

THESIS

HOW WOMEN'S CALLING FOR SCIENCE CAREERS RELATES TO PSYCHOLOGICAL
PREDICTORS OF PERSISTENCE IN SCIENCE

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ABSTRACT

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Society is lacking numbers and diversity of trained scientists to address important key problems. Undergraduate women have been identified as a group that leaves the science-career pipeline at high rates (NSF, 2015), though researchers have highlighted science self-efficacy, identity, values, and intentions, as critical predictors of their persistence (Estrada et al., 2011). The current study proposes and investigates a new predictor of women's persistence in science: perceiving a calling as a scientist. Perceiving a calling predicts career development tasks and outcomes that are similar to known predictors of women's persistence in science (Hirschi, 2012). The present study explores if and how calling as a scientist relates to undergraduate women's science self-efficacy, identity as a scientist, interest in science, scientific community values, and intentions to pursue science. Bivariate correlations suggest perceiving a calling as a scientist is positively related to undergraduate women's science self-efficacy, identity as a scientist, prosocial values of the scientific community, and intentions to pursue science. Using Social Cognitive Career Theory (SCCT) as a framework, the hypothesis that the relationship between perceiving a calling as a scientist and intentions to pursue science is mediated by science self-efficacy and science identity (respectively) was supported. Explanations and implications of all investigated relationships are discussed. This study establishes calling as a new predictor, and SCCT as useful framework, for continued investigation of women's persistence in science.

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CHAPTER I

Introduction

Scientists are vital instruments in solving society's most pressing challenges. Today, the United States is facing an economic crisis regarding whether there will be enough trained scientists to address these issues (U.S. Congress Joint Economic Committee, 2012). Recently, the President's Council of Advisors on Science and Technology (PCAST) reported a predicted deficit of one million college graduates in science, technology, engineering, and mathematics (STEM) over the next decade (Olson, & Riordan, 2012). Not only are the numbers of scientists lacking, the science workforce also lacks diversity, thus likely stifling its potential for greater scientific innovation (Hill, Corbett, & St. Rose, 2010).

The National Science Foundation (NSF) has begun to address these problems through identifying a particular gap in the representation of both women and people of color entering and persisting in science and engineering fields of study (NSF, 2008; NSF, 2010; NSF, 2015). Although school-aged girls and boys take STEM courses in approximately equal numbers (U.S. Department of Education, 2012), and girls outperform boys in math and science courses (Duckworth & Seligman, 2006), women drop out of the STEM career pipeline in greater numbers than men in both undergraduate and graduate degree programs. For example, in 2011, undergraduate women earned 27% of mathematics and computer science degrees, 20% of engineering degrees, and 36% of physical science degrees (NSF, 2011). These low rates of women's participation continue to decrease at the graduate degree level (NSF, 2011).

Increasing the number of women and people of color in the sciences will not only address a major economic problem for the U.S., it also promotes equity and justice for minority

populations and women who have traditionally held lower-paying jobs (Ong, Wright, Espinosa, & Orfield, 2011). Research demonstrates that teams are more innovative and effective when team diversity is achieved (Cheruvilil et al., 2014). Thus, to develop high-performing research teams, it is critical to involve voices and viewpoints from a variety of social backgrounds and disciplines. The proposed study focuses on identifying and understanding the relationships between potential factors that predict undergraduate women's persistence in the sciences. More specifically, because earth and environmental science fields tend to have greater gender disparities than other STEM fields (NSF, 2015; Gonzales & Keane, 2011), the present study focuses on understanding factors that influence undergraduate women's participation specific to earth and environmental science. Future research could potentially build on these findings to inform efforts aimed at increasing participation and persistence in other STEM fields with both women and people of color.

College and Career Development

Postsecondary training is a critical time for individuals to not only figure out their desired career path, but also to explore who they are. Identity development is one of the essential psychosocial tasks that occurs during the period of emerging adulthood, ages 18-25 (Arnett, 2004). Questions such as, "Who am I?" "What do I want to do with my life?" and "What are my values and beliefs?" arise in adolescence and continue to be of concern throughout this developmental stage (Arnett, 2004; Schwartz, Zamboanga, Luyckx, Meca, & Ritchie, 2013). Often, emerging adults face new and changing environments and experience new freedoms to make choices concerning lifestyle, hobbies, habits, social circles, values and career paths. According to Super's Theory of Career Development, college-aged individuals are characterized as being in the "exploration" life stage (Super, 1990). Exploration involves engaging in new and

different experiences – like taking a science course – which often play a large role in informing the development of one’s meaning systems (e.g., sense of calling) and identity formation, which can consequently shape the societal roles that individuals will engage later in life (Schwartz et al., 2013). Through engaging in exploration, individuals further discern their vocational identities, identify how they might fit with various occupations, and establish career goals. The formation of emerging adults’ vocational identities at this stage has been shown to influence their short-term motivation and long-term persistence in a career (Kaplan & Flum, 2012). Therefore, the period of emerging adulthood represents a potentially critical time to identify factors that impact women’s intentions to persist in a scientific career. Understanding how college students develop and maintain a scientific calling, identity, interests, values, and self-efficacy, is an important first step towards developing effective interventions that target a population in a critical time of their vocational development.

Hypothesized Predictor of Women’s Persistence in Science

Perceiving a calling. Developing a calling is an important factor in emerging adult career choice and development. Perceiving a calling, or feeling drawn to a meaningful career for transcendent and prosocial reasons, gives researchers one lens through which they can investigate the meaning individuals derive in their work (Dik & Duffy, 2009). Although this concept has been around for centuries, there continues to be a lack of consensus around what exactly constitutes a calling and how perceiving a calling is defined. Current definitions of calling can be classified into “neoclassical” and “modern” categories. Neoclassical approaches are rooted in historical conceptualizations of calling and emphasize a perceived sense of destiny and prosocial duty (Bunderson & Thompson, 2009). In contrast, modern approaches tend to focus on an inner drive toward self-fulfillment or personal happiness (Duffy & Dik, 2013). For

example, calling has been defined through the modern lens as an expression of one's purpose (Hall & Chandler, 2005), a fulfillment important to one's identity (Berg, Grant, & Johnson, 2010) and as a "consuming, meaningful passion people experience towards a domain" (Dobrow & Tosti-Kharas, 2011, pp. 1003).

In part to address some of these conceptualization discrepancies, Dik and Duffy (2009) derived a definition and measurement of perceiving a calling that is among the most frequently cited in the current calling literature. Their definition involves three elements: 1) a transcendent summons 2) to a career that is perceived as meaningful and 3) is motivated by prosocial concerns. The transcendent summons refers to a sense that one is compelled or drawn by something beyond the self, such as a higher power, a family legacy, fate, or a social need (Steger, Pickering, Shin, & Dik, 2010). The second component, a common theme among many definitions of calling, refers to the idea that to have a calling to a particular career, the work must be perceived as meaningful to the individual (Hirschi, 2011). The final component means that some of the meaning that the individual gains from the work is due to a subjective sense that the individual is working towards a goal that is larger than oneself. Put simply, individuals who state they have a calling often report they are drawn towards a career that makes their life feel meaningful because it allows them to make a difference. Despite observed differences in the perceived source of the call, and/or how the individual conceptualizes their calling, empirical evidence suggests that this definition applies to individuals at a variety of life and career stages, as well as for both religious and nonreligious individuals (Dik, Eldridge, Steger, & Duffy, 2012). Having a calling is likely an inclusive and cross-culturally relevant approach to work that every person can potentially have in any area of work (Domene, 2012; Hagmaier & Abele, 2012;

Hirschi & Hermann, 2013; Rothmann & Hamukang'andu, 2013; Shim & Yoo, 2012; Zhang, Dik, Wei, & Zhang, 2015).

Emerging adulthood is a life stage where the process of developing a calling is especially salient. Searching for and discovering one's calling is an important process for many individuals who are determining their career path, with 40% of college students indicating that they have a calling to a particular line of work (Duffy & Sedlacek, 2010). Even more striking, more than two thirds of college students indicate this construct is an important and relevant consideration in how they think about their careers (Hunter et al., 2010). Not only do emerging adults report that perceiving a calling is important, developing a calling may be a critical precursor to other relevant developmental tasks associated with this stage of life. For instance, calling is conceptualized as an important factor in developing one's vocational identity – a process of constructing meaning regarding one's work (Hirschi, 2011). This process shares a close conceptual relationship with current definitions of calling (which also entail discerning meaning and purpose for one's career). Calling is also linked to career decidedness and career maturity, which are two critical milestones of transitioning to adulthood (Hirschi & Hermann, 2013). For this reason, perceptions of calling in college-aged women may be an important factor to consider in understanding their participation and persistence in science careers.

Not only is the process of developing a calling an important element of college student's discernment of who they are and how they are called to make a difference, having a calling has been found to relate to a host of positive psychological and work-related outcomes. Studies have linked presence of calling to greater well-being, meaning in life and life satisfaction (Duffy, Manuel, Borges, & Bott, 2011; Hirschi & Hermann, 2012). In the career domain, calling has also been positively linked with vocational self-clarity, vocational identity achievement, career

maturity, work satisfaction, and career decidedness (Duffy & Sedlacek, 2007; Duffy & Dik, 2013; Hirschi & Herrmann, 2013). Although it is evident that calling is often associated with positive outcomes for individuals, it is important that research continues to determine the mechanisms underlying these relationships. Several studies have made efforts to examine causal mechanisms that explain the links between perceiving a calling and career-related criterion variables. In a cross-sectional study conducted with 855 first and second year undergraduate students, a sense of calling was found to indirectly predict students' expectations for a successful future, through influencing their occupational self-efficacy (Domene, 2012). Similarly, Allan and Duffy (2013) explored relationships between calling, self-efficacy, and positive career outcomes in a cross-sectional study, finding support for a partial mediation model in which career goal self-efficacy mediates the relationship between perceiving a calling and life satisfaction. In another attempt to explain the relationships between calling and positive work outcomes, a survey of 370 university employees found career commitment to serve as a link between calling and the following work outcomes: organizational commitment, withdrawal intentions, and job satisfaction (Duffy, Dik, & Steger, 2011). Although researchers cannot draw causal inferences from these cross-sectional designs, these models suggest that self-efficacy and/or career commitment may be two potential mechanisms of change explaining the relationships between perceiving a calling and positive career outcomes.

Longitudinal work on calling is sparse, but recent findings have been consistent with cross-sectional and qualitative research. For instance, Praskova, Hood, and Creed (2014) conducted a 2-wave longitudinal study with young adults, finding small, but significant mediation effects. Young adults with higher levels of career calling at Time 1 reported higher use of career strategies, elevated career adaptability, and higher meaning in life, six months later

(Praskova, Hood, & Creed, 2014). Their mediation hypothesis was supported; specifically, higher levels of career calling predicted the use of beneficial career strategies, which in turn, led to higher meaning in life and greater career adaptability in young adults. Future research is needed to continue to tease out potential causal relationships. However, based on current research it is likely that perceiving a calling facilitates a plethora of beneficial career and psychological outcomes. A possible interpretation of how calling may relate to well-being and work-related outcomes is that having a calling to a particular career is likely to 1) lead an individual to feel capable and committed in their line of work, 2) engage in job activities that fulfill that commitment, and thus 3) experience happiness and perform better in their job (Duffy, Dik, & Steger, 2011; Praskova, Hood, & Creed, 2014). Due to this evidence linking having a calling with vocational identity development, occupational self-efficacy, and career commitment in emerging adults, this study examines the extent to which having a calling will predict persistence in science in undergraduate women.

Purpose of this Study

The purpose of this study is to investigate if and how having a calling as a scientist relates to psychological predictors of persistence in science (e.g., science self-efficacy, interest in science, science identity, and internalization of scientific community values). This study also examines the extent to which perceiving a calling predicts persistence intentions beyond the influence of perceiving an identity as a scientist. It is important to examine new predictors of persistence in the sciences and assess if they predict persistence over and above other variables, because doing so may result in key policy implications for higher education initiatives seeking to increase women's participation in the scientific workforce. For example, if having a calling for a scientific career emerges as a unique predictor of persistence intentions, it may be beneficial to

aim programming and other efforts toward helping women explore the ways in which they may be “called” to make a positive difference as a scientist.

Psychological Predictors of Persistence in the Sciences

With the current workforce demographics revealing an increasing need for trained employees in science careers, identifying psychological variables that predict women’s long-term retention in science careers is critical. Important contributions to this goal have been the work of Chemers et al. (2011) and Estrada et al. (2011), which points to the importance of several psychological variables (self-efficacy, science identity, interest, and internalization of scientific community values) as key predictors of retention in science for students who were deemed underrepresented in U.S. science graduate degree programs and faculty positions in 2005 (Estrada et al., 2011).

One of the most widely studied factors for predicting both academic and career engagement and retention is an individual’s self-efficacy, or self-appraisal of ability for a particular task (Bandura, 1986). Self-efficacy is a fundamental component of the Social Cognitive Career Theory, a widely used model for explaining the psychological processes behind how individuals develop career interests and achieve their career goals (Lent, 2005). Besides being rooted in widely accepted theoretical models, self-efficacy has been demonstrated to predict achievement not only in career tasks, but also in academics, athletics, and other healthy psychosocial functioning tasks (Chemers, Hu, & Garcia, 2001; Moritz, Feltz, Fahrback, & Mack, 2000; Holden, Moncher, Schinke, & Barker, 1990). Many research studies have supported the importance of STEM self-efficacy, finding that poor math and science self-efficacy leads to classroom underperformance, lower enrollment in STEM courses, and ultimately selecting out of STEM majors and careers (Durik et al., 2006; Valian, 2007; Wang & Degol, 2013). Since self-

efficacy has continually been linked to positive career-related and developmental outcomes, and continues to be a relevant factor for individual's persistence in STEM, it is a critical to examine self-efficacy as a likely predictor of women's interest and persistence intentions in science.

Another concept foundational to many vocational theories is person-environment (P-E) fit. This approach can be traced to one of the earliest theories of career development: Frank Parsons's (1909) Tripartite Model of Career Choice. Per this model, a person should 1) understand oneself, 2) understand the job requirements and 3) make an objective, rational career decision based on which job best matches the individual (Parsons, 1909). This philosophy, now termed person-environment fit, continues to heavily influence career counseling interventions and theories of career development (such as Holland's (1997) Theory of Vocational Personalities and Work Environments and Dawis & Loftquist's (1984) Theory of Work Adjustment; Su, Murdock, & Rounds, 2015). Due to the support for the concept of P-E fit, it is unsurprising that an emerging determinant of persistence in science is the level to which individuals perceive they "fit" in the scientific community. This fit is assessed through the examination of many psychological variables including perceived science identity, sense of belonging, and internalization of scientific community values. In fact, feeling like one identifies as a scientist has been demonstrated to enhance individual interest and retention in science careers over and above other psychological and behavioral predictors of persistence in science (Chemers, Zurbriggen, Syed, Goza, & Bearman, 2011; Merolla, Serpe, Stryker, & Schultz, 2012; Merolla & Serpe, 2013). Research has also found that even if an individual believes that she or he has the needed skills or abilities (i.e., self-efficacy) to succeed as a scientist, the individual may choose to leave STEM fields because she or he does not identify as being a part of that community

(Estrada, Woodcock, Hernandez, & Schultz, 2011; Chemers, Zurbriggen, Syed, Goza, & Bearman, 2011; Jacobs et al., 2005).

This link between an individual's science identity and internalization of scientific community values resulting in greater science involvement can be conceptualized through the lens of identity theory (Merolla & Serpe, 2013). Identity theory postulates that individuals have many role identities based on social roles that the individual fulfills (e.g., being a science student, Serpe, 1987). Per this theory, individual's role identities are ranked in a hierarchical order, with role identities that are more salient having a greater impact on the individual's behavior (Serpe, 1987). Therefore, in addition to confidence in one's ability to succeed, identity theory suggests that career choices also depend upon how one views oneself in relation to the scientific community. For example, an individual who strongly identifies as a scientist will be more likely to engage in science-related activities and make career decisions that promote their participation in science careers. The current study examines whether women who perceive that they have a more salient identity as a scientist, and rate higher in internalizing scientific community values, will report higher interest and persistence intentions for scientific careers.

Calling and Psychological Predictors of Persistence

Although presence of calling has not yet been assessed with women who persist in STEM, there seems to be conceptual overlap between correlates and outcomes of having a calling, and predictors of women's persistence in science. For example, calling is related to occupational identity which can be defined as the clear perception of occupational interests, abilities, goals, and values (Hirschi, 2012). Calling is also related to vocational identity achievement, characterized by high degrees of identity exploration and commitment (Hirschi & Herrmann, 2012). Researchers have attempted to explain this link between calling and vocational

identity, typically concluding that an important component of having a calling to a particular domain is a strong sense of personal identification with the domain (Dik, Duffy, Eldridge, 2009). Furthermore, evidence reveals that exploring and developing a calling to a particular field facilitates one's occupational identity development and achievement (Hirschi, 2012; Hirschi & Herrmann, 2012). Therefore, because individuals' callings are strongly linked and aids in the development of domain-specific identities, this study investigates the extent to which having a calling for a scientific career predicts undergraduate women's identification with science. Also, because individuals' vocational identities are made up of their specific values and interests, this study examines whether perceiving a calling for a scientific career also predicts undergraduate women's scientific community values and interest in science.

The overlaps between the typically studied outcomes of having a calling and persistence in science suggest that calling may also predict psychological predictors of persistence in science. Examining the relationships between having a calling and science self-efficacy, science identity, science interests and scientific community values is an important first step in determining if and how calling is related to persistence in science.

A proposed SCCT model of persistence in STEM. To further investigate predictors of women's participation, persistence, and retention, it is useful to work from a theoretical model that summarizes how these variables influence and interact with one another to effect career choice. Social Cognitive Career Theory (SCCT) emerges as a useful conceptual schema for understanding how these psychological constructs link to career development choices for women in science. This theory is anchored in three psychological variables (self-efficacy, outcome expectations, and personal goals) that interact to influence individuals' behavior. Specifically, SCCT summarizes the following processes: (1) the development of academic and vocational

interests, (2) the formation of educational and vocational choices, and (3) how academic and career success is obtained (see Figure 1).

Using SCCT as a framework for examining the career development processes among women in science, this study proposes a conceptual model for how undergraduate women's perception of calling for a scientific career, science self-efficacy, interest in science, science identity, and internalization of scientific community values relate to persistence in science. It is important to note that, like most studies informed by SCCT (Lent et al., 2005), this study does not capture all the constructs that could map onto each of the components of the full SCCT model, nor does it investigate all the possible relationships between these constructs. Rather, several variables that are particularly relevant to women's participation and persistence in STEM fields are examined, with SCCT serving as a guide to inform hypotheses. For example, in this study, although individual choice actions or performance are not assessed, students' intentions to pursue a scientific research career is conceptualized as a choice goal that indicates strong likelihood of acquiring science employment. See Figure 2 for this study's conceptual model.

According to SCCT, a greater interest in science careers results for individuals who believe 1) they are capable of accomplishing science-related tasks and 2) their engagement in science-related tasks will lead to positive, valued outcomes. Individuals' interests (their likes, dislikes and indifferences for particular activities) play a critical role in their subsequent career decisions because, as proposed in SCCT, individuals are drawn towards niched activity on the bases of their interests (Holland, 1959, Lent & Brown, 2006). Research has supported this tenet of SCCT through research on undergraduate women majoring in engineering. Lent et al. (2013) found that having higher interest in engineering predicted satisfaction with an engineering major as well as intentions to persist in the major (Lent et al., 2013). For the purpose of this study,

individuals' self-reported interest in pursuing earth and environmental coursework, education, and careers, is conceptualized as a measure of career-specific interests leading to choice goals (as is proposed in SCCT). This study also mirrors current research that applies the SCCT model to underrepresented minority students in STEM conceptualizing science identity (students' identification with science) and individuals' internalization of scientific community values as two additional measures of individuals' interest in science (Herrera & Hurtado, 2011).

Since developing an interest in science is a critical step leading to persistence in science, it is important to focus on possible factors leading to the development of career-specific interests. According to SCCT, self-efficacy emerges as an important factor to consider. Self-efficacy has been empirically demonstrated to serve as a strong predictor of persistence for women in STEM (Lent, Lopez, Sheu, & Lopez, 2011) and likely influences undergraduate women's interest and motivation to pursue a scientific career. The present study examines participants' perceived capability for specific scientific tasks such as generating a research question and using scientific terminology as a proxy measure for the career-specific self-efficacy variable proposed in SCCT. The current study investigates the extent to which undergraduate women's science self-efficacy predicts their interest in science as well as their intentions to pursue a career in science.

In summary, several variables have been established as relating to women's persistence in STEM careers. Social Cognitive Career Theory emerges as a useful contextual framework for examining relationships between important possible predictors of science engagement and behaviors. Due to the scope of this study, not all of the potential relationships are explored. This study conceptualizes possible relationships between having a calling as a scientist, self-efficacy for scientific tasks, interest in science, scientific identity, identification with scientific

community values, and intentions to pursue a scientific career, to better understand individuals' persistence in science careers.

The Present Study

Drawing from the Social Cognitive Career Theory (SCCT) framework and previous research, this study seeks to address the following research questions:

1. What psychological factors predict undergraduate women's intentions to pursue a scientific research career?
2. How does having a calling for science relate to psychological predictors of persistence in science for undergraduate women?
3. Is calling a unique predictor of undergraduate women's intentions to pursue a scientific research career over and above perceiving an identity as a scientist?
4. Is the relationship between having a calling for science and interest in science mediated by self-efficacy for scientific tasks?

Research identifies science identity, self-efficacy, interest, identity and internalization of scientific community values as important factors in predicting women's persistence intentions for science careers. Furthermore, emerging adult college students are at a critical developmental stage where they begin to solidify their vocational callings and identities, and make career decisions that will shape the societal roles they will engage later in life. Understanding relationships between variables that predict undergraduate women's engagement and persistence in the sciences is vital to the creation of successful intervention efforts aimed at increasing the number of women in science careers. Therefore, the purpose of this study is to examine relationships between having a calling as a scientist, and other constructs related to women's participation and persistence in science. Several hypotheses and research questions that seek to

generate evidence regarding the relationships between having a calling and psychological criterion variables associated with intentions to pursue a scientific career will be explored. Significant relationships would justify further research into the relationships between these variables, aimed at determining causal relationships.

Calling has been found to correlate with domain-specific self-efficacy measures in several studies. For example, in a sample of 255 undergraduate students, having a calling positively correlated with career decision self-efficacy (Dik, Sargent, & Steger, 2008). Similarly, in a recent study of 846 German undergraduate students, perceiving a calling was found to relate to career-specific self-efficacy across three time points (Hirschi & Hermann, 2013). Both studies utilized the Brief Calling Scale (BCS) to assess participant's calling, the same scale that will be used in the present study. Other studies have also found significant relationships between calling and occupational self-efficacy defined as the competence that a person feels concerning his or her ability to successfully fulfill the tasks involved in his or her work (Hirschi, 2012; Domene, 2012). Based on SCCT and related empirical evidence, it is hypothesized that perceiving a calling as a scientist will be positively related to science self-efficacy.

Hypothesis 1: Perceiving a calling to a career in science will be positively related to undergraduate women's science self-efficacy.

College students who perceive a calling towards a particular career path tend to feel their work is a strong fit with their personal interests and preferences (Duffy & Dik, 2013). The relationship between calling and interests can be conceptualized in two ways: interests as an aspect of one's occupational identity and interests as an aspect of one's perceived person-environment fit. This notion – that individuals thrive when they are in an environment that supports their interests, abilities, values, and personalities – is the foundation of the study of

vocational behavior and forms the basis of several major theories of career development such as Holland's (1997) theory of vocational types and the Theory of Work Adjustment (Dawis & Lofquist, 1984; Betz, 2008). Since calling has been found in research to positively correlate with person-environment fit (Hirschi, 2012) I hypothesize a positive relationship between having a calling as a scientist and interest in science. According to person-environment fit theory, if this relationship is significant, it is likely that interest in science and participation in scientific major would lead to greater intentions to pursue a scientific career.

Hypothesis 2: Perceiving a calling to a career in science will be positively related to undergraduate women's interest in science.

Since science identity is a critical component of women's participation and persistence in science, measuring calling as a distinct component of one's "meaning system" and identity (Parks, 2005), is likely an important construct to consider when attempting to understand the conditions that will lead to women's persistence in the sciences. Calling has been found in past studies to correlate with measures of identity including vocational self-clarity (Duffy & Sedlacek, 2007), vocational identity achievement (Hirschi & Herrmann, 2012) and occupational identity (Hirschi, 2012). Since occupational identity is defined as "the clear perception of occupational interests, abilities, goals, and values, and the structure of the meanings that link these self-perceptions to career roles" (Hirschi, 2012, p. 480), identification with the values of the scientific community is conceptualized in this study as fulfilling a portion of one's scientific identity. Therefore, I hypothesize that having a calling will be positively related to both women's identity as a scientist and internalization of the values of the scientific community.

Hypotheses 3 and 4: Perceiving a calling to a career in science will be positively related to undergraduate women's identity as a scientist and internalization of scientific community values.

As stated earlier, studies have linked presence of calling to outcomes that are conceptually similar to persistence. For example, having a calling has been found to positively relate to comfort with one's career choice and career decidedness (Duffy & Sedlacek, 2007), as well as career commitment, organizational commitment, and lower withdrawal intentions (Duffy, Allan, & Dik, 2011). Due to past evidence linking having a calling with both psychological and behavioral outcomes similar to persistence measures, it is hypothesized that having a calling will be related to intentions to persist in science for undergraduate women.

Hypothesis 5: Perceiving a calling to a career in science will be positively related to undergraduate women's intentions to pursue a scientific research career.

Self-efficacy is an extensively studied predictor of career-related interests and intentions to pursue in STEM in both undergraduate women and minority populations (Lent, 2005, p. 101; Bandura, 1986; Lent, Brown, & Larkin, 1984; Lent, Brown, Larkin, 1986; Fouad et al., 2016) I predict the results will mirror this relationship: believing one is capable of science-related tasks lead to greater intentions to persist in the sciences.

Hypothesis 6: Science self-efficacy will predict undergraduate women's intentions to pursue a scientific research career.

Career-related interests is an extensively studied predictor of vocational goals, including undergraduate women's intentions to pursue in STEM (Lent, 2005, p. 101, Lent et al., 2013). I predict the results will mirror this relationship: undergraduate women's greater interest in science will lead to greater intentions to persist in the sciences.

Hypothesis 7: Interest in science will predict undergraduate women’s intentions to pursue a scientific research career.

Individuals who begin to see themselves as scientists are more likely to persist in science-related careers (Estrada, Woodcock, Hernandez, & Schultz, 2011; Chemers, Zurbriggen, Syed, Goza, & Bearman, 2011; Merolla, Serpe, Stryker, & Schultz, 2012; Merolla & Serpe, 2013; Jacobs et al., 2005). I expect the results to mirror this finding: developing an identity as a scientist will lead to greater intentions to persist in the sciences for undergraduate women.

Hypothesis 8: Identity as a scientist will predict undergraduate women’s intentions to pursue a scientific research career.

Individuals who report that they “fit” in their career and work-environment are more likely to stay in their career (Su, Murdock, & Rounds, 2015). Individuals who believe they have the same values and belong to the scientific community are more likely to report intentions to stay in STEM (Estrada, Woodcock, Hernandez, & Schultz, 2011; Chemers, Zurbriggen, Syed, Goza, & Bearman, 2011). I expect the findings to mirror these results: developing values that align with the scientific community will predict undergraduate women’s intentions to greater intentions to persist in the sciences.

Hypothesis 9: Internalization of scientific community values will predict undergraduate women’s intentions to pursue a scientific research career.

Having a calling to a particular work-domain leads individuals to feel committed to their line of work and find a specific job that fulfills that commitment (Duffy, Dik, & Steger, 2011). As discussed above, perceiving a career-specific calling has been empirically demonstrated to predict career commitment. I expect the findings to mirror these results: undergraduate women who have a calling as a scientist will develop greater intentions to persist in the sciences.

Hypothesis 10: Presence of a calling to career in science will predict undergraduate women's intentions to pursue a scientific research career.

Identity as a scientist is a strong predictor of women's persistence in science, however, due to environmental factors, developing an identity as a scientist can be challenging for undergraduate women. Identity theory suggests that the development of more salient role identities is influenced through social relationships and feeling like one belongs in a community (Merolla & Serpe, 2013; Hernandez et al., 2017). Therefore, the reality that men tend to dominate the majority of the scientific fields and that many stereotypes exist about women's capability in science, likely makes it challenging for women to develop an identity as a scientist (Hernandez et al., 2017). This theory also explains why identity as a scientist emerges as a predictor of persistence in science over and above other psychological variables for women and minorities in STEM.

In response, research must continue to identify factors that promote women's science identity to increase women's participation and persistence in these fields. This study proposes perceiving a calling to a scientific career as a promising construct that may relate to and influence women's identification as a scientist and persistence in science. Conceptually, calling may play a distinct role in guiding individuals' vocational behavior and career selection due to it being a large portion of an individual's "meaning system" (Park, 2005). Park describes individual's meaning system as the sum of an individuals' beliefs, goals, values, and sense of meaning – all of which influence their career choices and outcomes. Per Park's model, an individual's meaning system influences many aspects of work life through the following pathways: 1) career choice and coping, 2) on the job conduct, 3) work-related stress and coping, and 4) work related well-being (Park, 2012).

Applying Park's model, calling can be framed as a specific component of an individual's meaning system, which guides a large portion that person's career selection and behavior. Individuals who report having a calling for a particular type of work most likely approach their everyday lives differently than those who don't. In the same way, an individual's identity as a scientist makes up a portion of their meaning system. For the purpose of this paper, perceiving a calling is conceptualized as theoretically broader, and perhaps deeper and more potent, factor in making up an individual's meaning system compared to one's specific identity as a scientist. Calling not only informs a deeper understanding of one's identity, it also involves feeling drawn to specific work and/or activities by something beyond the self, in addition to, fostering connections between one's work with a prosocial purpose (Dik & Duffy, 2009). Having a calling has been shown in longitudinal studies to increase individuals' vocational identity (Hirschi & Herrmann, 2012). Since the relationship between women's science identity and calling for science has not been examined in the current literature, it thus remains a potential mechanism for increasing both women's identity as a scientist and persistence in scientific fields. The first step is to test whether calling is significantly related to these two constructs, and then to test if individual differences in people's sense of calling accounts for differences in persistence intentions over and above measures of scientific identity. I propose that holding identity as a scientist constant, calling will positively predict undergraduate women's intentions to persist in the sciences.

Hypothesis 11: Holding women's identification with science constant, having a calling for science will predict unique variance in undergraduate women's intentions to pursue a scientific research career.

The focus of the current study is to explore how a sense of calling predicts psychological constructs predictive of undergraduate women's persistence in science. To do so, it examines the extent to which having a scientific calling predicts science self-efficacy, interest in science, and intentions to pursue a career science. A conceptual model of persistence in science is proposed, including ideas for how science self-efficacy, interest, identity, and community values map onto SCCT constructs. It is important to note that although possible relationships between the theorized predictors of persistence were discussed, due to scope of this study, I empirically investigate one portion of the overall conceptual model. Figure 2 presents the hypothesized model (in bold) linking having a calling to persistence intentions. In this model, I hypothesize that perceiving a calling for a career as a scientist predicts intentions to pursue a scientific research career, and that at least a portion of participants' intentions can be explained by science self-efficacy and interest in science.

Individuals who perceive a domain-specific calling feel drawn to their career for a purpose larger than themselves (Domene, 2012). They also feel they are more capable of completing career-related tasks (Hirschi, 2012). When considering the potential connections between individuals' callings and their career-specific self-efficacy, it is useful to adopt a Social Cognitive Career Theory framework, as this theory contains extensive literature on the topic of self-efficacy (Lent, Brown, & Hackett, 1994). According to this theory, individual's ideas about their ability to complete a career-related task is shaped by their learning experiences (Dik & Rottinghaus, 2013). Having a calling for science could be conceptualized as part of the overall set of learning experiences that influence people's career outcome expectations (Domene, 2012). Existing research on the link between calling and self-efficacy is limited. One rare study that did so was Dobrow and Tosti-Kharas's (2011) longitudinal investigation of 1,500 participants in four

separate career domains: music, art, business, and management. The authors found that having a calling predicted career-related self-efficacy 3.5 years later and 7 years later. Given the propositions of SCCT and emerging evidence of a link between calling and self-efficacy I expect having a calling as a scientist will predict undergraduate women's science self-efficacy.

Dispositional interests, or “motivations that determine life decisions” (Walsh, 1999, p. 273), have received an enormous amount of attention in vocational psychology, as interests play a crucial role in individuals' career intentions and decisions (Dik & Rottinghaus, 2013). Social Cognitive Career Theory (SCCT; Lent, Brown, & Hackett, 1994) provides a well-researched framework for how career-specific interests are created. According to this theory, individuals first develop ideas about their self-efficacy and outcome expectations for a particular task. If individuals hold a sense of personal competence and expectation that their engagement in the task will lead to valued outcome, a stable interest in the activity will develop (Lent, Brown, & Hackett, 1994). This relationship between self-efficacy leading to interest development has been supported in numerous studies, including studies with undergraduate women in STEM (Lent et al., 2005). Because this relationship is rooted in a major theory of career development and supported with current empirical literature, I expect that undergraduate women's self-efficacy for science-related tasks will predict their interest in science.

Career-related interests is an extensively studied predictor of vocational goals. Numerous studies, including research with undergraduate women in STEM, have found that individuals who report higher interest in a specific domain, report greater intentions to pursue that domain (Lent, 2005, p. 101, Lent et al., 2013). In SCCT, interests are conceptualized as the precursor to developing choice goals (i.e., one's intentions to engage in a particular activity; Lent, 2005).

Therefore, this study examines whether undergraduate women's greater interest in science is linked to their intentions to pursue a scientific research career.

Hypothesis 12: Having a calling for a career in science predicts individual's intentions to pursue a scientific research career and the increase in intentions to pursue a scientific research career can be explained at least in part by increases in scientific self-efficacy and interest in science.

CHAPTER II

Method

Participants and Procedure

Participants. Undergraduate students were recruited to participate in an NSF-funded longitudinal research study on factors influencing women's interest and persistence in science careers. The data for this research proposal comes from the Spring 2017 survey of this larger project. The participant sample consisted of undergraduate women who indicated they are interested in majoring in STEM-related fields. Participants were recruited in fall 2015 (cohort 1) and Fall 2016 (cohort 2), from five colleges in the Colorado/Wyoming Front Range (University of Wyoming, Colorado State University, University of Colorado, Colorado College and Metropolitan State University) and four colleges in the Carolinas (North Carolina State University, University of South Carolina, University of North Carolina Charlotte, and North Carolina A&T State University). Each college recruited their participants via flyers, emails (addresses were obtained from university registrar offices, department listservs, or science faculty forwarded emails), and in-person announcements to introductory STEM courses. All participants who met the recruitment inclusion criteria (first or second year, interest in majoring in STEM, female) were invited to participate in the study as well as attend a weekend "PROmoting Geoscience Research, Education, and SucceS (PROGRESS)" workshop. Those who attended the weekend workshop became a part of the larger project's experimental group. However, all students who met the study requirements, regardless of if they attended the workshop, were invited to participate in the Spring 2017 survey and were compensated \$10 for their participation.

393 participants completed the Spring 2017 survey analyzed for this project. It was deemed that this sample size was sufficient to ensure reaching statistical power for the tests of potential relationships. Participants reported their year in college in an earlier survey of the larger project. Assuming that all individuals progressed through school at a normal rate, 109 participants were in their first year of college, 178 in their second year, 102 in their third year, and 4 in their senior year. They were predominately white (see Table 1).

Procedure. Early in the Fall 2015 semester, first- and second-year female science students were recruited from seven universities in the Colorado/Wyoming Front Range or the Carolinas regions of the United States. Students were recruited via email (cooperation with university registrar offices, department listservs, or individual science faculty forwarding email solicitation to students in their classes), in-person recruitment announcements in introductory science courses, and flyers advertising the study posted across campus.

Instruments

All of the following measures were included in the Spring 2017 follow-up survey.

Demographic form. Participants were asked to provide gender, race/ethnicity, year in school, enrollment status, age, academic major, grade point average, high school grade point average, and high school academic preparation.

Presence of calling. Presence of calling was assessed with the two-item “presence” subscale of the Brief Calling scale (BCS) from Dik, Eldridge, Steger, and Duffy (2012). Participants were presented with a description of what it means to have a calling to a specific area of work, and asked to respond to two items assessing their perceived level of calling. Having calling was described as: “a person's belief that she or he is called upon (by the needs of society, by a person's own inner potential, by God, by Higher Power, etc.) to do a particular kind of work.”

Participants were next asked to indicate on a 5-point scale ranging from 1 (*not at all true of me*) to 5 (*totally true of me*) how much they agree with the two statements “I have a calling to a particular kind of work” and “I have a good understanding of my calling as it applies to my career.”

Scores on this scale have been found to have high internal consistency reliability with undergraduate students. In the current study, scores on the two-item short form demonstrated high internal reliability ($\alpha = .79$). Supporting its construct validity, BCS scores have correlated positively with scores of other measures of calling and were found to be a best predictor of having a calling compared to other measures of calling (Dik et al., 2012; Duffy et al., 2015).

For this project, the scale was adapted in two ways. First, to assess student’s presence of calling for a career in science, the scale’s directions were adapted from “The following questions assess the degree to which you see this concept as relevant to your life and career” to “The following questions assess the degree to which you see this concept as relevant to your life and career *as a scientist*.” This specification was included to be able to assess not only if participants perceive they have a calling, but if they perceive they have a calling for a scientific career. The second adaption to this scale is that participants rated the two statements on a 7-point scale instead of a 5-point scale. The rationale for this change was that all the items in each scale included in this survey asked participants to rate their responses on a 7-point scale. To avoid participant confusion and response error, I decided to keep the response format consistent with the other items in the survey.

Scientific self-efficacy. Individual’s perceptions of their ability to function as a scientist were measured using the three-item short form of the Scientific Self-Efficacy scale from Estrada et al. (2011) which was adapted from Chemers et al. (2010). Participants were directed to

“indicate the extent to which [they are] confident [they] can successfully complete the following tasks.” The items assessed student’s perceived ability to function as a scientist on a 7-point response scale of 1 (*not at all confident*) to 7 (*absolutely confident*). Items included “use technical science skills (use of tools, instruments, and/or techniques),” “use scientific language and terminology,” and “generate a research question to answer.” Higher scores were indicative of having higher science self-efficacy. Scores on the six-item Scientific Self-Efficacy scale have been found to have high internal reliability ($\alpha = .91$) in the current data (Estrada et al., 2011). In this study, scores on this 3-item short form scale demonstrated high internal reliability ($\alpha = .77$).

Interest in earth systems / environmental science. Student’s interest in earth systems / environmental science coursework, education and career were assessed with the two items: “How interested are you in taking courses in Earth Systems or Environmental Sciences?” and “How interested are you in pursuing an Earth Systems or Environmental Sciences career?” The response options ranged from 1 (*Not at all interested*) to 7 (*Very interested*) with higher scores indicating higher interest in science. The scale was scored by taking the average of the two items. This measure was derived from prior literature on student motivation and interest development (Hulleman & Harackiewicz, 2009). Scores on this short form have been found to have high internal consistency reliability with undergraduate women ($\alpha = .92$, 95% *CI* [.88, .94]) (Hernandez et al., 2017). In the current study, scale scores demonstrated high internal consistency reliability ($\alpha = .92$).

Science identity. The extent to which students identify as a scientist was assessed using a three-item short form of the Scientific Identity Scale (Chemers et al., 2011; Estrada et al., 2011; Hernandez et al., 2017). The instructions state that the purpose of the scale is to “understand how much you think that being a scientist is part of who you are.” Participants were also told that “the

word scientist is intended to mean a professional undertaking in research activities in your area of study.” After reading the instructions, students were asked to indicate on a 7-point Likert scale ranging from 1 (*Strongly Disagree*) to 7 (*Strongly Agree*) their response to the following items: “In general, being a scientist is an important part of my self-image,” “I have a strong sense of belonging to the community of scientists,” and “I have come to think of myself as a ‘scientist’.” The scale was scored by taking the average of the three items, with higher scores indicating higher science identity. Scores on this short form of the Scientific Identity Scale have been found to have high internal reliability with undergraduate women interested in science ($\alpha = .86$, 95% *CI* [.81, .90]; Hernandez et al., 2017). In the current study, scores on this short form scale demonstrated high internal consistency reliability ($\alpha = .85$).

Scientific community values. The extent to which students internalize the values of the scientific community was assessed using a four-item short form of the Scientific Community Objectives Value Scale (Estrada et al., 2011). Students were asked to indicate “how much the person in the description is like you” on a 7-point Likert-type scale ranging from 1 (*Not at all like me*) to 7 (*Very much like me*). Survey items included the following, “A person who thinks discussing new theories and ideas between scientists is important,” “A person who thinks it is valuable to conduct research that builds the world’s scientific knowledge,” “A person who feels discovering something new in the sciences is thrilling,” and “A person who thinks that scientific research can solve many of today’s world challenges.” Scores on this scale have been found to have high internal consistency reliability with undergraduate students ($\alpha = .85$; Estrada et al., 2011). In the current study, scores on this short form scale demonstrated high internal reliability ($\alpha = .87$).

Intentions to pursue a scientific research career. Students' intentions to pursue a scientific research career were assessed using a three-item short-form of the following items: "To what extent do you plan to pursue a science-related research career?" "What is the likelihood of you obtaining a science-related degree?" and "To what extent do you plan to pursue a science-related graduate degree?" The response options ranged from 1 (*Definitely will not*) to 7 (*Definitely will*). The scale was scored by calculating the average of the three items. A two-item variation of this scale consisting of the items "To what extent do you intend to pursue a science-related research career?" and "How likely is it that you will attend graduate school?" had high internal consistency reliability ($\alpha = .75$) in a study of undergraduate students (Woodcock, Hernandez, & Schultz, 2016). In the current study with undergraduate women the three-item scale exhibited high internal reliability ($\alpha = .74$).

CHAPTER III

Results

Missing Data and Tests of Assumptions

Prior to running analyses, Little's Missing Completely at Random (MCAR) test was conducted to determine if missing values were randomly distributed across all observations. A non-significant Little's MCAR test, $\chi^2(10, N = 393) = 10.75, p = .378$, revealed that the data were missing completely at random (Little, 1988). Since the data was consistent with MCAR, cases with missing data were dropped listwise from the following analyses (Garson, 2015). That is, cases were dropped if they had one or more missing values specific to each SPSS analysis. Deleted cases ranged from 6-45 depending on the variables included in the analyses. Listwise deletion reduced the sample size, but has been shown not to bias regression results (Garson, 2015).

The data was also screened for violations of linearity, normality, homoscedasticity and independence. Linearity was assessed by obtaining the residuals of the two multiple linear regression analyses and then plotting the residuals against each predictor variable in the analysis. The dependent variable (intentions to pursue science) was regressed on the independent variable (perceiving a calling) and the control variable (science identity). Residuals from this model were saved and plotted against perceiving a calling and science identity. These scatterplots revealed that a linear relationship was appropriate. Then, the dependent variable (intentions to pursue) was regressed on the mediators (science self-efficacy and science identity) and the independent variable (perceiving a calling). Residuals from this model were saved and plotted against each predictor variable. Results revealed that a linear relationship remained appropriate.

The assumption of normality was assessed in several ways. Upon visual inspection of the histograms, each scale appeared to be sufficiently normally distributed, with no outliers. Tests of skewness and kurtosis confirmed this analysis. For all of the scales, skewness values were within the range of ± 2 and Kurtosis values were in the range of ± 7 . Next, visual inspection of the P-P plots of the residuals for each model confirmed normality. Based on skewness and kurtosis results, combined with visual P-P plot inspection, it was determined that data in each scale met criteria to assume normality (Garson, 2012).

To assess for homoscedasticity, visual inspection of a scatterplot of both of the regression residuals was utilized. The spread of residuals appeared fairly constant over the range of values of the independent variable (perceiving a calling) providing evidence of homoscedasticity.

Investigation of correlations and descriptive statistics of the variables revealed no problems related to multicollinearity. In all correlations there were not two scales that were highly correlated that were present in the regression analyses (see Table 2 for more information). This avoids the potential of co-linearity.

Descriptives

Next, descriptive statistics were conducted on all variables of interest to acquire means, standard deviations, and intercorrelations. The internal consistency for each scale was assessed using Cronbach's alpha reliability calculations (See Table 2). All scales demonstrated adequate internal consistency reliability (DeVellis, 2016).

Correlational analyses between perceiving a calling and criterion variables of interest (science self-efficacy, interest in science, identity as a scientist, identification with scientific community values and intention to pursue a scientific career) are reported with descriptive statistics (See Table 2).

Bivariate Linear Correlations

Bivariate linear correlational analyses were conducted to 1) test whether perceiving a calling is positively related to psychological predictors of persistence in science (i.e., science self-efficacy, interest in science, identity as a scientist, and internalization of scientific community values, and intentions to pursue) and 2) test if each of these psychological predictors of persistence are positively related to intentions to pursue a scientific research career.

The hypotheses that calling will positively correlate with predictors of persistence in science was supported with all but two predictors of persistence in science. Specifically, hypotheses one, three, and five were supported: having a calling as a scientist positively correlated with science self-efficacy ($r = .23, p < .001$), science identity ($r = .23, p < .001$), and persistence intentions ($r = .12, p < .05$). Hypothesis four was not initially supported: the correlation between having a calling and presence of scientific community values ($r = .08, p > .05$) was slightly positive and not-significant. After examining the items on the community values scale, an exploratory bivariate correlational analysis was conducted between perceiving a calling and one item representing prosocial values of the scientific community, compared with the other, more agentic, value items. Perceiving a calling positively correlated with the following item from the Scientific Community Values scale: “Indicate how much the person in the description is or is not like you... A person who thinks that scientific research can solve many of today’s world challenges” ($r = .14, p < .05$). Hypothesis five was also not supported: the correlation between having a calling and interest in science ($r = -.02, p > .05$) was not significantly different from zero (see Table 2). After examining the items on the interest in science scale (i.e., “How interested are you in taking courses in Earth Systems or Environmental Sciences?” and “How interested are you in pursuing an Earth Systems or Environmental Sciences career?”) it was determined that

this scale may only operationalize “interest in science” for a subset of participants – namely those majoring in Earth and Environmental Sciences. An exploratory bivariate analysis was conducted to assess if perceiving a calling related to interest in science for undergraduate women who previously indicated an interest in majoring in Earth and Environmental Sciences on an earlier survey (assessed Fall 2015, using the terms “Natural/Geological Sciences”). The correlation between perceiving a calling and interest in science for self-reported potential Natural/Geological Science majors was nonsignificant ($r = -.181, p > .062$).

Hypotheses 6-10, that science self-efficacy, interest in science, science identity, scientific community values, and presence of calling for a career in science will be positively related to undergraduate women’s intentions to pursue a scientific research degree was supported for all five hypothesized predictors of persistence. Intentions to pursue science was positively related to science self-efficacy ($r = .25, p < .001$), interest in science ($r = .32, p < .001$), identity as a scientist ($r = .60, p < .001$), internalization of scientific community values ($r = .43, p < .001$), and presence of calling for a career in science ($r = .12, p < .05$; see Table 2).

Multiple Linear Regression

Next, a multiple linear regression was conducted holding women’s identification with science constant to test if having a calling for science predicts women’s persistence intentions over and above effects of their scientific identity. A significant regression equation accounted for a significant proportion of variance in women’s intentions to pursue a scientific degree, $F(2, 345) = 98.94, p < .000, R^2 = .37$. Undergraduate women’s predicted intentions to pursue science are equal to $2.78 + .61(\text{reported level of intention}) - .02(\text{reported level of calling})$. With science identity included in the model, perceiving a calling was not a significant predictor of persistence.

Hypothesis 11, that perceiving a calling would predict undergraduate women's intentions to pursue science over and above the effects of science identity, was not supported.

Mediation Models

As noted above, the hypothesis that perceiving a calling predicts interest in science was not supported. Therefore, the proposed mediation model in hypothesis 12 (that the relationship between perceiving a calling and intentions to pursue science is partially mediated by self-efficacy and interest in science) could not be further investigated. Instead, an adapted mediation hypothesis conceptualizing scientific identity as a proxy measure of interest in science was explored. It was hypothesized that higher levels of perceived scientific calling would predict higher levels of science identity, which would predict greater intentions to pursue a science degree. To investigate a portion of the original mediation hypothesis, the hypothesis that the relationship between perceiving a calling and intentions to pursue science is mediated by science self-efficacy was also tested. It was predicted that higher perceived calling would predict greater science self-efficacy, which in turn would predict greater intentions to pursue a science degree.

To test these mediation hypotheses Hayes' (2013) indirect effects PROCESS (model 4) with 5000 bootstrap samples and 95% corrected CIs was utilized. Results indicated that there is an indirect effect between having a calling and intentions to pursue science via science identity, $B = 0.15$, $SE = .04$, $p < .05$, and via science self-efficacy, $B = 0.06$, $SE = .05$, $p < .05$. Specifically, having a calling predicts greater science identity ($B = .24$, $p < .05$), which in turn predicts greater intentions to pursue science ($B = .61$, $p < .05$; see Figure 3). The same pattern is true of calling predicting greater science self-efficacy ($B = .19$, $p < .05$), which in turn predicts greater intentions to pursue science ($B = .29$, $p < .05$; see Figure 4).

To further examine the hypothesized model of persistence, a serial mediation analysis was calculated. Serial mediation assumes “a causal chain linking the mediators, with a specified direction of causal flow” (Hayes, 2012, p. 14). For this analysis, Hayes’ (2013) indirect effects PROCESS (model 6) with 5000 bootstrap samples and 95% corrected CIs was utilized to examine why having a scientific calling predicts intentions to pursue science. Having a calling as a scientist served as the first (X) variable, with science self-efficacy and science identity serving as mediators, in that order. Intentions to pursue a scientific research degree (Y) served as the final variable (see Figure 5). Initially the total effect (c) for perceiving a calling was significant ($B = .13$, 95% CI = .08-.23, $p < .05$), but after the inclusion of the mediators its direct effect (c') was reduced to a nonsignificant level ($B = -.02$, 95% LLCI = [-.12] ULCI [-.07], $t = -.50$, $p > .05$). Science self-efficacy and science identity fully mediated the effect of perceiving a scientific calling on intentions to pursue science.

The indirect effect of perceiving a calling on intentions to pursue science via science self-efficacy and science identity was significant, ($B = .05$, bootstrap $SE = .02$, 95% bootstrap CI = .03-.09, $p < .05$). The indirect effect in which science self-efficacy served as the first mediator (M_1) was nonsignificant ($B = .00$, bootstrap $SE = .02$, 95% bootstrap LLCI = [-.03] bootstrap ULCI [.02], $p > .05$), whereas the indirect effect of science identity serving as the second mediator (M_2) was significant ($B = .10$, bootstrap $SE = .04$, 95% bootstrap LLCI = [.03=] bootstrap LLCI [.17], $p < .05$).

CHAPTER IV

Discussion

This study aimed to understand how undergraduate women's perceived calling as a scientist relates to psychological predictors of their persistence in science (i.e., science self-efficacy, interest in science, science identity, scientific community values, and intentions to pursue science). Perceiving a calling was assessed by examining the level to which undergraduate women believe they have a calling as a scientist and understand how this calling applies to their career life. Results confirmed significant and positive relationships between all hypothesized predictors of persistence in science and women's self-reported intentions to pursue a science-related research degree, career, and graduate degree. Results indicated that having a calling was positively related to many of these psychological predictors of persistence in science including: science self-efficacy, science identity, and intentions to pursue science. Potential ways in which calling relates to persistence in science were explored. Results suggest that the relationship between perceiving a calling as a scientist and intentions to pursue science is fully mediated by undergraduate women's science self-efficacy and identity as a scientist, respectively.

Calling and Psychological Predictors of Persistence

A goal of this study was to investigate relationships between perceiving a calling and the proposed psychological predictors of persistence. Science self-efficacy, interest in science, science identity, presence of scientific community values, were all positively related to undergraduate women's intentions to pursue science. These results are in line with the hypotheses of this study and replicate past research findings (Chemers et al., 2011; Estrada et al.,

2011; Lent, 2007; Morella, Serpe, Stryker & Schultz, 2010). These results also validate this study's conceptualization of these constructs serving as predictors of women's persistence in science.

It was hypothesized that perceiving a calling as a scientist would positively relate to all psychological predictors of persistence in science (i.e., science self-efficacy, interest in science, science identity, scientific community values, and intentions to pursue science). This hypothesis was partially supported, in that calling was positively and significantly related to undergraduate women's science self-efficacy, science identity, and intentions to pursue science. Since perceiving a calling has not been investigated with this population, these results provide a significant contribution to both the calling literature as well as literature aimed at understanding the gender-gap of women in STEM.

The hypothesis that perceiving a scientific calling would be positively related with internalization of the values of the scientific community was not supported. Although having enough statistical power to detect a meaningful relationship as statistically significant is a potential consideration in explaining this finding, a more likely explanation is that there were conceptual issues with the underlying theory of this hypothesis. This hypothesis was developed in observation of the well-established link between calling and occupational identity (Hirschi, 2012). Since one's occupational identity consists of their goals and values as they pertain to a domain-specific occupation, it was hypothesized that perceiving a calling as a scientist would be positively related to internalization of the values of the scientific community (Hirschi, 2012). The observed lack of relationship between calling and scientific community values may be explained by the discrepancy between the prosocial nature of having a calling (Dik & Duffy, 2009), and the agentic nature of some of the items on the Scientific Community Values Scale

(i.e., “Indicate how much the person in the description is or is not like you... A person who feels discovering something new in the sciences is thrilling;” Estrada et al., 2011). This explanation was tested using a bivariate correlation analysis between having a calling and the more prosocial item on the Scientific Community Values Scale: “A person who thinks that scientific research can solve many of today’s world challenges” (Estrada et al., 2011). This correlation was significantly positive. Based on this finding, it may be the case that perceiving a calling as a scientist is positively related to values of the scientific community that are more prosocial in nature.

Research has established positive links between calling and domain-specific interests (Duffy & Dik, 2013). The null relationship between perceiving a calling and interest in science was not in line with this research. The operational definition of interest in science may explain why this hypothesis was not supported. For the purposes of this study, interest in science was measured as it specifically relates to interest in pursuing coursework and a career in Earth and Environmental Sciences. The scale consisted of items, “How interested are you in taking courses in Earth Systems or Environmental sciences?” and “How interested are you in pursuing an Earth and Environmental Sciences career?” These items reflect a specific interest, rather than a broader interest in the field of science. This operationalization of “interest in science” may be problematic because is not commensurate with the broader conceptualization and operationalization of perceiving a calling as a scientist. In the Brief Calling Scale (BCS), participants were instructed to “assess the degree to which you see [calling] as relevant to your own life and career as a scientist.” Next, they rated the statements “I have a calling to a particular kind of work” and “I have a good understanding of my calling as it applies to my career.” When measures are not assessed along commensurate dimensions, it interferes with, and often limits,

the accuracy at which researchers can draw conclusions between variables of interest (Caplan, 1987). Since the measures assessing “interest in science” and “perceiving a calling as a scientist” were conceptualized and assessed at two different levels of abstraction, there may be other factors influencing the relationship between these two constructs, thus accentuating the likelihood of obtaining a null finding. For instance, it may be the case that the hypothesized positive relationship between perceiving a calling and interest in science does exist, but that participants answered the BCS items without considering their calling to specifically be an Earth and Environmental scientist. In this case, it is likely these individuals are motivated to pursue science due to their presence of scientific calling and interest in science, but not by their specific interest in pursuing the field of Earth and Environmental Science.

To further explore the null relationship between calling as a scientist and interest in Earth and Environmental Science, bivariate correlational analyses were conducted to examine if perceiving a scientific calling positively related to interest in science for participants who reported an initial interest in majoring in Earth and Environmental Sciences (at this time, assessed using the term “Natural/Geological Sciences”). Results were nonsignificant; perceiving a calling as a scientist did not relate to interest in Earth and Environmental Sciences for individuals who expressed interest in majoring in Natural/Geological Sciences three semesters prior. Although not significant, these exploratory results suggested that these variables may be negatively related ($r = -.181, p > .062$). This finding poses an important area of future research, as there are many factors that may be influencing the null, unanticipated results. For example, since only 30.1% of participants indicated an interest in majoring in Natural/Geological Sciences and even less were included in the analyses due to listwise deletion procedures, it may be the case that there was not enough statistical power in this analysis to detect a true relationship. In addition,

sorting participants by their past self-reported intended major may be problematic, since this measure was obtained a year and a half prior to obtaining their interest in Earth and Environmental Sciences and perceived calling as a scientist. It is likely that students have changed their intended major between survey waves, making this sorting procedure irrelevant. In this case, there may be a new subgroup of students who have a calling as a scientist and a particular interest in Earth and Environmental science that cannot be detected due to methodological limitations of the study design. There is also additional room for statistical error due to the wording discrepancy between assessing individuals' interest in majoring in "Natural/Geological Sciences" and interest in "Earth and Environmental Sciences." All of these methodological and measurement constraints introduce additional error, making it more difficult to assess the true relationship between perceiving a calling as a scientist and interest in science in the current study.

Regardless of the measurement and conceptual limitations, an alternative explanation of the null, and perhaps negative, relationship between calling as a scientist and interest in science should be considered. It may be the case that these variables do not relate because they exist on different levels of abstraction and application. Work by Park (2012) illustrates this potential conceptual discrepancy, discussing how individuals' global meaning systems (i.e., their general orienting systems consisting of their beliefs, goals, and sense of meaning/purpose) may not match their daily experiences (i.e., their goals, values, and interests). In this case, calling would be conceptualized as a component of one's global meaning, and interest in science (operationalized as interest in pursuing Earth and Environmental coursework and careers) would be conceptualized as part of one's daily experiences. Applying this framework, it may be that individuals engage in different thought processes when considering their calling as a scientist

and their interest in science coursework and career. For instance, one may connect with having a calling as a scientist, perhaps viewing this construct as encompassing a broader range of career and life roles offering greater perceived meaning and purpose. However, when reflecting on their interest in science, especially when primed to consider their interest in their specific science coursework and career, individuals may orient towards their daily experiences of being involved in science and report lower interest. That is, it may be that students apply calling as a scientist to many life roles (e.g., teaching science, leading wilderness groups, etc.) and are more limited when orienting to their interest in science coursework and career (e.g., considering careers as a research scientist in different laboratory settings). This explanation suggests that some individuals may not connect their science coursework and career with the summons, meaning, and prosocial aspects of perceiving a calling. This differing conceptualization between calling and interests may explain the potential null or negative relationship. Future research in which both perceiving a calling as a scientist and interest in science are assessed using consummate measures is critical to determine the true nature of this relationship. If the relationship is not positive or significant, future research should explore whether these variables exist on differing levels of abstraction and application, the implications of this discrepancy, and whether there are moderators of this relationship.

The hypothesis that perceiving a calling would predict intentions to pursue science over and above science identity was not supported. The theoretical reasoning for this hypothesis was that calling may be a broader and perhaps deeper construct, influencing a greater portion of one's overall "meaning system," and therefore accounting for more variability in intentions to pursue science over and above the effects of science identity (Park, 2005). Instead, identity as a scientist continued to emerge as an integral predictor of women's persistence in science (Chemers et al.,

2011; Estrada et al., 2011). This may be because it can be difficult for women to develop an identity as a scientist, particularly due to environmental factors like existing stereotypes about women's decreased capability in science-related fields (Hernandez et al., 2017). Perhaps due to this struggle, once women have solidified a science identity, they are much more likely to persist (over and above other factors) due to a feeling that they belong (Merolla & Serpe, 2013).

Although presence of a scientific calling did not incrementally add to the likelihood of one persisting in science, this finding supports the need to continue to explore models examining potential precipitates to women's science identity and intentions to pursue science. This finding supports the subsequent investigation of the following proposed hypothesis: that science identity mediates the relationship between having a calling and intentions to pursue science.

Calling and Proposed SCCT Model of Persistence

The results of the initial analyses demonstrate that women who perceive a calling as a scientist also have greater science self-efficacy, science identity, and intentions to persist in science. A subsequent aim of this study was to explore potential ways that calling relates to predictors of persistence in science for undergraduate women in STEM. Social Cognitive Career Theory (SCCT) was used as a conceptual schema for informing hypotheses about how calling and persistence variables interact to effect career choice. According to this theory, an individual's set of learning experiences influences their self-efficacy and outcome expectations, leading to the development of their interests, which results in the development of their choice goals (see Figure 1; Lent, Brown, & Hackett, 1994).

Using SCCT as a framework for examining undergraduate women's career development processes, the constructs of interest were mapped onto specific components of the SCCT model. First, two simple mediation analyses were conducted to investigate portions of this study's

proposed model. The proposed hypothesis that the relationship between perceiving a calling and intentions to pursue science is mediated by science self-efficacy was supported. The next mediation hypothesis was adapted slightly because calling did not predict interest in science in this study. Instead, as reflected by research applying SCCT model to underrepresented minority students in STEM, science identity was conceptualized as a proxy measure of interest in science (Herrera & Hurtado, 2011). The results of this mediation model conceptualizing scientific identity as a proxy measure of interest was also significant. The indirect effects of the bootstrapped mediation analyses are consistent with the proposed mediation model, suggesting that perceiving a calling predicts greater science self-efficacy which in turn predicts intentions to pursue science. The same pattern is true of calling predicting greater science identity, which in turn predicts greater intentions to pursue science. Due to the cross-sectional design of this study, these mediation results cannot be interpreted as causal relationships.

The conceptual model as a whole (see Figure 2) illustrates the proposed serial mediation hypothesis: that the relationship between perceiving a calling and individual's intentions to pursue science can be explained in part by increases in science self-efficacy and science identity (respectively). Results support this conceptual SCCT model of persistence; science self-efficacy and science identity fully mediated the link between calling and intentions to pursue science. Opposed to the simple mediation model, the indirect effect in which self-efficacy served as the first mediator was nonsignificant. This result is in line with Estrada et al.'s (2011) past research with minority populations in STEM in which linear regression analyses revealed that self-efficacy no longer predicted intentions to pursue science after the inclusion of science identity (Estrada et al., 2011). The present study extends this work, finding that although self-efficacy was not associated with intentions over and above the effect of science identity, self-efficacy

predicted undergraduate women's science identity. This supports Estrada et al.'s (2011) theoretical explanation that students who feel they can succeed as a scientist are more likely to develop a stronger identity and values of the scientific community. Based on past research and current results, it may be the case that undergraduate women's intentions to pursue science are influenced by their development of a scientific calling, belief in their ability to succeed as a scientist, identification as a scientist.

Limitations and Directions for Future Research

Since this is the first known study to investigate perceiving a calling with this population, there are potential oversights and limitations as well as many directions for future investigation. First, there may be measurement issues influencing the results of the current study. As noted above, there were potential problems with the operationalization of the "interest in science" variable. Since a major purpose of the overall project was to increase women's participation and persistence in Earth and Environmental Sciences, interest in science was assessed specific to that field. This narrow conceptualization of science interest was not as useful for the purpose of this study; the domain-specific measurement of interest in science did not align with the broader conceptualization and measurement of perceiving a calling as a scientist. It is possible that if a broader measure of interest in science was included, calling may be positively and significantly related to interest in science for undergraduate women. Future research should investigate this hypothesis with this population using a scale that measures interest in pursuing any science-related field instead of interest in pursuing Earth and Environmental Sciences.

Due to the nonsignificant, negative relationship between calling as a scientist and interest in science for potential Earth and Environmental Sciences majors, a qualitative research study should be conducted further examine the hypothesis that calling did not relate to interest in

science due to the differences in conceptual understanding of the variables. For instance, if perceiving a calling as a scientist did not relate to interest in science even after changing the measure of interest, it may be the case that these variables do not relate because they exist on different levels of abstraction and application. Researchers should gather qualitative data assessing how individuals think about potential careers/life roles when considering their calling as a scientist opposed to their interest in science coursework and career.

An alternative explanation for the lack of relationship between perceiving a calling and interest in Earth and Environmental Sciences may be due to the alterations in the Brief Calling Scale (BCS). For the purpose of this study, the directions in the BCS were altered to obtain a measure of individual's perceived level of calling *as a scientist*. It may be the case that when answering the items "I have a calling to a particular kind of work" and "I have a good understanding of my calling as it applies to my career," participants did not apply their calling to a specific career in science. Since past literature has not adapted the BCS to assess a domain-specific calling, future research should examine the validity of this scale alteration.

The finding that presence of calling did not relate to the Scientific Community Values Scale but positively and significantly related to the prosocial item on this scale suggests that perceiving a calling may only relate to certain values of the science community. Since the construct of calling is more often prosocial in nature, it is likely that calling would positively correlate with prosocial values of the scientific community and negatively correlate with agentic values of the scientific community (Dik & Duffy, 2009). Future research should test this hypothesis. If this is the case, it would be important to also assess whether individuals who report high levels of perceiving a calling as a scientist are likely to perceive that this career path affords them opportunities to live out prosocial/communal values. This is critical to examine because

past research has shown that individuals who hold assumptions that STEM careers do not support communal goals (e.g., working with or helping other people) often hold more negative attitudes towards STEM careers (Diekman, Brown, Johnson, & Clark, 2010). While perceiving a calling as a scientist may predict a plethora of psychological persistence variables for undergraduate women, this relationship may depend on women's presence of communal values, as well as their perceptions that careers in science afford them opportunities to live out these values. Future research should examine if perceiving a scientific calling positively relates to presence of prosocial/communal values, as well as if presence of calling and presence of prosocial/communal values act as a barrier to persistence in science for women who perceive that the science community will not afford them opportunity to live out their prosocial values.

The cross-sectional nature of this study limits the ability to understand how psychological persistence variables interact to influence undergraduate women's intentions to pursue science over time. Since all variables were measured at one time-point, causal interpretations of the results cannot be made. For example, although regression and mediation models were explored in this study, we cannot say that any hypothesized predictor variables caused increases in undergraduate women's intentions to pursue science. Instead, we can conclude that perceiving a calling as a scientist appears to be important and related to increases in undergraduate women's intentions to pursue science. We can also say that the relationship between perceiving a calling as a scientist, science self-efficacy, science identity and persistence intentions is consistent with a serial mediation model – meaning that it is possible that these variables interact in the hypothesized ways. Future longitudinal research across multiple time points is needed to gain a deeper understanding of these constructs develop and interact to promote persistence in science over time.

Although there are limitations due to measurement concerns, additional theoretical explanations, and research design limitations, this study provides initial support for the importance of studying how women's calling as a scientist relates to their persistence in STEM careers. This study builds off the current calling literature, replicating observed relationships between presence of calling and positive career development variables (i.e., self-efficacy, interest, occupational identity and career commitment; Hirschi & Hermann, 2013; Hirschi, 2012; Duffy, Allan, & Dik, 2011). In addition to replicating previous research, this study provides a useful method for 1) examining effects of a domain-specific calling and 2) extending the calling literature to a new population, one that is in dire need of tools to foster their persistence in science-related fields. The finding that calling as a scientist positively relates to science self-efficacy, identity, presence of prosocial community values, and intentions to pursue science provides support for future research investigating how these variables interact to influence women's persistence in STEM.

Implications for Practice

The results of this study have several implications for practice. As noted earlier, increasing women's participation and persistence is a critical factor in solving many of today's current issues. Finding ways to encourage and support women in science not only combats social justice issues (i.e., lessens the gender pay gap), it is an important factor in promoting economic growth and the development of innovative technologies (U.S. Congress Joint Economic Committee, 2012; NSF, 2015). This research emphasizes the need to investigate new factors that promote women's persistence in science careers.

An important take-away from this study is the need for professors, mentors, and career counselors to make sure to spend adequate time 1) exploring undergraduate women's global

meaning systems (i.e., their calling, purpose, identity, and values) and 2) helping them find ways to connect their motives and values to their work as a scientist. This notion is well supported in the career development literature, as the alignment of one's work with their global meaning system is a critical factor associated with positive career development and well-being outcomes across many work-domains (Park, 2012). It is possible that academic advisors and counselors are missing this vital career development conversation – instead narrowing their focus to exploring student's interests and abilities (Savickas et al., 2009). This may be a disservice to their students. Evading these big-picture conversations around meaning and purpose may especially negatively impact women, as this population often identifies with having more communal/prosocial values in conjunction with perceiving minimal opportunities to live out these in science careers (Diekman, Brown, Johnson, & Clark, 2010). In addition, college is a time where having conversations around meaning and purpose is especially impactful – as individuals at this stage of life are beginning to solidify their identity, beliefs, and values (Arnett, 2004). The current study suggests that exploring undergraduate women's calling may be a particular avenue for having these conversations, as calling can be conceptualized as a component of one's global meaning system. It may be the case that connecting undergraduate women to their calling/purpose as a scientist will positively influence empirically-supported career development variables (i.e., self-efficacy, identity, interests, values), leading to their persistence in science careers.

The null finding from hypothesis four offers additional information about how calling may affect persistence for women interested in science. Undergraduate women's sense of calling did not correlate with their identification with the values of the scientific community. However, when further explored, perceiving a calling as a scientist was related to presence of prosocial

values of the science community, opposed agentic values. This finding suggests that women with a calling as a scientist may be interested in a career where they feel like they can make a difference. It is likely that interventions targeted towards this population will be more effective if they emphasize how careers in science afford scientists opportunity to live out their prosocial values and purpose. Instructors, academic advisors, mentors, and counselors can more effectively promote science careers to this audience by emphasizing the ways in which science career tasks are critical to solving important societal problems.

The finding that science identity explained persistence in science over and above the effect of perceiving a calling, as well as, over and above the effect of science self-efficacy, has additional implications for practice. Most importantly, this finding further supports the notion that developing an identity as a scientist is a critical factor associated with women's persistence in science (Hernandez et al., 2017). Based on the results of this study, it appears it is vital to aim intervention efforts at developing undergraduate women's identification with as a scientist. Even though calling as a scientist and science self-efficacy didn't uniquely predict persistence intentions when science identity was included in each model, both factors influenced persistence through predicting science identity. More specifically, the significant indirect effects of the serial mediation model suggest that a potential way to influence student's science identity is by developing undergraduate women's sense of calling as a scientist and science self-efficacy. Although future longitudinal research is needed to confirm the presence of these causal relationships, these preliminary results are in line with the calling literature as well as literature on women's persistence in STEM career pathways. If future research supports the proposed model, these results are particularly relevant for designing and implementing interventions for undergraduate women. It is likely that increasing women's sense of calling as a scientist will

have a positive effect on increasing women's participation and persistence in positions that are critical in solving some of today's most pressing challenges.

TABLES

Table 1.
Study Demographic information

	<i>n</i>	<i>%</i>
Sex		
Female	393	100
Male	0	0
Race		
European decent	230	58.52
African	26	6.62
Asian	25	6.36
Latina	19	4.83
Native American/Pacific Islander/First Nation	4	1.02
Other	3	0.76
Multiracial	61	15.52
No response	25	6.36
Assumed year in college		
First year	109	27.73
Second year	178	45.29
Third year	102	25.95
Fourth or more year	4	1.02

Table 2.

Variable Means, Standard Deviations, Reliabilities, and Intercorrelations

Variable	1	2	3	4	5	6
1. Calling						
2. Science self- efficacy	.23**					
3. Interest in science	-.02	.07				
4. Science identity	.23**	.39**	.33**			
5. Science community values	.08	.26**	.27**	.39**		
6. Intentions to Pursue Science	.12*	.25**	.32**	.60**	.42**	
Mean	5.39	5.37	4.31	4.91	6.26	5.65
(SD)	(1.29)	(1.07)	(2.07)	(1.36)	(.86)	(1.40)
Cronbach's α	.79	.77	.92	.85	.87	.74

** $p < .001$,* $p < .05$

Table 3. *Multiple regression analysis to determine whether perceiving a calling as a scientist predicts intentions to pursue science over and above the effects of identity as a scientist.*

	<i>B</i>	<i>SE(B)</i>	β	<i>t</i>	<i>p</i>
(Constant)	2.776	0.298		9.323	.000
Perceiving a calling	-0.022	0.047	-0.021	-0.472	.637
Science identity	0.609	0.044	0.608	13.788	0.017

FIGURES

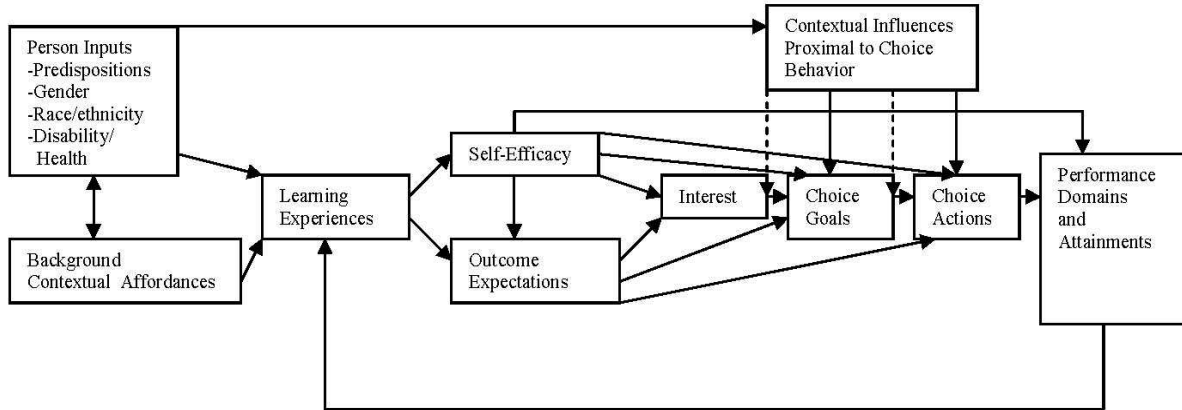


Figure 1. *Social Cognitive Career Theory: Choice Model - Lent, Brown, & Hackett (1994)*
Note: Figure used with author's permission.

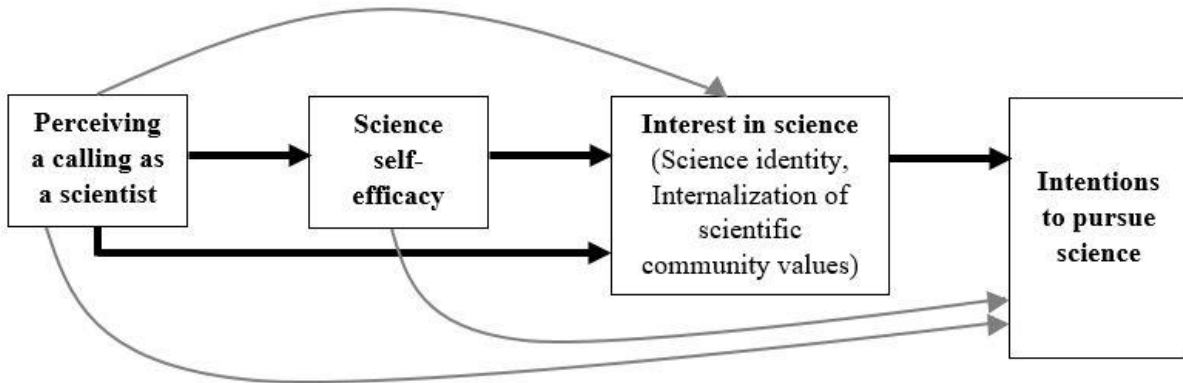


Figure 2. *The Conceptual Model*

Note: The black arrows and bold font refer to the constructs in the proposed serial mediation model. The gray arrows point to additional relationships examined in this study.

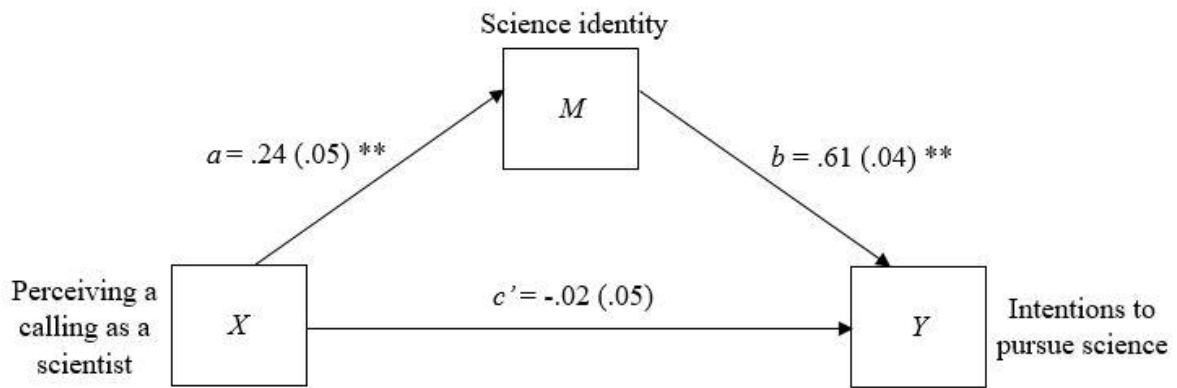


Figure 3. *Indirect effects model showing the direct effect and indirect effects linking perceiving a calling to intentions to pursue a scientific research career.*

** $p < .001$, * $p < .05$

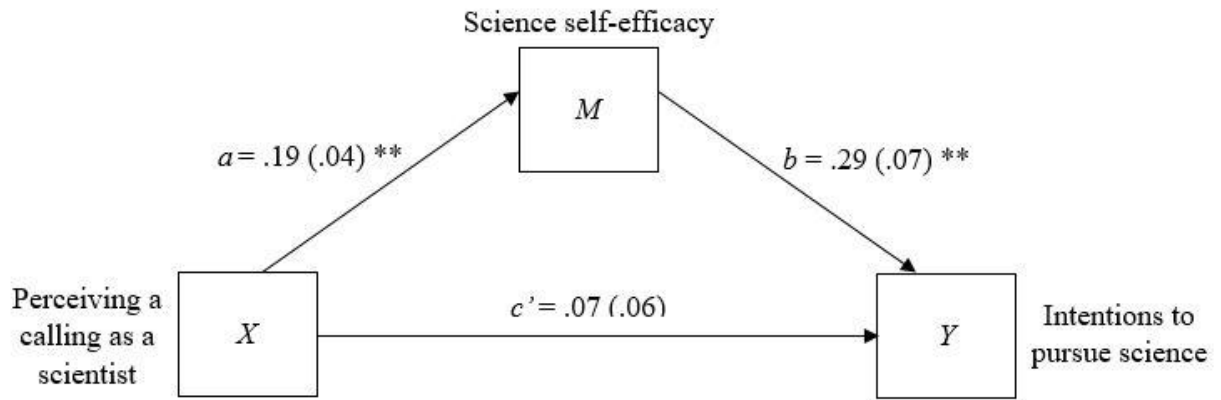


Figure 4. *Indirect effects model showing the direct effect and indirect effects linking perceiving a calling to intentions to pursue a scientific research career.*

** $p < .001$, * $p < .05$

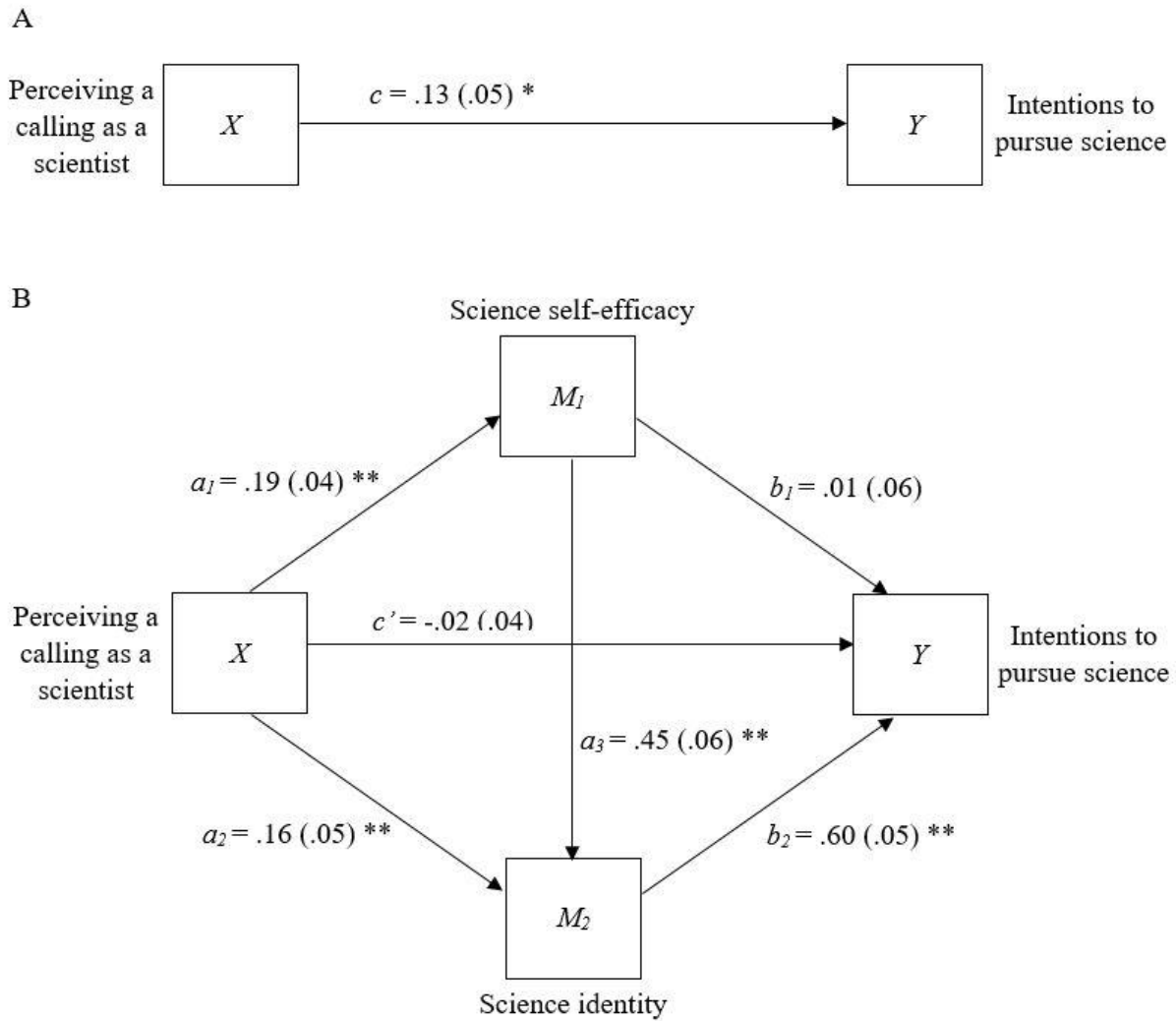


Figure 5. Path diagram showing (A) the total effect of perceiving a scientific calling on intentions to pursue a scientific research degree and (B) the direct effect and indirect effects linking perceiving a scientific calling to intentions to pursue a scientific research career.

** $p < .001$, * $p < .05$

REFERENCES

- Allan, B. A., & Duffy, R. D. (2013). Calling, goals, and life satisfaction: A moderated mediation model. *Journal of Career Assessment*, 1069072713498574.
- Arnett, J. (2004). A longer road to adulthood. *Emerging Adulthood: The Winding Road from the Late Teens through the Twenties* (pp. 3-25). Oxford University Press
- Bandura, A. (1986). The explanatory and predictive scope of self-efficacy theory. *Journal of social and clinical psychology*, 4(3), 359-373.
- Bunderson, J. S., & Thompson, J. A. (2009). The call of the wild: Zookeepers, callings, and the double-edged sword of deeply meaningful work. *Administrative science quarterly*, 54(1), 32-57.
- Betz, N. E. (2008). Advances in vocational theories. *Handbook of counseling psychology*, 4, 357-374.
- Berg, J.M., Grant, A.M., & Johnson, V. (2010). When callings are calling: Crafting work and leisure in pursuit of unanswered occupational callings. *Organization Science*, 21, 973–994.
- Caplan, R. D. (1987). Person-environment fit theory and organizations: Commensurate dimensions, time perspectives, and mechanisms. *Journal of Vocational behavior*, 31(3), 248-267.
- Chemers, M. M., Hu, L. T., & Garcia, B. F. (2001). Academic self-efficacy and first year college student performance and adjustment. *Journal of Educational psychology*, 93(1), 55.
- Chemers, M. M., Zurbriggen, E. L., Syed, M., Goza, B. K., & Bearman, S. (2011). The role of

- efficacy and identity in science career commitment among underrepresented minority students. *Journal of Social Issues*, 67(3), 469-491. doi:10.1111/j.1540-4560.2011.01710.x
- Cheruvilil, K. S., Soranno, P. A., Weathers, K. C., Hanson, P. C., Goring, S. J., Filstrup, C. T., & Read, E. K. (2014). Creating and maintaining high-performing collaborative research teams: the importance of diversity and interpersonal skills. *Frontiers in Ecology and the Environment*, 12(1), 31-38.
- DeVellis, R. F. (2016). *Scale development: Theory and applications* (Vol. 26). Sage publications.
- Diekman, A. B., Brown, E. R., Johnston, A. M., & Clark, E. K. (2010). Seeking congruity between goals and roles: A new look at why women opt out of science, technology, engineering, and mathematics careers. *Psychological Science*, 21(8), 1051-1057. doi:10.1177/0956797610377342
- Diekman, A. B., Clark, E. K., Johnston, A. M., Brown, E. R., & Steinberg, M. (2011). Malleability in communal goals and beliefs influences attraction to stem careers: Evidence for a goal congruity perspective. *Journal Of Personality And Social Psychology*, 101(5), 902-918. doi:10.1037/a0025199
- Dik, B. J., & Duffy, R. D. (2009). Calling and vocation at work: Definitions and prospects for research and practice. *The Counseling Psychologist*, 37(3), 424-450. doi:10.1177/0011000008316430
- Dik, B. J., Eldridge, B. M., Steger, M. F., & Duffy, R. D. (2012). Development and validation of the calling and vocation questionnaire (CVQ) and brief calling scale (BCS). *Journal of Career Assessment*, 1069072711434410.

- Dik, B. J., Duffy, R. D., & Tix, A. P. (2012). Religion, spirituality, and a sense of calling in the workplace. *Psychology of religion and workplace spirituality*, 113-133.
- Dik, B. J., & Rottinghaus, P. J. (2013). Assessments of interests.
- Dik, B. J., Sargent, A. M., & Steger, M. F. (2008). Career development strivings: Assessing goals and motivation in career decision-making and planning. *Journal of Career Development*, 35(1), 23-41.
- Domene, J. F. (2012). Calling and career outcome expectations: The mediating role of self-efficacy. *Journal of Career Assessment*, 1069072711434413.
- Douglass, R. P., Duffy, R. D., & Autin, K. L. (2016). Living a calling, nationality, and life satisfaction: A moderated, multiple mediator model. *Journal of Career Assessment*, 24(2), 253-269.
- Dobrow, S. R., & Tosti-Kharas, J. (2011). Calling: The development of a scale measure. *Personnel Psychology*, 64(4), 1001-1049.
- Duckworth, A. L., & Seligman, M. E. (2006). Self-discipline gives girls the edge: Gender in self-discipline, grades, and achievement test scores. *Journal of educational psychology*, 98(1), 198.
- Duffy, R. D., Allan, B. A., Autin, K. L., & Bott, E. M. (2013). Calling and life satisfaction: It's not about having it, it's about living it. *Journal of Counseling Psychology*, 60(1), 42.
- Duffy, R. D., Autin, K. L., Allan, B. A., & Douglass, R. P. (2015). Assessing work as a calling: An evaluation of instruments and practice recommendations. *Journal of Career Assessment*, 23(3), 351-366.
- Duffy, R. D., Allan, B. A., & Dik, B. J. (2011). The presence of a calling and academic

- satisfaction: Examining potential mediators. *Journal of Vocational Behavior*, 79(1), 74-80.
- Duffy, R.D., Bott, E.M., Allan, B.A., Torrey, C.L., & Dik, B.J. (2012). Perceiving a calling, living a calling, and job satisfaction: Testing a moderated, multiple mediator model. *Journal of Counseling Psychology*, 59, 50-59. doi: 10.1037/a0026129
- Duffy, R. D., & Dik, B. J. (2013). Research on calling: What have I learned and where are I going?. *Journal of Vocational Behavior*, 83(3), 428-436.
- Duffy, R. D., Manuel S.R., Borges N.J., & Bott E.M. (2011). Calling, Vocational Development, and Well Being: A Longitudinal Study of Medical Students. *Journal of Vocational Behavior*, 79(2), 361–66. doi:10.1016/j.jvb.2011.03.023.
- Duffy, R. D., & Sedlacek, W. E. (2007). The presence of and search for a calling: Connections to career development. *Journal of Vocational Behavior*, 70, 590–601.
doi:10.1016/j.jvb.2007.03.007
- Durik, A. M., Vida, M., & Eccles, J. S. (2006). Task values and ability beliefs as predictors of high school literacy choices: A developmental analysis. *Journal of Educational Psychology*, 98(2), 382.
- Estrada, M., Woodcock, A., Hernandez, P. R., & Schultz, P. W. (2011). Toward a model of social influence that explains minority student integration into the scientific community. *Journal Of Educational Psychology*, 103(1), 206-222. doi:10.1037/a0020743
- Fouad, N. A., Singh, R., Cappaert, K., Chang, W. H., & Wan, M. (2016). Comparison of women engineers who persist in or depart from engineering. *Journal of Vocational Behavior*, 92, 79-93.
- Garson, G. D. (2012). Testing statistical assumptions. *Asheboro, NC: Statistical Associates*

Publishing.

- Garson, G. D. (2015). Missing values analysis and data imputation. *North Carolina State University. Asheboro, USA: Statistical Associates Publishers.*
- Gonzales, L., Keane, C., & Martinez, C. (2011). Status of the geoscience workforce. *The American Geological Institute (AGI), American Geological Institute Workforce Program.*
- Hagmaier, T., & Abele, A. E. (2012). The multidimensionality of calling: Conceptualization, measurement and a bicultural perspective. *Journal of Vocational Behavior, 81*(1), 39-51.
- Hanauer, D. I., Graham, M. J., & Hatfull, G. F. (2016). A Measure of College Student Persistence in the Sciences (PITS). *CBE-Life Sciences Education, 15*(4), ar54.
- Hall, D.T., & Chandler, D.E. (2005). Psychological success: When the career is a calling. *Journal of Organizational Behavior, 26*, 155–176.
- Hayes, A. F. (2013). *An introduction to mediation, moderation, and conditional process analysis: A regression-based approach.* New York: Guilford Press. Retrieved from <http://www.guilford.com>.
- Hayes, A. F. (2012). PROCESS: A versatile computational tool for observed variable mediation, moderation, and conditional process modeling.
- Hernandez, P. R., Bloodhart, B., Barnes, R.T., Adams, A.S., Clinton, S.M., Pollack, I., Godfrey, E., Burt, M., & Fischer, E.V. (2017). Promoting professional identity, motivation, and persistence: Benefits of an informal mentoring program for female undergraduate students. *Plos One.*
- Herrera, F. A., & Hurtado, S. (2011). Maintaining initial interests: Developing science,

- technology, engineering, and mathematics (STEM) career aspirations among underrepresented racial minority students. In *Association for Educational Research Annual Meeting, New Orleans, LA*.
- Hill, C., Corbett, C., & St. Rose, A. (2010). *Why so few? Women in science, technology, engineering, and mathematics*: The American Association of University Women.
- Hirschi, A. (2011). Callings in career: A typological approach to essential and optional components. *Journal of Vocational Behavior*, 79(1), 60-73.
- Hirschi, A. (2012). Callings and work engagement: moderated mediation model of work meaningfulness, occupational identity, and occupational self-efficacy. *Journal of counseling psychology*, 59(3), 479.
- Hirschi, A., & Herrmann, A. (2012). Vocational identity achievement as a mediator of presence of calling and life satisfaction. *Journal of Career Assessment*, 20(3), 309-321.
- Holden, G., Moncher, M. S., Schinke, S. P., & Barker, K. M. (1990). Self-efficacy of children and adolescents: A meta-analysis. *Psychological Reports*, 66, 1044–1046.
doi:10.2466/PRO.66.3.1044-1046
- Holland, J. L. (1959). A theory of vocational choice. *Journal of counseling psychology*, 6(1), 35.
- Jacobs, J. E., Davis-Kean, P., Bleeker, M., Eccles, J. S., & Malanchuk, O. (2005). I can, but I don't want to. *The impact of parents, interests, and activities on gender differences in math*. In A. Gallagher & J. Kaufman (Eds.), *Gender difference in mathematics*, 246-263.
- Kaplan, A., & Flum, H. (2012). Identity formation in educational settings: A critical focus for education in the 21st century. *Contemporary Educational Psychology*, 37(3), 171-175.
doi:10.1016/j.cedpsych.2012.01.005
- Lent, R. W., Brown, S. D., & Larkin, K. C. (1984). Relation of self-efficacy expectations to

- academic achievement and persistence. *Journal of counseling psychology*, 31(3), 356.
- Lent, R. W., Brown, S. D., & Larkin, K. C. (1986). Self-efficacy in the prediction of academic performance and perceived career options. *Journal of Counseling Psychology*, 33, 265-269.
- Lent, R. W., Brown, S. D., & Hackett, G. (1994). Toward a unifying social cognitive theory of career and academic interest, choice, and performance. *Journal of vocational behavior*, 45(1), 79-122.
- Lent, R. W., & Brown, S. D. (2006). On conceptualizing and assessing social cognitive constructs in career research: A measurement guide. *Journal of career assessment*, 14(1), 12-35.
- Lent, R. W., Brown, S. D., Sheu, H. B., Schmidt, J., Brenner, B. R., Gloster, C. S., & Treistman, D. (2005). Social cognitive predictors of academic interests and goals in engineering: Utility for women and students at historically black universities. *Journal of Counseling Psychology*, 52(1), 84.
- Lent, R. W., Lopez, F. G., Sheu, H. B., & Lopez Jr, A. M. (2011). Social cognitive predictors of the interests and choices of computing majors: Applicability to underrepresented students. *Journal of Vocational Behavior*, 78(2), 184-192.
- Lent, R. W., Miller, M. J., Smith, P. E., Watford, B. A., Lim, R. H., Hui, K., & Williams, K. (2013). Social cognitive predictors of adjustment to engineering majors across gender and race/ethnicity. *Journal of Vocational Behavior*, 83(1), 22-30.
- Merolla, D. M., & Serpe, R. T. (2013). STEM enrichment programs and graduate school matriculation: the role of science identity salience. *Social Psychology of Education*, 16(4), 575-597.

- Merolla, D. M., Serpe, R. T., Stryker, S., & Schultz, P. W. (2012). Structural precursors to identity processes: The role of proximate social structures. *Social psychology quarterly*, 75(2), 149-172. doi:10.1177/0190272511436352
- Moritz, S. E., Feltz, D. L., Fahrback, K. R., & Mack, D. E. (2000). The relation of self-efficacy measures to sport performance: A meta-analytic review. *Research Quarterly of Exercise and Sport*, 71, 280-294.
- National Science Foundation. (2008). Division of Science Resources Statistics. Science and engineering degrees: 1996-2006. Arlington, VA: National Science Foundation.
- National Science Foundation. (NSF). (2010). Science and engineering indicators: Higher education in science and engineering. <http://www.nsf.gov/statistics/seind10/c2/c2s3.htm>
- NSF. (2015). *Women, Minorities, and Persons with Disabilities in Science and Engineering: 2015*. (Special Report NSF 15-311). Arlington, VA: National Science Foundation
Retrieved from <http://www.nsf.gov/statistics/wmpd/>.
- Olson, S., & Riordan, D. G. (2012). Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics. Report to the President. *Executive Office of the President*. Retrieved from <https://files.eric.ed.gov/fulltext/ED541511.pdf>.
- Ong, M., Wright, C., Espinosa, L., & Orfield, G. (2011). Inside the double bind: A synthesis of empirical research on undergraduate and graduate women of color in science, technology, engineering, and mathematics. *Harvard Educational Review*, 81(2), 172-209.
- Park, C.L. (2005). Religion and meaning. In R.F. Paloutzian & C. L. Park (Eds.), *Handbook of the psychology of religion and spirituality* (pp. 295-314). New York, NY: Guilford.
- Park, C. L. (2012). Religious and spiritual aspects of meaning in the context of work

- life. *Psychology of religion and workplace spirituality*, 25-42.
- Parsons, F. (1909). *Choosing a vocation*. Houghton Mifflin.
- Praskova, A., Hood, M., & Creed, P. A. (2014). Testing a calling model of psychological career success in Australian young adults: A longitudinal study. *Journal of Vocational Behavior*, 85(1), 125-135.
- Rothmann, S., & Hamukang'andu, L. (2013). Callings, work role fit, psychological meaningfulness and work engagement among teachers in Zambia. *South African Journal of Education*, 33(2), 1-16.
- Savickas, M. L., Nota, L., Rossier, J., Dauwalder, J. P., Duarte, M. E., Guichard, J., ... & Van Vianen, A. E. (2009). Life designing: A paradigm for career construction in the 21st century. *Journal of vocational behavior*, 75(3), 239-250.
- Schwartz, S., Zamboanga, B., Luyckx, K., Meca, A., & Ritchie, R. (2013). Identity in emerging adulthood: Reviewing the field and looking forward. *Emerging Adulthood*, 1(2), 96-113
- Serpe, R. T. (1987). Stability and change in self: A structural symbolic interactionist explanation. *Social Psychology Quarterly*, 44-55.
- Shim, Y., & Yoo, S. K. (2012). Development and validation of the Korean version of the calling and vocation questionnaire (CVQ-K). *The Korean Journal of Counseling and Psychotherapy*, 24(4), 847-872.
- Steger, M. F., Frazier, P., Oishi, S., & Kaler, M. (2006). The meaning in life questionnaire: Assessing the presence of and search for meaning in life. *Journal of Counseling Psychology*, 53(1), 80–93. doi:10.1037/0022-0167.53.1.80
- Steger, M. F., Pickering, N. K., Shin, J. Y., & Dik, B. J. (2010). Calling in work: Secular or sacred?. *Journal of Career Assessment*, 18(1), 82-96.

- Su, R., Murdock, C. D., & Rounds, J. (2015). Person-environment fit. *APA handbook of career intervention, 1*, 81-98.
- Super, D. E. (1990). A life-span, life-space approach to career development.
- Tang, M., Fouad, N. A., & Smith, P. L. (1999). Asian Americans' career choices: A path model to examine factors influencing their career choices. *Journal of Vocational Behavior, 54*(1), 142-157.
- U.S. Congress Joint Economic Committee. (2012). *STEM education: Preparing for the jobs of the future*. Washington, DC.
- Valian, V. (2007). *Women at the Top in Science--And Elsewhere*. American Psychological Association. Washington, DC.
- Walsh, W. B. (1999). What we know and need to know: A few comments. In M. L. Savickas & A. R. Spokane (Eds.), *Vocational Interests: Meaning, measurement and counseling use* (pp. 371-382). Palo Alto, CA: Davies-Black.
- Wang, M. T., & Degol, J. (2013). Motivational pathways to STEM career choices: Using expectancy–value perspective to understand individual and gender differences in STEM fields. *Developmental Review, 33*(4), 304-340.
- Whiston, S. C., & Keller, B. K. (2004). The influences of the family of origin on career development: A review and analysis. *The Counseling Psychologist, 32*(4), 493-568.
- Woodcock, A., Hernandez, P. R., & Schultz, P. W. (2016). Diversifying science: Intervention programs moderate the effect of stereotype threat on motivation and career choice. *Social psychological and personality science, 7*(2), 184-192.
- Zhang, C., Dik, B. J., Wei, J., & Zhang, J. (2015). Work as a calling in China: A qualitative study of Chinese college students. *Journal of Career Assessment, 23*(2), 236-249.