toward STEM careers. The current statistics about gender participation in STEM careers -- when considered in relation to findings in the literature regarding science identity, gender and STEM career choice -- indicate that understandings of how women view themselves in relation to scientists may be in need of refinement, with greater emphasis placed on how women perceive themselves as potential scientists and perceive STEM fields as potential career choices.

This research investigated the relationship between the extent to which women identify as scientists (“identity congruence”) and their intentions to pursue a career in STEM (“persistence”). Existing data from a national sample of male and female undergraduates across a diverse array of majors were analyzed to examine relationships between students’ gender, science identity, and intentions to pursue a career in science. The variables of interest for the proposed research were: (1) Identity congruence, measured by the “Scientist-Self Similarity” (SSS) scale, which is a difference score between how participants view themselves and how they view scientists (Ryder-Burge, 2010), (2) Gender, coded as self-
reported male or female, and (3) Intentions to persist in STEM, measured as a composite score of intention-related items from the “Career Intentions in Science” scale (CIS) (Schneider, 2010). This research provides a more nuanced and comprehensive assessment of the issue of identity fit than is currently available in the literature, and used a more robust measure of persistence than previous research.

Identity Theory

This section describes theories about identity and career choice that have been developed in the literature and that are the most salient for application to STEM career choices. Each theory identifies important components of personal identity formation and describes how congruities between personal identity and stereotypes of potential careers are identified and assessed. The role of self image in the identification of viable career options is highlighted across the theories, with primary components of identity being personal goals, abilities and values.

In an overview of research about social identity theory (SIT), Ashforth, Harrison and Corley (2008) summarized empirical findings about how identity impacts career choices. SIT emphasizes the importance of social roles in the formulation and reinforcement of identity, linking an individual’s self-concept to group membership and roles. An important part of SIT as explained by Ashforth, Harrison and Crowley (2008) is that identity congruence influences individuals’ career choices. Ashforth, Harrison and Crowley outlined the process through which people identify with external collectives; delineating between a cognitive process of identification and an affective process.
According to Ashforth, Harrison and Crowley, cognitive identification entails the recognition that membership with a certain group aligns with personal identity. Individuals assess the characteristics of a certain group and determine that membership with that group reinforces aspects of their self-identity. The affective identification described by Ashforth, Harrison and Corley is reflective of other research that examines women’s choices to pursue STEM careers through a value congruity lens (Diekman et al., 2011; Keith & Cardador, 2007). These studies highlight the importance of values on career choice; if women perceive a potential career as reinforcing their personal values, then they are more likely to pursue that career path (Diekman et al., 2011; Keith & Cardador, 2007). The distinction between cognitive and affective processes in SIT has been further examined in other theories that focused more specifically on the impact of different components of self image, such as self-efficacy or values, on career choice. Ashforth, Harrison and Corley’s (2008) research suggests that both cognitive and affective processes of identity development play a role in the development of women’s science identity and their decisions to pursue STEM careers.

In 1994, Lent, Brown and Hackett developed the “Social Cognitive Career Theory,” (SCCT) to explain the development of career interests, career-related choices, and persistence in educational pursuits related to careers. Through the SCCT lens, perceived similarities between self image and scientists are revealed to influence career choices to pursue or persist in STEM careers. The researchers argued that students take into consideration perceived similarities and differences between themselves and scientists when considering whether or not to pursue a STEM career. SCCT identifies “three social cognitive
mechanisms that seem particularly relevant to career development: (a) self-efficacy beliefs, (b) outcome expectations, and (c) goal representations,” (p. 83). SCCT takes a cognitive constructionist approach to identity development and career choice by considering these mechanisms of career choice as rooted in dynamic self images that interact with other factors such as experience, notions of self and social interactions. Importantly, SCCT asserts that career choices involve self-referential analyses regarding self, context and behavior.

A unique aspect of SCCT at the time it was developed was its incorporation of goals as part of the self image that informed career choices. Researchers using SCCT assert that perceptions of congruity between personal goals and career goals are an important component of how individuals identify with potential careers. However, the goals described by SCCT only relate to achievement and status, such as opportunities for promotions and increased salary. Later research identified the importance of congruence in other types of goals on career choices, such as goals regarding interpersonal interactions and life/work balance (Diekman et al., 2010; Diekman et al., 2011).

SCCT also highlights the importance of perceived self-efficacy in career choices, outlining career interests as being prefaced by the development of self-efficacy and outcome expectations, which are rooted in self images about capabilities and perceptions about professional requirements. Through the SCCT model, we can see that self images regarding efficacy are likely to have profound impacts on individual’s career choices, which establishes the viability of self images as predictors of career choices. According to the SCCT, an individual must perceive congruence between her/his abilities and the required abilities of a
potential career.

The SCCT lays the groundwork for approaching career choices through identity congruence; we can expect that the more similar women believe themselves to be to successful STEM professionals, the more likely they are to believe that they, too, can be successful in a STEM career, and so choose to pursue a STEM career.

During the same time that Lent, Brown and Hackett (1994) were developing the SCCT, Eccles (1994) developed a model of career choice specifically for women. Eccles’ model reinforces the SCCT emphasis on self image in career choice by highlighting the importance of two mechanisms in career choice; women’s expectations of success in a certain career, and the value placed on career options. Eccles argued that a woman is more likely to pursue a specific career if she believes that she will be successful in that career, meaning that her self image is such that she can imagine herself operating successfully within a certain career. Eccles then linked those mechanisms to other factors such as socializing influences and gender role beliefs. These factors influence individuals’ expectations of success and value of career options.

Eccles’ model also highlights the importance of gender stereotypes in career choices by women, which are plausibly linked to the role that perceptions of identity congruence play in career choices. The impact of stereotypes about professionals on career choice is not addressed in Eccles’ model; however it is reasonable to think that the assessment of potential efficacy would involve assumptions or perceptions about the requirements of the profession under consideration. According to Eccles’ model, it would be expected that the more an
individual perceives similarities between herself and members of a certain profession, the more likely she would be to choose that career.

**Identity, Gender and STEM Persistence**

Previous research has examined the relationships between gender, science identity and STEM career choices. General findings in the literature indicate that perceived identity congruence is an important indicator of individuals’ choices to pursue STEM careers. The literature also describes differences between women and men in science identity and perceived identity congruity.

In 2008, Bernstein and Russo provided an overview of identity congruence and STEM career choice in women. They focused on the psychosocial phenomenon of perceived person/environment (P/E) fit as the lens through which to examine women’s choice to persist in STEM careers. They described careers as being constructed by individuals through subjective processes and choices that represent self concepts and goals, and contrast that view of careers with the traditional, linear career path of the scientist which involves an early choice and persistent, almost dogged, dedication. This latter career path, note Bernstein and Russo, is a very traditional and masculine career path and is not likely to match career expectations of women, who “assess their options and make choices in keeping with their values and preferences in navigating, avoiding or leaving STEM careers” (p. 3).

According to Bernstein and Russo (2008), while both women and men express dissatisfaction with imbalance between personal and work lives, women express more dissatisfaction than men. The problem with life balance as an issue of congruity thus remains
particularly poignant for women. The notion of balancing identities and valuing a career that fits with other life goals is encapsulated in a quote from a woman faculty member, “I feel like my career is a constant gamble to strike the right balance between three things: (i) how much I must commit myself to my career in order to get tenured/remain a competitive scientist/earn enough clinical revenue; (ii) how much time and effort I give to my husband/household to stay married; and (iii) how much time and effort I give to my children to guide their growth and development” (p. 14).

Settles (2004) applied the notion of identity interference to female scientist career choices. “Identity interference” occurs when people’s multiple identities interfere with one another. The example provided by Settles is a female physics student who feels pressure to mask her gender identity in order to fit in with other, male physics students. Settles linked identity interference to negative outcomes such as psychological and physical stress, and lower job satisfaction. She asserted that past research on identity interference has focused on interference between work roles and family roles and describes her intention to examine identity centrality, or how important a specific component of identity is to one’s self image, as related to women in science.

Settles (2004) hypothesized that women scientists who exhibit higher levels of identity interference will also report more negative outcomes, and that identity centrality will impact the significance of that relationship. She administered survey measures to undergraduate students in STEM fields to assess their levels of identity interference, identity centrality for gender and science, academic performance, and psychological well-being.
Specifically for her research, Settles developed the Woman-Scientist Identity Interference Scale, which is a 17 item Likert based measure that addresses specific conflicts between gender identity and scientist identity (e.g. “Being a scientist makes me less attractive as a woman,” and “Being a woman makes me more capable as a scientist,”). She reported a Cronbach’s alpha score of .86 for the scale. Identity centrality was measured using a modified version of the racial centrality subscale of an inventory of Black identity (Sellers et al., 1997). Settles found that identity interference was related to negative outcomes. Women reporting high identity interference also reported lower self esteem ($r = -0.32, p < .01$), lower academic performance ($r = -0.33, p < .01$), lower life satisfaction ($r = -0.28, p < .01$), and higher depression ($r = 0.36, p < .01$). She also found that identity centrality affects the relationship between identity interference and negative outcomes; women with high identity centrality experienced more negative outcomes associated with identity interference such as depression ($\beta = 0.35, p < .01$), lowered self-esteem ($\beta = 0.043, p < .01$), and lowered life satisfaction ($\beta = -0.22, p < .05$) than women with less identity centrality.

Settles’ research is an attempt to address the impact of identity fit on women’s experiences in STEM careers. Her development of the Woman-Scientist Identity Interference Scale shows a consideration of the need to comprehensively measure congruence between gender and scientist identities in women. However, her measure falls short in that it directly measures participants’ perceptions of how their gender and science identities intersect; it confounds science identity with gender identity, which does not allow for nuanced assessment of effects related to either identity. Additionally, her use of measures
of performance and psychological well being is important, but they do not directly address women’s intentions to persist in science careers, since presumably high performance and psychological well-being would be of benefit to women in any field. There is face validity to the idea that women who perceive themselves as performing well and who are experiencing psychological well being would be more likely to continue in a STEM career. However, it would be useful to directly measure intentions to persist in STEM careers in relation to identity congruence.

Rosenthal, London, Levy and Lobel (2011) examined undergraduate women’s sense of belonging in STEM fields by using perception of compatibility between their identity as women and STEM fields (“identity compatibility”) as a predictor. They found that perceived identity compatibility was related to a greater sense of belonging in both their STEM program and their university. The study was exploratory and focused on identifying the utility and feasibility of using identity compatibility as a predictor of STEM field engagement.

Rosenthal, London, Levy and Lobel (2011) administered online surveys at two timepoints; one during the first year of undergraduate studies and another during the second year. The surveys measured identity compatibility by using the “Inclusion of Other in the Self” instrument to assess perceived compatibility between self and STEM field. The “Inclusion of Other in the Self” instrument asks participants to choose one of a series of 7 interlocking circles to show how compatible or connected they feel their gender is with their major. To measure engagement with their major, the researchers used a measure of
“belongingness” in their major that the authors adapted an 8 question Likert survey from a measure of institutional belongingness. This measure asked how comfortable participants felt in their major, with their peers, and at their university. Rosenthal, London, Levy and Lobel (2011) used hierarchical regression to examine if identity compatibility predicted a greater sense of belonging in the STEM program. They found that at time two, after participants had gained experience in their program, a greater identity compatibility predicted both a greater sense of belonging in their STEM program ($\beta = .25, p < .05$) and at the University ($\beta = .23, p < .05$).

This study reveals that undergraduates’ perceptions of identity congruence impacted their sense of engagement with STEM fields, and that experiences with STEM fields may influence that relationship. The “Inclusion of Other in the Self” has been demonstrated to have test-retest reliability and convergent validity with identity integration, but it does not distinguish between different components of identity. It is a one item measure that encompasses both gender and STEM disciplines. It also only addresses external perceptions; it asks about participants’ gender and major but not about how those participants perceive themselves. Additionally, sense of belonging may only indirectly measure engagement or commitment to a STEM field. This study would have benefited from more comprehensive and robust measures of identity congruence and STEM persistence.

In 2005, Lent et al. examined the fit of the SCCT model with undergraduate racial minorities and women in engineering, to see if the predictions made by SCCT, that self-efficacy and outcome expectations would predict interests and goals, held true across
ethnicity and gender. They examined undergraduate Engineering students at historically Black colleges or universities (HBCU) and at predominantly white institutions (PWI). Most of the students were in their first or second year of school. Participants were asked to complete a battery of surveys that measured self-efficacy, outcome expectations, engineering related interests, major choice goals (intentions to remain in major and persist in major), social supports/barriers related to pursuit of an engineering major, and demographic information. The fit of the data to the SCCT model was tested via structural equation modeling, performing fit analyses for all data, and data stratified by gender and race. They found that for all students, self-efficacy appeared to be the primary predictor of goals. This reflects previous discussions on the impact of self image and professional stereotypes on career choice.

To examine the unique experiences of women in engineering majors, Lent et al. (2005) tested the fit of the SCCT model across gender, and found that the impact of self-efficacy and outcome expectations on major choice goals does not differ by gender. One explanation for this finding, as noted by Lent et al., is that the undergraduate students in their sample were early in their academic career and may not have been exposed to socialization or experiences that would impact their major choices. They also cite past research findings that goals to enter and remain in STEM majors predict enrollment and persistence in STEM majors, and assert that their findings are consistent with those results. It is important to note that these findings occurred with early undergraduates, and addressed choice of major; the findings may not transfer to more experienced students who are considering the pursuit of a
career in STEM fields above simply completing a STEM undergraduate degree.

Schaefers, Epperson and Nauta (1997) found that persistence in scientific careers was predicted by a match between an individual’s interests and personal characteristics and the interests and characteristics of a scientific discipline. They examined the impact of interest congruence on persistence in Engineering by surveying 278 undergraduate Engineering students. Interest congruence refers to the extent to which an individual’s interests and characteristics match those demanded by a specific career, and it was measured through the comparison of participants’ pre-college interest indications on the ACT Interest Inventory with their actual college major. The ACT Interest Inventory measures interests across six fields ranging from Technical, Science, Arts, Social Service, Business Contact, and Operations (Cronbach’s alpha = .83 to .93 across subscales), and identifies the field rated most interesting by individuals. This field was then compared to participants’ college majors to assign levels of interest congruence for each participant. Persistence was measured by continued presence in an Engineering, Physical Science, or Mathematics major. Through logistic regression analysis, Schaefers, Epperson and Nauta’s (1997) found that interest congruity added significantly to the prediction of persistence when ability, self-efficacy, support, and barriers were held constant ($G = 160.87, p < .02$). These findings suggest that the extent to which women identify with STEM careers impacts their decisions to pursue and persist in those careers, but the findings are limited by the use of an insufficient measure of persistence that is of limited utility in a one-time cross-sectional survey study.

Diekman et al. (2011) put forth a “goal congruity perspective” for examining
women’s choices regarding STEM careers. Goal congruity is similar to role congruity but focuses specifically on how well women perceive a potential career fits with their personal goals. In fact, Diekman et al. asserted that goal congruity theory is an attempt to “further develop the motivational underpinnings of role congruity theory,” (p. 903). Diekman et al. identified two types of goals that are considered when people consider potential careers; agentive goals and communal goals. They identified communal goals as those related to connection with others, such as working with others and helping others. Agentive goals were described as those pertaining to achievement, success, and mastery. The goals identified by Diekman et al. (2011) may be important components of overall science identity, and may play a role in perceptions of identity congruence.

Diekman et al. (2011) examined the impact of goal congruity on STEM career choice through a “goal affordance” perspective, meaning that people choose careers due to expectations about how easily that career will allow them to meet their goals. Diekman et al. and noted that STEM careers are not traditionally considered to reinforce communal goals, which may turn women away from STEM careers, as it is believed that women value communal goals more than do men. They cited previous research that found 60.2% of women found communal goals more important than agentive goals, while 61.6% of men believed agentive goals were more important than communal goals. They examined how perceptions of congruence across both agentive and communal goals impacted interest in STEM careers in undergraduate psychology students. They noted that this approach is especially pertinent with current research that indicates “that over recent decades, gender
differences in agency have narrowed, whereas gender differences in communion have remained fairly stable” (p. 903).

Diekman et al. (2011) examined the impact of goal affordance stereotypes on STEM career choice by examining the impact of activating communal goals on STEM interest. They activated communal goals by having 64 undergraduate participants perform a writing task that was either about communal action or about the forest floor (neutral activation). After the writing task, participants were asked to rate their career interest using a 7 point Likert scale asking about STEM careers, stereotypically male non-STEM careers, and stereotypically female non-STEM careers. They found that activation of communal goals decreased interest in STEM careers in relation to neutral activation for both men and women ($F(1, 62) = 4.37, p = .04$), while interest in stereotypically male non-STEM careers and stereotypically female non-STEM careers remained unchanged. The study points toward the importance of preconceptions about scientists in students’ interest in STEM careers, but the small sample size prevents generalization of results and prevents more nuanced examination.

Cech, Rubineau, Silbey and Seron (2011) refined understandings of how identity congruity impacts STEM persistence by directly comparing perceived fit between individual characteristics and anticipated professional role requirements to behavioral and intentional choices to pursue and persist in STEM careers in undergraduates. Cech, Rubineau, Silbey and Seron made the argument that personal characteristics such as competencies and personal values must be considered a good fit with anticipated career requirements in order for undergraduates to choose to study a STEM field and persist into a STEM career.
To assess the impact of personal values and competencies on STEM career persistence, the authors investigated the effect of professional role confidence on undergraduate students’ persistence in STEM careers. Professional role confidence was defined as “individuals’ confidence in their ability to successfully fulfill the roles, competencies, and identity features of a profession” (p. 641). As such, professional role confidence is a fit assessment between the individual’s assessments of his/her abilities compared the expected requirements of a STEM career. Cech, Rubineau, Silbey and Seron (2011) noted that professional role confidence is a new construct that remains fairly untested.

The variable of professional role confidence was broken down into two dimensions; expertise confidence and career fit confidence, which represents the perceived fit between one’s interests and values and the career. Persistence was measured through continuance in an engineering major from freshman year through senior year, and through a survey measure of intentional persistence (whether or not students plan a STEM career in the future). Professional role confidence variables (expertise confidence and career-fit confidence) were measured via 4 item and 5 item survey measures, respectively. Participants were an entire matriculating class of undergraduates \( n = 288 \), with special attention paid to those students in an engineering program. Professional confidence measures were taken during participants’ first year in college to gauge their expectations for their STEM experience. Relationships between professional confidence and persistence were assessed through regression analyses and both expertise confidence \( \beta = 1.78, p < .05 \) and career-fit confidence \( \beta = 1.06, p < .05 \), were found to predict persistence in a STEM discipline.
The findings of Cech, Rubineau, Silbey and Seron (2011) lay an important foundation for the direct comparison of identity congruence and intentions of undergraduates to persist in STEM disciplines and pursue STEM careers. However, their measures were developed for the research specifically, not validated or assessed via factor analysis.

**Research Objectives and Hypotheses**

Taking into account previous research and assessing gaps in knowledge, this research examined the relationship between identity congruity and undergraduates’ intentions to persist in STEM, with the expectation that identity congruity predicts persistence and that gender influences the relationship between identity congruence and persistence. The research used an existing data set \( n = 1639 \) to establish values for identity congruence and persistence. The use of such extensive participant numbers provides opportunities for greater external validity as well as more robust and nuanced understandings of how students view science in relation to their own skills and abilities.

Intentions to persist in STEM careers were measured via the Career Intentions in Science (CIS) scale (Nassar-McMillan, Wyer, Oliver-Hoyo, & Schneider, 2012; Schneider, 2010; Wyer, Schneider, Nassar-McMillan & Oliver-Hoyo, 2010), which consists of 12 items with a Cronbach’s alpha score of .98, and therefore offers a more robust and psychometrically sound measure of persistence than is found in previous research. Identity congruence was measured using the Scientist-self Similarity (SSS) score, which is derived from items on the Stereotype of Scientists (SOS) scale (Schneider, 2010; Wyer, Schneider, Nassar-McMillan & Oliver-Hoyo, 2010). The SOS and CIS have been validated and tested
in previous research (Schneider, 2010, Wyer, Schneider, Nassar-McMillan & Oliver-Hoyo, 2010; Nassar-McMillan, Wyer, Oliver-Hoyo, & Schneider, 2012), as has the derivation of the SSS score from SOS items (Ryder-Burge, 2010). Both the SOS and SSS have been demonstrated to include two subscales measuring distinct factors; perceptions regarding professional competencies and perceptions regarding interpersonal competencies (Ryder-Burge, 2010; Schneider, 2010). Both factors were included in analyses. Because the CIS and SOS were developed on two robust and separate samples (Ryder-Burge, 2010; Schneider, 2010), the data provide an opportunity to explore the viability of extending this work to research on the relationship of identity congruence and persistence, and offer more accurate and reliable data than other measures available in the literature. Regression analyses including moderation analysis were used to gain a fuller understanding of the direction and relationship between identity congruence and persistence, with attention to the impact of gender on that relationship.

H1: Identity congruence will be a predictor of intentions to persist in STEM

H1a: Identity congruence along the professional competencies factor will predict intentions to persist in STEM

H1b: Identity congruence along the interpersonal competencies factor will predict intentions to persist in STEM

H2: Gender will moderate the relationship between identity congruence and intentions to persist in STEM, with the relationship between identity congruence and STEM career intentions being more pronounced for women than for men.
H2a: Gender will moderate the relationship between identity congruence and intentions to persist in STEM along the professional competencies factor

H2b: Gender will moderate the relationship between identity congruence and intentions to persist in STE along the interpersonal competencies factor

Additionally, because the SSS score is derived from a difference score, there is some question regarding the most appropriate method for calculating the SSS score. A secondary hypothesis for this research was to compare two methods to calculate the SSS; a simple difference score and the Kruskal and Goodman gamma correlation (Goodman & Kruskal, 1954). There is some concern among researchers that using a simple difference score may lead to inaccuracies (Edwards, 2001), and the use of a simple difference score also denotes directionality of identity congruence; a positive difference score indicates that individuals scored themselves lower on a certain characteristic than they rated scientists while a negative score indicates that individuals scored themselves higher than scientists. The Goodman and Kruskal gamma correlation (Goodman & Kruskal, 1954), which measures difference scores as a proportion of differently scored items to all items, results only in scores ranging from 0 to 1 indicating the degree to which individual self-assessments differ from assessments of scientists (Nelson, 1984; Neupert & McDonald-Miszczak, 2004). The comparison of these two methods of calculation will allow for a greater understanding of the SSS score, and allow for the identification of error in the SSS scale and inform more refined analyses.

H3: Using a Goodman and Kruskal gamma correlation (Goodman & Kruskal, 1954) to measure identity congruence will result in different outcomes than a simple difference
Methods

This study examined existing data that were collected between 2007 and 2009 from undergraduate students, in the context of the National Science Foundation Measurement Matters study (Wyer, Schneider, Nassar-McMillan & Oliver-Hoyo, 2010; Nassar-McMillan, Wyer, Oliver-Hoyo, & Schneider, 2012), which involved the administration of surveys to develop two scales, the Stereotypes of Scientists (SOS) scale and the Career Intentions in Science (CIS) scale. Survey data were collected from 1639 undergraduate students at 7 universities nationwide, from a variety of classes across academic disciplines (Schneider, 2010), using a refined version of the SOS developed by Wyer, Schneider, Nassar-McMillan & Oliver-Hoyo, (2010). Persistence data were measured via the CIS. SOS data were used to derive a “Scientist-Self Similarity” (SSS) score that measured, among other things, individuals’ perceptions of scientists and perceptions of self (Nix, 2009; Ryder-Burge, 2010; Wyer, Schneider, Nassar-McMillan & Oliver-Hoyo, 2010).

Participants

Participants in the Measurement Matters study were all undergraduate students. The use of data from undergraduate students is consistent with previous research on gender, identity and STEM career intentions, and represents an important time in the life of a burgeoning STEM professional during which decisions to remain in a STEM discipline are made (Cech, Rubineau, Silbey & Seron, 2011). Students from STEM classes such as mathematics, life sciences and engineering comprised 81.9% of the sample, with non-STEM
majors being represented by humanities and social science classes (Schneider, 2010). Nearly 72% of participants were STEM majors, reporting majors in Agricultural Sciences, Life Sciences, Engineering, Physical Sciences and Math Sciences. Other, non-STEM majors were reported as Education, Humanities, Social Sciences, Other and Undecided (Schneider, 2010). The primary ethnic categories reported by participants were White/European-American (72%), Asian/Asian-American (13%), and Black/African-American (7%). Females comprised 59% of the sample, and males 41%.

Measures and Variables

Independent variable: Identity Congruence

Identity congruence was measured through the derivation of an SSS score from items in the SOS (Schneider, 2010, Wyer, Schneider, Nassar-McMillan & Oliver-Hoyo, 2010). The SSS was derived from a difference score between SOS items phrased as images of scientists (“When I think about a scientist, I think of someone who…”) and SOS items phrased as self images (“When I think about myself, I think I am someone who….”). Wyer, Schneider, Nassar-McMillan, and Oliver-Hoyo (2010) present the SOS as a methodical, nuanced, and psychometrically sound measure of stereotypes about scientists that can be used across various demographic groups. The development of the SOS scale was a first step toward developing a comprehensive understanding of how women’s perceptions of STEM professionals relate to their perceptions of themselves and to their career choices. Wyer, Schneider, Nassar-McMillan, and Oliver-Hoyo (2010) examined previous literature that identified commonly held stereotypes of scientists as masculine in nature, such as the Draw-
a-Scientist test (DAST) (Chambers, 1983) and Image of Science and Scientists Scale (ISSS) (Smith & Krajkovich, 1979). They cited Chambers’ (1983) early work with the DAST, which asked people to draw a scientist and identified common characteristics as being white, male and wearing a lab coat and glasses. Another scale, the Women in Science Scale (WiSS), created by Erb and Smith in 1984, addresses both stereotypes of scientists and stereotypes about gender but is hampered by conflation between attitudes about women and attitudes about scientists, and like the DAST and ISSS, the WiSS was not developed to compare stereotypes across different groups.

To create the SOS, Wyer, Schneider, Nassar-McMillan, and Oliver-Hoyo compiled common stereotypes about scientists from the existing literature and through focus groups with undergraduates. The SOS was then piloted in a large sample (n = 1,106) of undergraduate students across a variety of majors and demographic backgrounds. They examined the item responses for skewness and kurtosis, eliminating several on the grounds that there was too much agreement or too little agreement about the items to be conceptually useful in developing a stereotypes scale. They then conducted a series of exploratory factor analyses that resulted in a two-factor solution. Items that did not load on one of two remaining factors at .40 or higher were removed, leaving a total of 22 items loading on two sub-scales, identified as interpersonal competencies and professional competencies.

Schneider (2010) further refined and validated the SOS by administering it to 1,639 undergraduate students in a national sample and conducting regression analyses to determine the relationship between stereotypes of scientists and undergraduate major choice and STEM
career commitment. Schneider assessed psychometric properties of the SOS by performing exploratory and confirmatory factor analyses, using a more a loading cutoff of .40, and refined the SOS scale from 22 items to 18. The 18 items were subdivided into the two factors identified by Wyer, Schneider, Nassar-McMillan, and Oliver-Hoyo (2010); professional competencies (Cronbach’s alpha = .81), and interpersonal competencies (Cronbach’s alpha = .77).

A particular strength of the SOS is that data were collected for parallel items that asked participants about their self images. The stem was changed to address images of the self as a scientist by changing an item from “When I think about scientists I think…” to “When I think about myself, I think….” In her master’s research, Amy Ryder-Burge (2010) utilized the item stem flexibility within the SOS to create a new variable, the Scientist-Self Similarity Score (SSS). The SSS is derived from a difference score between SOS items phrased as images of scientists (“When I think about a scientist, I think of someone who…”) and SOS items phrased as self images (“When I think about myself, I think I am someone who….”). This difference extrapolates the SSS score into a measure of “science identity,” so that how much an individual identifies as a scientist is represented by the difference between her/his self image and her/his image of scientists. A smaller score indicates congruence.

Ryder-Burge (2010) piloted the development of the SSS by utilizing SOS scores from a local sample of undergraduates (n = 935) at North Carolina State University. She generated SSS scores and evaluated the psychometrics of the SSS scores by conducting an exploratory factor analysis and identifying items that did not load adequately on the two factors in the
stereotypes scale. At the end of the exploratory factor analysis, 18 items remained and were divided into the two factors of the SOS, professional competencies and interpersonal competencies. The professional competencies factor was measured by a subscale containing 11 items (Cronbach’s alpha = .82), and the interpersonal competencies factor was measured by a subscale containing 6 items (Cronbach’s alpha = .68). In this research, identity congruence was measured using both the professional and interpersonal competencies subscales of the SOS. Each subscale represents a distinct and important element of identity congruency, and each subscale was entered as a separate variable in regression analyses.

**Dependent Variable: Intention to persist in STEM**

Intention to persist in STEM (“persistence”) was measured using the Career Intentions in Science (CIS) scale, (Schneider, 2010, Nassar-McMillan, Wyer, Oliver-Hoyo, & Schneider, 2012; Wyer, Schneider, Nassar-McMillan, & Oliver-Hoyo, 2010). The CIS scale was developed alongside the SOS, and measured undergraduate students’ intentions to pursue a career in a STEM field. It consists of 12 Likert scaled items that ask students to rate the likelihood of pursuing and persisting in a STEM career (Cronbach’s alpha = .98). In developing the CIS, Wyer, Schneider, Nassar-McMillan, and Oliver-Hoyo (2010) and Nassar-McMillan, Wyer, Oliver-Hoyo, and Schneider (2012) examined previous research on career choice, primarily using Ellis and Herrman’s (1983) work as a foundation for the scale development. Schneider (2010) conducted a confirmatory factor analysis on the CIS, and found that each of the twelve items loaded significantly on the measure’s one factor. Factor loadings ranged from .88 to .92 and the measure accounted for 76.56% of the variance in
students’ intentions to pursue STEM careers. Ryder-Burge (2010) confirmed the one factor solution, with the same items, in a second study with another undergraduate population.

Analyses

Data were assessed via linear regression analysis and moderation analysis. These statistical analyses are appropriate for this research because the predictor and dependent variables are measured on a Likert scale, and therefore data are continuous. Moderation analyses were conducted via linear regression, with gender as a dichotomous moderating variable.

CIS scores were aggregated across all items, generating one composite score measuring students’ intentions to pursue a STEM career. This composite score was used as a dependent variable. SSS scores were calculated using both simple difference scores and the Kruskal and Goodman gamma correlation. SSS scores were aggregated into a composite score to represent identity congruence, and additionally subdivided into the professional competencies and interpersonal competencies factors (Schneider, 2010). Regression analyses were run using SSS scores derived from both a simple difference score and Kruskal and Goodman gamma correlation. A Fischer’s r to z transformation was used to compare Pearson’s correlation coefficients across both methods of calculation.

Results

Identity congruence was measured by SSS scores, which were first calculated through a simple difference score. SSS scores were calculated for each survey item, and then aggregated into scores for overall science identity congruence (M = 0.06, SD = 0.44), and
along both the professional competencies \((M = 0.36, SD = 0.60)\) and interpersonal competencies \((M = -0.50, SD = 0.69)\) factors. See Table 1 for a list of measure items included in each factor. SSS scores were then calculated using the Kruskal and Goodman gamma correlation, aggregating into overall science identity \((M = 0.59, SD = 0.19)\) and the professional competencies \((M = 0.54, SD = 0.21)\) and interpersonal competencies \((M = 0.58, SD = 0.25)\) factors.

To prepare for the linear regressions, it was first necessary to examine the descriptive statistics of all included variables to ensure a normal distribution. See Table 2 for descriptive statistics for each variable. Each aggregated identity congruence variable computed via the Kruskal and Goodman gamma correlation exhibited skewness and kurtosis of less than 1. Aggregated identity congruence variables calculated via simple difference score exhibited skewness of less than 1 and kurtosis ranging from 1.67 to 1.91. While the difference in kurtosis across calculations is interesting, and the slightly higher kurtosis of variables calculated via simple difference likely reflect inaccuracies resulting from the calculation method, kurtosis levels were low enough that the variables were considered to be normally distributed. Skewness and kurtosis for intentions to pursue a STEM career were both less than 1, but when graphed, the variable did not display a normal distribution. See Figure 1 for the graph of intentions to pursue a STEM career. However, given the skewness and kurtosis values of the variable and the general robustness of linear regression, it was determined appropriate to continue with regression analyses and correlation analyses were run on all variables. See Table 3 for outcomes of all correlation analyses. All variables were
significantly correlated with each other; however, these correlations are not unexpected given the related nature of the variables and expectations that identity congruence is related to intentions to pursue a STEM career. To assess the impact of multicollinearity in the linear regression analyses, the collinearity statistics of tolerance and VIF were assessed for each model, and results fell within acceptable bounds, with Tolerance scores ranging from 0.90 to 1.00, and VIF scores ranging from 1.00 to 1.11.

Aggregated identity congruence scores were included in linear regressions with persistence as a dependent variable. Linear regressions were run including each overall identity congruity variable separately, and including both factors of identity congruity together. See Table 4 for outcomes of all linear regressions. When the SSS score was calculated using a simple difference score, overall identity congruence significantly predicted intentions to pursue a STEM career ($\beta = -0.08, p < .001$), with those students exhibiting higher senses of identity congruity (smaller scores equaling more congruence) also reporting higher intentions of pursuing a STEM career. That model, while only explaining 0.7% of variance in the data, was still a significant fit to the data ($F(1) = 11.21, p = .001$). When identity congruence along the professional competencies and interpersonal competencies factors were used in the model instead of overall identity congruence, the amount of variance accounted for by the model increased to 8.9%, and the model was a better fit ($F(2) = 79.64, p < .001$). Identity congruence along the professional competencies factor significantly predicted students’ intentions to pursue a STEM career ($\beta = -0.21, p < .01$). Likewise, perceptions of congruity in interpersonal competencies also significantly predicted students’
intentions to pursue a STEM career ($\beta = 0.19$, $p < .01$), but the positive $\beta$ value indicates that students exhibiting higher senses of congruity along the interpersonal competencies factor were less likely to intend to pursue a STEM career. This unusual finding may represent a heretofore unexamined distinction in how students identify as STEM professionals, or it may represent an inaccuracy related to the use of a simple difference score to measure identity congruence.

When the Kruskal and Goodman gamma correlation was used to measure identity congruence, overall identity congruence significantly predicted intentions to pursue a STEM career ($\beta = -0.25$, $p < .001$), and the model was a good fit to the data ($F(1) = 110.23$, $p < .001$), explaining 6.3% of variance in the dependent variable. Using identity congruence along the professional competencies and interpersonal competencies factors in the model instead of overall identity congruence did not change the percent of variance explained. Perceptions of congruity along both the professional competencies factor ($\beta = -0.20$, $p < .01$), and along the interpersonal competencies factor ($\beta = -0.10$, $p < .01$), significantly predicted students’ intentions to pursue a STEM career with students exhibiting higher senses of congruity stating higher likelihood of pursuing a STEM career.

To further compare the use of a simple difference score and Kruskal and Goodman’s gamma correlation, Pearson’s correlation coefficients were compared across calculation method using Fisher’s $r$ to $z$ transformation. To conduct the Fisher’s $r$ to $z$ transformation, correlations were run between the dependent variable and all aggregated identity congruence
scores. See Table 3 for correlation coefficients. The Fisher’s $r$ to $z$ transformation was conducted using a calculator found at http://www.vassarstats.net/rdiff.html. See Table 5 for outcomes of the Fisher’s $r$ to $z$ transformation. The Fisher’s $r$ to $z$ transformation found that all Pearson’s correlation coefficients were significantly different across methods used to calculate identity congruencies. Correlations to the dependent variable of identity congruence calculated by simple difference scores were significantly less than those of identity congruities calculated by Kruskal and Goodman’s gamma correlation for overall identity congruence ($z(1640) = -5.14, p < .001$) and for the professional competencies factor ($z(1640) = -2.29, p = .02$). Interestingly, identity congruence along the interpersonal differences factor exhibited higher correlation with the dependent variable when calculated via simple difference score versus the Kruskal and Goodman gamma correlation ($z(1640) = 19.62, p < .001$). This difference between the professional competencies factor and the interpersonal competencies factor demonstrates the uniqueness of each subscale, and suggests that the interpersonal competencies factor exhibits unique dynamics relative to the professional competencies factor.

To further explore the two factors, a hierarchical regression was conducted wherein each factor was introduced to the model separately so as to determine if the addition of the second factor explained a significant change in the amount of variance explained. Identity congruence along the professional competencies factor was entered into the model first, followed by identity congruence along the interpersonal competencies factor. For both
methods of identity congruence calculation, the addition of the second factor significantly increased the amount of variance explained. For variables calculated using a simple difference score, the $R^2$ value of the model increased from .05 to .09 when the second factor was added ($p < .001$). For variables calculated using the Kruskal and Goodman gamma correlation, the $R^2$ value of the model increased from .05 to .06 when the second factor was added ($p < .001$). See Table 6 for hierarchical regression results.

**Moderation Analyses**

Moderation analyses were conducted to determine how gender moderates the relationship between students’ sense of science identity congruence and their intentions to pursue a STEM career. Moderation analyses were run with aggregated variables calculated via both simple regression and using the Kruskal and Goodman gamma correlation. See Table 7 for full moderation results. Moderation analysis identified a main effect for gender in only two models, that including the overall identity congruence variable calculated by simple difference ($\beta = -0.07$, $p < .01$), and that including the interpersonal competencies factor calculated by simple difference score ($\beta = -0.06$, $p = .05$). Gender was represented by a dummy variable in which “male” equaled 0 and “female” equaled 1, so regression results indicate that males were more likely than females to report intentions to pursue a STEM career. In both models, there was no main effect for overall identity congruency ($\beta = -0.02$, $p = .63$), but there was a main effect for identity congruity along the interpersonal competencies factor ($\beta = 0.21$, $p < .001$). All other models, using identity congruence scores
measured via both simple difference and using the Kruskal and Goodman gamma correlation, exhibited a significant main effect for identity congruence \((p < .001)\), but no main effect for gender and no interaction effect for gender and identity congruence.

Interaction effects between gender and the professional competencies factor, calculated via both methods, approached significance \((p = .06)\), suggesting that the relationship between student perceptions of congruence in professional competencies and intentions to pursue a STEM career may be more influenced by gender than the relationship between perceptions of interpersonal competencies and intentions to pursue a STEM career. Multicollinearity was a problem in these models; each model accounted for a significant amount of variance in the dependent variable \((p < .001)\), but exhibited unfavorable collinearity statistics. See Table 8 for a full list of model significance and collinearity statistics.

**Discussion**

**Regression analyses**

Linear regression analyses upheld expectations that science identity congruence significantly influenced students' intentions to pursue a STEM career. Overall, regression analyses demonstrated that students reporting higher science identity congruence also exhibited higher intentions to pursue STEM careers. These findings are in line with previous research showing the importance of identity congruence on career intentions. That identity
congruities along the professional competencies factor significantly predicted intentions to pursue STEM careers upholds career identity theories that emphasize the role of anticipated success in career choices. Students who perceived a match between their professional competencies and the professional competencies of STEM professionals were more likely to indicate intentions to pursue a STEM career.

Unexpected findings during regression analyses related to interpersonal competencies are likely due to idiosyncrasies related to the method of variable calculation, and are not necessarily representative of a lack of influence of perceived interpersonal congruencies on intentions to pursue STEM careers. The finding that students exhibiting identity congruence along the interpersonal differences factor (when calculated via simple difference) were less likely to pursue STEM careers was not upheld when relationships were analyzed using the Kruskal and Goodman gamma correlation. It is likely that negative difference scores were affecting the variance of the overall composite variable calculated via simple difference, resulting in inaccuracies in the analysis. However, the unique characteristics of the interpersonal competencies factor warrant closer examination in future research, as they suggest that there are unique dynamics occurring in the way that students assess their own interpersonal competencies and the way in which they assess STEM professionals’ interpersonal competencies.

Of particular interest from the linear regression results was the increase in variance explained when both factors of identity congruence were introduced to the model using hierarchical regression. The significant increase in variance explained when both factors
were included in the model is further evidence that each factor measures a unique construct, and contributes uniquely to the variance in intentions to pursue a STEM career.

**Kruskal and Goodman Gamma Correlation vs. Simple Difference Score**

A key part of this research involved comparing the calculation of identity congruence variables by either simple difference score versus gamma correlation. The Fisher’s r to z transformation highlighted the importance of calculation method when using difference score variables. That all correlations were found to be significantly different from each other is a key finding, as it means that the different calculation methods are in fact generating significantly different variables and outcomes. Both overall identity congruence and identity congruence along the professional competencies factor were more significantly related to the dependent variable when calculated using the Kruskal and Goodman gamma correlation. This aligns with expectations and is evidence that using the Kruskal and Goodman gamma correlation results in fewer inaccuracies in computed variables. However, the third variable, identity congruence along the interpersonal competencies factor, exhibited much higher correlation with the dependent variable when calculated via simple difference score.

The supposition that the different calculation methods result in different outcomes is upheld by the correlation between identity congruence along the interpersonal competencies factor as calculated by gamma correlation and by simple difference, (r = -.44), which is a moderate negative correlation suggesting that the variables covary, but in opposition to one another. It is also important to note that using the Kruskal and Goodman gamma correlation to calculate identity congruity scores resulted in a correlation between overall identity
congruence and interpersonal competencies factor that changes from .47 when calculated via simple difference, which is lower than would be expected due to the relationship between the overall score and the factor score, to .71 when calculated via gamma correlation. These results, when taken in combination with other analysis results and expectations regarding relationships between variables, suggest that there are differences in information and outcomes provided by both calculation methods. It seems that a simple difference score and a Kruskal and Goodman are capturing different information about the way students view themselves in comparison to how they view STEM professionals.

**Moderation Analyses**

Moderation analyses did not find that gender significantly moderated the relationship between identity congruence and intentions to pursue a STEM career for any of the identity congruence variables. This may indicate that gender is playing less of a role in the development of science identity than previously thought. Previous research has demonstrated that the Stereotypes of Scientist Scale (SOS) is valid, reliable and stable across gender and that both men and women hold stereotypes about scientists (Ryder-Burge, 2010; Schneider, 2010; Wyer, Schneider, Nassar-McMillan, & Oliver-Hoyo, 2010). However, this research did not find a gender effect in the way that student perceptions of themselves vs. perceptions of STEM professionals impacted intentions to pursue a STEM career. This suggests that men and women’s assessments regarding themselves and scientists are more similar than previously thought. This is a unique finding that contrasts with earlier research findings that highlight the importance of differences between men and women’s perception
of themselves and assessments of STEM careers as a good career fit.

The near significance of the interaction between gender and identity congruence along the professional competencies factor may indicate that there may be some gender effect in the relationship between students’ perceptions of identity congruence and their intentions to pursue a STEM career; however this effect is limited to the professional competencies factor. The interaction between gender and identity congruence along the interpersonal competencies factor did not approach significance ($p > .2$). Assessments of interpersonal competencies, while clearly related to intentions to pursue STEM careers, are not clearly related to gender.

**Potential Limitations**

While it is reasonable that some collinearity exists between variables used for moderation analyses, given the theoretical expectation of relationship between variables, and that the predictor variables used in the models were measuring similar aspects of the identity congruence construct, it is nevertheless possible that collinearity obscured results from the moderation analyses.

Additionally, there are some limitations to the data from the SOS and CIS. Because a great number more STEM majors than non-STEM majors participated in the data collection for the CIS and SOS (Schneider, 2010; Wyer, Schneider, Nassar-McMillan, & Oliver-Hoyo, 2010), there is the potential for response bias in the overall SOS. Though mean scores on the SOS predict major (Schneider, 2010), and so demonstrate external validity, because STEM participants responded more positively to STEM related items than did non-STEM
participants, the scale analyses may have resulted in a “pro-STEM” scale wherein negatively worded items did not survive the factor analyses. Lack of cultural diversity is a weakness in the sample, so that the stereotypes captured by the SOS may not be applicable across ethnic populations within the United States, or outside the United States.

**Conclusions**

Further development of the SSS as a measure of science identity will strengthen future investigations into undergraduate students’ decisions to pursue and persist in STEM careers by providing more valid and reliable data than previous measures allow. Given the results of this research, a closer examination of each variable of interest and more specific understandings of relationships between variables is recommended in order to better understand how science identity, gender and student intentions to pursue a STEM career are related. Implications for future research include examining the underlying, assumed relationships of the moderation analyses, including a direct assessment of how gender influences identity congruence. These foundational analyses can then be used to inform more complicated analyses such as path modeling to continue examination into how the variables of interest interact. Further analysis of the calculation of identity congruence using the Kruskal and Goodman gamma correlation are warranted, focusing on the descriptive statistics of outcomes, impact on variance, and model fit implications.
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compatibility and social support for women in a single-sex STEM program at a co-


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APPENDIX
APPENDIX A

Full Career Intentions Scale (CIS)

In your future career, how likely is it that you will:
(Response choices are: Strongly Disagree, Disagree, Mildly Disagree, Mildly Agree, Agree, Strongly Agree)

1. Get college training in science
2. Get experience working as a scientist
3. Be a successful scientist
4. Get an advanced degree in science
5. Become a scientist
6. Have the ability to become a scientist
7. Take advanced courses in science
8. Complete your degree in science
9. Do advanced research in science
10. Apply to graduate programs in science
11. Have a lifelong career in science
12. Have a very successful career in science
Table 1

*Measure items included in the professional competencies and interpersonal competencies factors*

<table>
<thead>
<tr>
<th>Professional Competencies</th>
<th>Interpersonal Competencies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Item</strong></td>
<td><strong>Item</strong></td>
</tr>
<tr>
<td>Know a lot about the latest discoveries</td>
<td>Have fun with colleagues at work</td>
</tr>
<tr>
<td>Are the ones who know how equipment works</td>
<td>Maintain friendships with colleagues in other departments</td>
</tr>
<tr>
<td>Are careful with expensive instruments</td>
<td>Do not have a lot of friends*</td>
</tr>
<tr>
<td>Independent</td>
<td>Cooperative</td>
</tr>
<tr>
<td>Work oriented</td>
<td>Family oriented</td>
</tr>
<tr>
<td>Technically competent</td>
<td>Collaborative</td>
</tr>
<tr>
<td>Competent</td>
<td></td>
</tr>
<tr>
<td>Highly focused</td>
<td></td>
</tr>
<tr>
<td>Able to learn to use new equipment quickly</td>
<td></td>
</tr>
<tr>
<td>Especially intelligent</td>
<td></td>
</tr>
<tr>
<td>Logical</td>
<td></td>
</tr>
</tbody>
</table>

*item was reverse coded
Table 2

*Descriptive statistics for each variable included in linear regression analyses*

<table>
<thead>
<tr>
<th>Intention to pursue STEM career</th>
<th>Simple difference calculation</th>
<th>Kruskal and Goodman gamma correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Overall identity congruence</td>
<td>Professional competencies</td>
</tr>
<tr>
<td></td>
<td>Interpersonal competencies</td>
<td>Overall identity congruence</td>
</tr>
<tr>
<td>(N)</td>
<td>1640</td>
<td>1640</td>
</tr>
<tr>
<td>Mean</td>
<td>4.12</td>
<td>0.06</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>1.49</td>
<td>0.45</td>
</tr>
<tr>
<td>Skewness</td>
<td>-0.70</td>
<td>0.09</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>-0.71</td>
<td>1.73</td>
</tr>
<tr>
<td>Variance</td>
<td>2.22</td>
<td>0.19</td>
</tr>
<tr>
<td>Range</td>
<td>5.00</td>
<td>4.29</td>
</tr>
<tr>
<td>Minimum</td>
<td>1.00</td>
<td>-2.24</td>
</tr>
<tr>
<td>Maximum</td>
<td>6.00</td>
<td>2.06</td>
</tr>
</tbody>
</table>
Table 3

Correlation outcomes

<table>
<thead>
<tr>
<th>Simple difference score</th>
<th>Kruskal and Goodman gamma correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall identity congruence</td>
<td>Professional competencies</td>
</tr>
<tr>
<td>Intent to pursue a STEM career</td>
<td>.21*</td>
</tr>
<tr>
<td>Overall identity congruence</td>
<td>.83*</td>
</tr>
<tr>
<td>Professional competencies</td>
<td>- .10*</td>
</tr>
<tr>
<td>Interpersonal competencies</td>
<td>-.32*</td>
</tr>
<tr>
<td>Overall identity congruence</td>
<td>.89*</td>
</tr>
<tr>
<td>Professional competencies</td>
<td></td>
</tr>
<tr>
<td>Interpersonal competencies</td>
<td>.31*</td>
</tr>
</tbody>
</table>

*p < .001
Table 4

*Linear regression outcomes with intentions to pursue a STEM career as dependent variable*

<table>
<thead>
<tr>
<th></th>
<th>B (SE)</th>
<th>β</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Simple difference</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall identity congruence</td>
<td>-0.28 (.08)</td>
<td>-0.08*</td>
</tr>
<tr>
<td>Professional competencies</td>
<td>-0.52 (.06)</td>
<td>-0.21*</td>
</tr>
<tr>
<td>Interpersonal competencies</td>
<td>0.42 (.05)</td>
<td>0.19*</td>
</tr>
<tr>
<td><strong>Kruskal and Goodman gamma</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall identity congruence</td>
<td>-2.02 (.19)</td>
<td>-0.25*</td>
</tr>
<tr>
<td>Professional competencies</td>
<td>-1.42 (.12)</td>
<td>-0.20*</td>
</tr>
<tr>
<td>Interpersonal competencies</td>
<td>-0.60 (.15)</td>
<td>-0.10*</td>
</tr>
</tbody>
</table>

*p < .01
Table 5

*Fisher’s r to z transformation outcomes comparing variables measured using simple difference score versus the Kruskal and Goodman gamma correlation (Goodman & Kruskal, 1954)*

<table>
<thead>
<tr>
<th>Category</th>
<th>z(N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall identity congruence</td>
<td>-5.14 (1640)**</td>
</tr>
<tr>
<td>Professional competencies</td>
<td>-2.29 (1640)*</td>
</tr>
<tr>
<td>Interpersonal competencies</td>
<td>19.62 (1640)**</td>
</tr>
</tbody>
</table>

*p < .05   **p < .001
Table 6

*Outcomes of hierarchical linear regression with Intentions to pursue a STEM career as dependent variable*

<table>
<thead>
<tr>
<th></th>
<th>Simple difference</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Kruskal and Goodman gamma correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$B$ ($SE$)</td>
<td>$\beta$</td>
<td>$R^2$</td>
<td>Sig $F$ Change</td>
<td>$B$ ($SE$)</td>
<td>$\beta$</td>
</tr>
<tr>
<td>Professional competencies</td>
<td>-0.57 (.06)</td>
<td>-0.23*</td>
<td>.052</td>
<td></td>
<td>-1.65 (.17)</td>
<td>-0.23*</td>
</tr>
<tr>
<td>Professional competencies</td>
<td>-0.52 (.06)</td>
<td>-0.21*</td>
<td></td>
<td></td>
<td>-1.42 (.12)</td>
<td>-0.20*</td>
</tr>
<tr>
<td>and Interpersonal competencies</td>
<td>0.42 (.05)</td>
<td>0.19*</td>
<td>.089</td>
<td>.00</td>
<td>-0.60 (.15)</td>
<td>-0.10*</td>
</tr>
</tbody>
</table>

*p < .001
Table 7

Results from moderation analyses

<table>
<thead>
<tr>
<th>Simple Difference</th>
<th>B (SE)</th>
<th>β</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>-0.22(0.08)</td>
<td>-0.07*</td>
</tr>
<tr>
<td>Overall identity congruence</td>
<td>-0.06(0.13)</td>
<td>-0.02</td>
</tr>
<tr>
<td>Gender*Overall identity congruence</td>
<td>-0.31(0.17)</td>
<td>-0.07</td>
</tr>
<tr>
<td>Gender</td>
<td>-0.03(0.08)</td>
<td>-0.01</td>
</tr>
<tr>
<td>Professional competencies</td>
<td>-0.40(0.10)</td>
<td>-0.16**</td>
</tr>
<tr>
<td>Gender*Professional competencies</td>
<td>-0.24(0.13)</td>
<td>-0.08</td>
</tr>
<tr>
<td>Gender</td>
<td>-0.18(0.09)</td>
<td>-0.06*</td>
</tr>
<tr>
<td>Interpersonal competencies</td>
<td>0.44(0.08)</td>
<td>0.21**</td>
</tr>
<tr>
<td>Gender*Interpersonal competencies</td>
<td>0.01(0.11)</td>
<td>0.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Kruskal and Goodman gamma</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>0.21(0.24)</td>
<td>0.07</td>
</tr>
<tr>
<td>Overall identity congruence</td>
<td>-1.55(0.31)</td>
<td>-0.19**</td>
</tr>
<tr>
<td>Gender*Overall identity congruence</td>
<td>-0.74(0.39)</td>
<td>-0.16</td>
</tr>
<tr>
<td>Gender</td>
<td>0.17(0.21)</td>
<td>0.06</td>
</tr>
<tr>
<td>Professional competencies</td>
<td>-1.22(0.27)</td>
<td>-0.17**</td>
</tr>
<tr>
<td>Gender*Professional competencies</td>
<td>-0.66(0.35)</td>
<td>-0.15</td>
</tr>
<tr>
<td>Gender</td>
<td>-0.06(0.19)</td>
<td>-0.02</td>
</tr>
<tr>
<td>Professional competencies</td>
<td>-0.77(0.23)</td>
<td>-0.13**</td>
</tr>
<tr>
<td>Gender*Interpersonal competencies</td>
<td>-0.31(0.29)</td>
<td>-0.07</td>
</tr>
</tbody>
</table>

*p < .05    **p ≤ .001
Table 8

*Moderation model significance and collinearity statistics*

<table>
<thead>
<tr>
<th>Simple Difference Score</th>
<th>Gender*Overall identity congruence</th>
<th>$F$</th>
<th>$df$</th>
<th>Tolerance</th>
<th>VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>7.84*</td>
<td>3</td>
<td>0.39</td>
<td></td>
<td>2.56</td>
</tr>
<tr>
<td></td>
<td>Gender*Professional competencies</td>
<td>31.67*</td>
<td>3</td>
<td>0.31</td>
<td>3.23</td>
</tr>
<tr>
<td></td>
<td>Gender*Interpersonal competencies</td>
<td>28.15*</td>
<td>3</td>
<td>0.32</td>
<td>3.18</td>
</tr>
<tr>
<td>Kruskal and Goodman gamma</td>
<td>Gender*Overall identity congruence</td>
<td>40.87*</td>
<td>3</td>
<td>0.08</td>
<td>13.1</td>
</tr>
<tr>
<td></td>
<td>Gender*Professional competencies</td>
<td>35.44*</td>
<td>3</td>
<td>0.10</td>
<td>10.4</td>
</tr>
<tr>
<td></td>
<td>Gender*Interpersonal competencies</td>
<td>19.24*</td>
<td>3</td>
<td>0.12</td>
<td>8.33</td>
</tr>
</tbody>
</table>

*p < .05
Figure 1
Histogram of student intentions to pursue a STEM career