THESIS

FEMALE GRADUATE STUDENTS IN ATMOSPHERIC SCIENCE EXPLAIN WHAT SUPPORTS AND CHALLENGES THEIR PERSISTENCE

Submitted by

Carlie D. Trott

Department of Psychology

In partial fulfillment of the requirements

For the Degree of Master of Science

Colorado State University

Fort Collins, Colorado

Fall 2013

Master's Committee:

Advisor: Silvia Sara Canetto
Co-Advisor: Patricia Aloise-Young

A. Scott Denning

ABSTRACT

FEMALE GRADUATE STUDENTS IN ATMOSPHERIC SCIENCE
EXPLAIN WHAT SUPPORTS AND CHALLENGES THEIR PERSISTENCE

Women are underrepresented in Atmospheric Science (ATS) higher education, particularly at the doctoral level (NSF, 2012c). The present study explored how female ATS graduate students explain their persistence in the field, with a focus on both supportive and challenging influences on persistence. In-depth, semi-structured interviews were conducted with 25 women in an ATS graduate program (11 doctoral and 14 Masters level students), their ages ranging from 22 to 30 (M_{age} = 25.13). Five interrelated thematic categories, comprised of positive and negative influences on persistence, were generated through the analyses: (1) academic self-confidence and academic self-doubt; (2) educational engagement and educational detachment, (3) supportive and undermining personal relationships; (4) motivating and discouraging professional relationships; and (5) supportive and undermining ATS academic/professional systems, expectations, and practices. Each of the main five themes is explained in relation to women's ATS persistence and is also examined through a 'gendered lens', offering critical insights into women's views and experiences by recognizing the impact of structural constraints. This study provides important new information on women in graduate ATS studies, with implications for the design of future research as well as programs aimed at supporting women's persistence in ATS higher education and careers.

ACKNOWLEDGEMENTS

I would like to express my sincere gratitude, first and foremost, to Silvia Sara Canetto—my advisor and mentor, without whose continuous support this project would not have been possible. Thank you for your motivation, expertise, and enthusiasm. I would like to thank the members of my committee—Patricia Aloise-Young and Scott Denning—for their advice and encouragement throughout the process. Thank you to Trevor Lee Even for the conversations that allowed my thoughts to align and also for the immensely valuable words of encouragement that supported my own persistence when I needed them most. I would like to thank also my participants, whose stories were inspiring and meaningful to me, both as a researcher as well as a fellow female graduate student. Thank you to my brilliant coding team: Carrisa Mayer, Tabitha Bhatti, and Stephanie Jo Voorhorst, as well as countless other research assistants who have contributed to data transcription and organization over the years. Your contributions have been invaluable. Finally, I offer my sincere gratitude to my parents, Daniel L. and Susan M. Trott, to my sisters, Miranda and Samantha, and to Jessica Velcoff, Lynette Hish, Brian Siers, and April Gonzalez, for supporting me from the earliest stages in my path to pursuing graduate studies.

This research was supported by the National Science Foundation Science and Technology Center for Multi-Scale Modeling of Atmospheric Processes, managed by Colorado State University under cooperative agreement ATM-0425247 (David Randall, P.I., Silvia Sara Canetto et al., Co-P.I.s).

TABLE OF CONTENTS

LIST OF KEYWORDS

Atmospheric Science

Career

Education

Gender

Persistence

Women

CHAPTER I: Introduction

Over the past fifty years, U.S. women's participation in Atmospheric Science (ATS) higher education has grown markedly. In the 1960s and 1970s, it was rare for women to pursue ATS, with women earning only a small proportion of ATS undergraduate degrees (M = 5.4%), and an even smaller proportion of ATS doctorates (M = 3.8%) (National Science Foundation [NSF], 2008). At present, women have been earning greater than 28% of ATS undergraduate degrees since 2001, and reached a peak representation of 36% in 2008 (NSF, 2008; NSF, 2012a). In the decade leading up to 2009, women's proportion of ATS doctorates averaged 28.5%, with a peak representation of 38% in 2007 (NSF, 2012c).

Despite these trends, women's participation in ATS education remains limited relative to their participation in other geosciences and many other science, technology, engineering, and mathematics (STEM) disciplines (Charlevoix, 2010; NSF, 2012a). In addition, the proportion of women employed in ATS falls considerably below the proportion of women completing degrees in the field, with women representing only 15% of ATS and space scientists combined in 2006 (Gonzales, 2010; NSF, 2006). Moreover, of the women with ATS doctorates, few pursue academic careers, and an even smaller proportion reach senior academic ranks (Tucker, Ginther, & Winkler, 2009; Winkler, Tucker, & Smith, 1996). Data from the American Geological Institute's Directory of Geoscience Departments indicate that in 2002, women represented fewer than 10% of full professors or department heads at geoscience doctorate-granting universities, with ATS recording the lowest percentage of female professors of any geoscience field (Holmes & O'Connell, 2003).

These data raise questions about what may support as well as what may challenge women's persistence in ATS education and careers, particularly during graduate school. Perhaps

women face unique difficulties as students in ATS. It may be that ATS women would benefit from specific supports to continue and complete their graduate ATS studies and stay in the field post-graduation.

Research on women's views and experiences of supports and challenges to their persistence in ATS is important for many reasons. At a minimum, this research generates information about an understudied STEM, geoscience field with relatively few women. At a more general level, research on ATS women contributes to the broader field of gender issues and experiences in STEM education and careers.

Background

In recent years, there has been significant growth in the number of undergraduate ATS programs as well as in the number of undergraduate ATS degrees awarded (Knox, 2008; NSF, 2012a). Between 1994 and 2004, the number of earned ATS undergraduate degrees increased by 47%—a growth unparalleled by earned undergraduate degrees in any other related science field (Knox, 2008). Women's undergraduate ATS degree earnings have also grown, with women earning more than 35% of ATS undergraduate degrees in four of six years between 2004 and 2009 (NSF, 2012a).

Trends in ATS Masters and doctorates earned by women. Similar to women's undergraduate ATS degree completion trends, women's share of ATS Masters degrees has shown consistent growth in recent decades. Since 1980, women's proportion of Masters degrees has increased 32.2% to reach its peak proportion of 40.4% in 2009 (NSF, 2008; NSF, 2012b). Women started earning at least 30% of ATS Masters degrees in 2002, a proportion that has increased every year for more than a decade (since 1997), with the exception of 2005 when their percentage declined to 32.5% (NSF, 2008; NSF, 2012b). At the same time, relative to other

geosciences, ATS has the lowest percentage of Masters degrees awarded to women (NSF, 2012b). In 2009, women's share of the ATS Masters degrees fell behind earth and ocean sciences by 5.8% and 16.5%, respectively (NSF, 2012b).

By contrast, over the past four decades women's doctorate degree completion has shown inconsistent and slow growth (NSF, 2008; NSF, 2012c). Although trends in women's ATS doctorate completion have shown increases averaging 10% growth per decade since 1980, women's share of the doctorates decreased in 11 of the 30 years (36.7% of the time) between 1980 and 2009 (NSF, 2008; NSF, 2012c). Moreover, the proportion of doctoral degrees awarded to women in earth and ocean sciences outnumbered ATS by 8.8% and 24.1%, respectively (NSF, 2012c). In sum, women's participation in ATS is lagging behind other geosciences (as well as many STEM disciplines), but to a greater extent at the doctoral level.

The importance of the doctorate for scientific leadership. A doctorate in ATS, as in other disciplines, provides the opportunity for an influential career in research and academia (American Meteorological Society, 1993; Bureau of Labor Statistics, 2011). For instance, the doctorate is required for the majority of academic positions in ATS. An academic position is a key appointment for women to serve as a role model or mentor for future atmospheric scientists (Holmes & O'Connell, 2003). Women in academic positions are important considering that female students (like male students) tend to prefer mentors of their own sex, and that most geosciences doctorate-granting universities have one female faculty per department (Gumbiner, 1998; Holmes & O'Connell, 2003). It has been suggested that women's underrepresentation among ATS doctorate earners may be related to the scarcity of women serving as role models and mentors for other women in academia and research institutions (Canetto, Trott, Thomas, & Wynstra, 2012; Ely, 1995; Etzkowitz, Kemelgor, Neuschatz, & Uzzi, 1994).

Women's Persistence in STEM Education and Careers

A significant body of research has documented that in many STEM disciplines the proportion of women drops markedly at each key educational transition, a phenomenon widely referred to as "the leaky pipeline" (Hartten & LeMone, 2010; Hill, Corbett, & St. Rose, 2010). The magnitude of such retention problems is greater in the geosciences than in other STEM fields, with ATS having the lowest percentage of graduate degrees awarded to women, particularly at the doctoral level (Huntoon & Lane, 2007; Levine, González, & Martínez-Sussmann, 2009; NSF, 2012b; NSF, 2012c).

Many studies have explored barriers to persistence for women in a variety of STEM degree programs and careers (Bernstein, 2011; Conefrey, 2001; Ferreira, 2002; Fouad & Singh, 2011; Hill, Corbett, & St. Rose, 2010; National Academy of Sciences [NAS], 2006). However, scant research has focused on challenges to persistence for women in ATS, with existing studies focusing on career choice rather than retention, and on the geosciences in general rather than on ATS (Canetto et al., 2012; Huntoon & Lane, 2007; Levine, González, Cole, Fuhrman, & Le Floch, 2007). There is also a need for understanding factors that sustain women's persistence in ATS. In order to increase women's participation in ATS, it is imperative to explore both what supports and challenges women's persistence within this male-dominated field.

Supports and challenges to women's persistence in STEM. Much research has focused on women's persistence in a range of STEM disciplines. This research has identified individual, interpersonal, and institutional factors that are important to women's persistence in STEM education and careers.

Individual factors in STEM persistence. Individual factors relevant to STEM persistence include academic preparedness in science and math (Buzzetto-More, Ukoha, &

Rustagi, 2010; Ma, 2011; Margolis, Fisher, & Miller, 2000), academic and career-related personal preference and goals (e.g, communal goals) (Diekman, Clark, Johnston, Brown, & Steinberg, 2011) as well as identification with science, particular STEM fields, and with being a scientist (Estrada, Woodcock, Hernandez, & Schultz, 2011; Hazari, Sonnert, Sadler, & Shanahan, 2010). Many studies have demonstrated that STEM course-taking by women during the pre-college and college years fuels STEM interest and provides the necessary academic background to pave the way to STEM graduate education and careers (Canetto et al., 2012; Griffith, 2010; Huang & Brainard, 2001). Such studies have led to initiatives aimed at attracting and retaining students from underrepresented groups in STEM fields by harnessing students' personal interests "as the starting point for instruction," thereby increasing engagement and improving performance in scientific coursework (Denofrio, Russell, Lopatto, & Lu, 2007, p. 1872).

Several studies have also identified the important role of scientific self-efficacy and self-confidence in supporting the success of underrepresented groups, including women, in STEM education and careers (Baber, Pifer, Colbeck, & Furman, 2010; Byars-Winston, Estrada, Howard, Davis, & Zalapa, 2010; Dweck, 2006, 2008; Huang & Brainard, 2001; Singh, Allen, Scheckler, & Darlington, 2007). Self-efficacy, or the belief in one's ability to accomplish tasks and reach goals, particularly in academic and science domains, has been linked with higher levels of learning, effort, achievement, and persistence in a variety of STEM fields, including engineering, physics, and computer science (Bong & Skaalvik, 2003; Concannon & Barrow, 2010; Lent, Lopez, Sheu, & Lopez Jr., 2011; Sawtelle, Brewe, & Kramer, 2012). A recent study by Chemers and colleagues (2011) found that scientific self-efficacy supports science career commitment among underrepresented minority undergraduate and graduate STEM students. A

factor in women's underrepresentation in STEM higher education in careers could be that women consistently express lower levels of self-confidence in their academic, particularly mathematics, abilities in relation to their male peers (Brainard & Carlin, 1998; Sax, 1994). Moreover, at the STEM career level, low levels of professional role confidence—the belief in one's ability to succeed in fulfilling the roles, identity features, and competencies of a profession—has been identified as playing a role in women's attrition from engineering careers (Cech, Rubineau, Silbey, & Seron, 2011).

A great deal of research has also demonstrated that a sense of belonging in academic settings is crucial to the persistence of women in STEM disciplines (Brainard & Carlin, 1998; Seymour & Hewitt, 1997; Shapiro & Sax, 2011; Stout, Ito, Finkelstein, & Pollock, 2013). This research has found that minority groups in STEM fields, including women, often feel unwelcomed and alienated in situations where they are outnumbered in terms of their social identities. As well, stereotype threat, or the anxiety related to confirming a negative stereotype about one's own group (e.g., the belief that women are less competent in math and science), is considered to be a factor in women's underrepresentation in STEM education and careers (Hill, Corbett, & St. Rose, 2010).

Interpersonal factors in STEM persistence. A variety of interpersonal factors have also been linked to women's persistence in STEM education and careers. In the academic domain, these include access to a supportive peer community (Amelink & Creamer, 2010; Brainard & Carlin, 1998; Conefrey, 2000; Espinosa, 2011; Ferreira, 2002; Fox, 2001; Lovitts, 2001; Koenig, 2009; NAS, 2006; Wentling & Camacho, 2008) as well as involvement in on-campus (including STEM) organizations (Brainard & Carlin, 1998; Espinosa, 2011; Wentling & Camacho, 2008). Peer networks are particularly influential as a source of valuable information to STEM students

(e.g., regarding who to turn to for assistance, how to appear competent), which allows students to "survive and thrive" in their academic departments (Golde, 2000, p. 202). Moreover, peers serve as a resource to one another in discussing difficult coursework and overcoming research roadblocks, which supports their academic success (Espinosa, 2011).

A crucial factor in women's persistence in STEM education and careers is the role of positive relationships with faculty members, particularly STEM role models and mentors (Amelink & Creamer, 2010; Brainard & Carlin, 1998; Downing, Crosby, & Blake-Beard, 2005; Fox, 2001; Fried & MacCleave, 2009; Gibson, 2004; Koenig, 2009; Sandler, 1991; Smith, 2006; Vogt, 2008; Wentling & Camacho, 2008). Mentorship has been demonstrated to support women's self-confidence, networking opportunities, research productivity, and access to information regarding possible career prospects (Dean, 2009; Nettles & Millet, 2006; Paglis, Green, & Bauert, 2006; Shapiro & Sax, 2011). A variety of intervention programs aimed at increasing the interest and participation of underrepresented groups in STEM fields have focused on the importance of such developmental relationships to STEM persistence. Undergraduate research programs (Espinosa, 2011; Pender, Marcotte, Sto. Domingo, & Maton, 2010; Zydney, Bennett, Shahid, & Bauer, 2002) and university-based diversity initiatives (Koenig, 2009) have been demonstrated to encourage students to pursue advanced degrees and careers in STEM by linking students with supportive mentors and peer communities through hands-on research involvement (Russell, Hancock, & McCullough, 2007).

In addition to interpersonal influences in the academic domain, family support factors, (consisting for example of emotional and financial support) also play important roles in women's commitment to STEM education and careers (Brainard & Carlin, 1998; Wentling & Camacho, 2008). Family members may also serve as role models to women, with several studies finding

that women's persistence in STEM is supported by having parents (Duberley & Cohen, 2009; Sax, 1994) or female family members (Seymour & Hewitt, 1997) in STEM professions.

Institutional factors in STEM persistence. Finally, studies have identified institutional factors associated with persistence during both undergraduate and graduate level STEM education as well as in STEM careers. During STEM education, funding opportunities, particularly during graduate studies, have been cited as a critical support to women's persistence in STEM (Ferrer de Valero, 2001; NAS, 2006). In a recent study examining retention and degree completion of doctoral women in STEM (Ampaw & Jaeger, 2011), it was found that women's attrition from STEM graduate studies may be a result of fewer research assistantships given to women (16%) compared to men (38%), with research assistantship funding being associated with a 67% greater likelihood of doctoral degree completion. Findings from this and other (Buzzetto-More, Ukoha, & Rustagi, 2010; Lovitts, 2001; Koenig, 2009; Sandler, 1991) studies suggest that the level and type of funding offered to students play an important role in STEM educational and career persistence. Research assistantships not only aid in degree completion, but are also associated with generally higher research productivity—another indicator of success in STEM. A longitudinal study of doctoral degree completion by STEM women (Nettles & Millet, 2006) found that STEM men graduate students showed a significant advantage in total research productivity (i.e., paper presentations, research article publications), with the most consistent contributions to productivity being research assistantships and positive mentorship experiences.

The culture and climate of STEM academic departments is another factor in women's persistence in STEM education and careers (Ferreira, 2009; Griffith, 2010). Several studies have pointed to the competitive nature of STEM courses in deterring women from choosing and

staying in STEM majors, as women tend to prefer a collaborative learning environment (Seymour & Hewitt, 1997; Strenta, Elliot, Adair, Matier, & Scott, 1994). Also impacting persistence is the increasing isolation felt by women that comes with further educational advancement, with women graduate students having fewer opportunities to connect with other women, less informal contact with male faculty and peers, and not as much encouragement and guidance from within their academic departments (e.g., advisors) in comparison to undergraduate education (Ferreira, 2002, 2003; Lovitts, 2001; Mallinckrodt & Leong, 1992; Nettles & Millet, 2006; Sandler, 1991). Moreover, several studies have found communication norms in academic science to favor males (Conefrey, 2000), which has a negative impact on women's persistence in STEM education and careers (Ferreira, 2002, 2003; Fox, 2001; Lovitts, 2001; Nettles & Millet, 2006; Sandler, 1991).

The "chilly climate" of academic science extends into STEM careers, particularly in academia, where women report lower job satisfaction in comparison to their male colleagues (Maranto & Griffin, 2011; Trower & Chait, 2002). Institutional factors associated with women's underrepresentation in academic STEM careers include lack of support and collaboration (Hill, Corbett, & St. Rose, 2010; Sandler, 1991) as well as the absence of mentoring (Macfarlane & Luzzadder-Beach, 1998; Trower & Chait, 2002), which prevents women from receiving valuable advice on workplace navigation, professional development, and career advancement (Hill, Corbett, & St. Rose, 2010; NAS, 2006). Women's persistence in STEM careers is also impeded by perceptions of unfair treatment in the workplace (Hill, Corbett, & St. Rose, 2010; Sandler, 1991) as well as university policies (e.g., the tenure system) that contribute to work-family commitment conflict (de Wet, Ashley, & Kegel, 2002; Hill, Corbett, & St. Rose, 2010).

Supports and challenges to women's persistence in the geosciences. In comparison to the attention given to STEM fields such as engineering, far fewer studies have explored supports and challenges to women's persistence in the geosciences, which include ATS. Within this body of literature, a variety of supports and challenges to persistence have been identified. In one study, female geoscientists from the U.S. and Canada were asked about the challenges they had experienced while completing their graduate studies (Larocque, 1995). The most common graduate school challenge was lack of self-confidence—reported by 63% of the female geoscientists. The second and third most common challenges experienced during graduate school were passive neglect (e.g., lack of encouragement by male advisors and faculty)—reported by 47% of the sample—and active discrimination/harassment (e.g., sexual harassment by faculty and male peers)—reported by 45% of the sample. Such findings point to the importance of positive mentorship relationships in women's pursuit of geoscience higher education and careers. A number of studies aimed at increasing diversity in the geosciences have found mentorship to play a critical supportive role (Brock, Fuhrman, González, & Levine, 2006; Canetto et al., 2012; Hallar et al., 2010; Huntoon & Lane, 2007; Levine et al., 2007; Pandya, Henderson, Anthes, & Johnson, 2007; Windham, Stevermer, & Anthes, 2004).

Limitations of the current research on STEM women's persistence. Most research on women's persistence in STEM education and careers focuses on the challenges that women face, rather than on supportive factors. This research has dispelled the notion that women's underrepresentation in STEM is related to lack of skill or motivation. What emerge as important are social, cultural, and structural barriers to persistence. In order to shed light on supportive factors impacting persistence, more research is needed that asks directly about factors that sustain women's pursuit of STEM higher education and careers.

Another limitation of the available research on women's persistence in STEM is that the majority of studies focus on undergraduate education rather than on graduate education. Understanding the supports and challenges women face in their path to completing doctorates in STEM disciplines is critical to supporting women's attainment of leadership and academic positions. In sum, more research is needed on female graduate students' persistence through the doctorate, with attention to factors that not only challenge, but also sustain their educational and career persistence. To date, no studies have explored how graduate level ATS women explain their persistence in the field.

Statement of the Problem

The slow, inconsistent growth and continued underrepresentation of women among U.S. ATS graduate degree earners, particularly at the doctoral level, remains an understudied issue, with broad economic and social implications. Increasing the entry of women into ATS scientific leadership careers is necessary if the U.S. is to maintain its position as a global leader in climate science, particularly in light of growing global economic and climate concerns (Baber et al., 2010; Huntoon & Lane, 2007; National Academy of Sciences, 2006). By understanding the supportive and challenging factors that impact women's persistence to the ATS doctorate and into ATS careers, the field will be better able to foster a more diverse workforce from its highest levels, with women holding positions of leadership (AMS, 1993; Hartten & LeMone, 2010).

Rationale for the Study

In light of important characteristics distinguishing ATS from other STEM fields, the way female ATS graduate students explain and sustain their persistence in science may differ from the way women in other STEM disciplines justify and sustain their persistence. With an increased understanding of supportive and challenging factors in women's persistence, more

effective programs and interventions can be developed to support women's completion of the ATS doctorate as well as their retention in the field post-graduation. An increased number of women ATS doctorates will likely contribute to a more varied pool of ATS scientists, thus increasing the diversity of approaches and solutions for the societal and scientific issues within the ATS domain (Chubin & Malcom, 2008; Hartten & LeMone, 2010; Wallace & Hobbs, 2006).

Purpose

This study was designed to expand our understanding of women's persistence in STEM disciplines in which they are underrepresented by focusing on the understudied STEM field of ATS. The present study also aimed to understand how women in ATS graduate studies explain their persistence in the field, exploring what they perceive as supportive and challenging factors affecting their educational and career persistence.

For the purposes of this study, "persistence" was defined as the pursuit of an ATS educational and career path following the initial choice of ATS. Therefore, factors influencing persistence are defined as either supporting or challenging the pursuit of an ATS educational and career path, and may occur at any educational level following this initial choice. For this reason, persistence factors were not limited to supports and challenges during graduate school.

Research Questions

This study's research questions were:

1. How do women in this ATS graduate program explain their persistence in the field?
2. What supports and challenges to their persistence in science do female ATS graduate students describe?

CHAPTER II: Method

Participants

This study's participants were 25 female graduate students (11 doctoral, 14 Masters level), ranging in age from 22 to 30 (M_{age} = 25.13 years), enrolled in an ATS graduate program at a large, state university in the Mountain West region of the U.S. Nearly all (21) students identified as White/European American. Of the 25 participants, 7 were married, 12 were in a committed relationship, and 6 were single.

Instruments

Semi-structured interviews were conducted to explore what women perceived as influential to their persistence in ATS graduate education and careers (Appendix I). The interview protocol explored supports and challenges to persistence along the ATS educational path and into ATS careers, following the initial choice to pursue ATS. The following domains were examined: (a) individual resources (e.g., self-confidence); (b) interpersonal resources (e.g., mentors); and (c) institutional resources (e.g., funding). Participants also completed a survey form recording for example their ethnicity, intimate relationship commitments, and educational history (Appendix II).

Procedure

The study's procedures were approved by the human research review board of the data-collection institution. Participants were recruited via various methods, including a department-wide email sent by department staff, in-class announcements by ATS professors, and eventually a snowball method, whereby students who had taken part in the study informed other ATS students about the study. Interviews were conducted in a private room on campus, between October, 2007 and February, 2012. Interviews were audio-recorded with participant consent and

lasted 60 to 90 minutes, with an additional 30 minutes preceding the interview to review consent and demographic forms.

Consistent with the goal of qualitative research (Creswell, 1994; Morrow & Smith, 2000), participants answered open-ended questions about what they viewed as supports and challenges to their persistence in ATS (see Appendix I). Questions were open-ended to allow participants to describe their experiences in their own words, and also to allow the interviewer flexibility to explore themes that might not have been identified in previous research (Ritchie et al., 1997; Shah & Corley, 2006). At the same time, to ensure that all participants addressed key research questions, interviewers guided the discussion into the specific topics (e.g., interest and persistence in science) that were the focus of the study (Shah & Corley, 2006).

Each interview began with a grand tour question (Fetterman, 1989): "What are the events in your life that led you to where you are now in your education and on your career path?" This question was designed to gain a broad perspective on the factors impacting persistence in ATS. Later, more specific questions explored supportive and challenging factors that may have steered the interviewee toward or away from her ATS education and career. Follow-up questions were based on participants' responses and encouraged elaboration on main ideas. At the conclusion of the interview, field notes indicating notable interview characteristics, including perceptions of rapport and interviewee engagement, possible interruptions, and other factors not captured by audio-recording were completed by the interviewer (Lincoln & Guba, 1985).

Data Analyses

Data analyses followed the process and rules of grounded theory (Strauss & Corbin, 1998). Using this approach, theory is generated through a series of steps involving, (1) data collection and coding of data into concepts; (2) categorization of concepts into increasingly

comprehensive aggregates of categories, or constructs; (3) description of categories based on their properties and dimensions; and (4) the articulation of a theory in which the emergent constructs and their relationships are described.

An all-female team consisting of one graduate and three undergraduate psychology students was responsible for data coding and analysis. In order to foster researcher reflexivity, all research team members engaged in a discussion, and then wrote about their relationship with the phenomenon under investigation to make explicit to themselves personal frameworks that could affect interpretation of the data (Lincoln & Guba, 1985).

The interviews were coded in three phases. The initial phase consisted of open coding, a process by which transcripts were reviewed line by line and broken down into small, discrete parts (e.g., phrases or groups of sentences) referred to as concepts (Strauss & Corbin, 1998). Each transcript was independently coded by each research assistant, and disagreements were resolved by consensus.

The second phase of analysis involved axial coding, in which concepts from the first phase were placed in higher order categories. Grounded theory methodology relies on a constant comparative approach. This was achieved by conducting the first two phases of analysis for each consecutive interview prior to reviewing the next. In doing so, all higher order categories were accumulated and applied to subsequent interviews for inclusion and comparison. All novel categories were added to the coding structure for all interviews until no new categories emerged, indicating that saturation had been reached.

The final phase of analysis was selective coding. This level of coding is intended to synthesize and integrate the codes yielded during phase two. During this phase, all higher order categories were placed into larger thematic groupings based on shared qualities. This was done

independently by each research team member, with a final coding structure developed by consensus. Finally, the author generated a model of the relationships between codes to be representative of the sample's experiences. An outside auditor provided feedback on the model for maximum parsimony and accessibility to a general audience.

Trustworthiness

Several steps were taken to ensure quality of the data analysis process. First, the analysis involved investigator triangulation, whereby, (1) all phases of coding were completed independently by multiple researchers, (2) all codes were created, augmented, and restructured by consensus during team meetings in which all coding decisions were evaluated and defended with direct reference to the interview data, and (3) reviews of coding categories took place periodically by an outside auditor not otherwise involved in data analysis (Brantlinger, Jimenez, Klingner, Pugach, & Richardson, 2005; Creswell, 1998; Lincoln & Guba, 1985). Trustworthiness was also established by creating a detailed audit trail, documenting decisions made throughout the research process (Lincoln & Guba, 1985). This documentation was revisited throughout the analysis process to aid in interpretation of the data. Finally, researcher reflexivity was established through discussion of the backgrounds and potential biases of all coding team members (Brantlinger et al., 2005; Lincoln & Guba, 1985).

CHAPTER III: Findings

Five interrelated themes about what influences women's persistence in ATS graduate education and careers (see Figure 1) were generated through the analyses. Each theme encompassed positive and negative influences on persistence in the field: (1) academic self-confidence and academic self-doubt (e.g., self-efficacious beliefs about academic capabilities, work ethic, and outcomes as well as feelings of insecurity about academic competence and about one's ability to reach their educational goals); (2) educational engagement and educational detachment (e.g., enthusiasm for, and commitment to science and academics as well as indifference and disengagement from science and academics); (3) supportive and undermining personal relationships (e.g., parents, intimate partners, and friends who are emotionally and/or practically supportive of women's educational and career goals as well as parents, intimate partners, and friends who are emotionally and/or practically undermining of women's educational and career goals); (4) motivating and discouraging professional relationships (e.g., mentors, role models, and peers who are emotionally and/or practically motivating in regards to women's educational and career goals as well as mentors, role models, and peers who are emotionally and/or practically discouraging of women's educational and career goals); and (5) supportive and undermining ATS academic/professional systems, expectations, and practices (e.g., graduate departments and careers allowing for congruence between women's personal and professional goals as well as careers perceived as causing conflict between women's personal and professional goals). Consistent with Duberley and Cohen's (2009) approach to investigating women scientists' perceptions of career capital in academic science, each of the main five themes was also examined through a 'gendered lens', that is, in terms of their meanings, sources, and implications for women in a science career given that science is assumed to be a male

domain. A gendered perspective offers critical insights into women's persistence in science by recognizing the impact of structural constraints and emphasizing the context specific nature of persistence influences.

All themes were constructed from textual segments of interest as they pertained to the present study's research questions. In total, 187 unique codes were generated, with 4,055 coded segments of text across all 25 transcripts. Each transcript contained between 57 and 100 unique codes. Because codes were applied more than once per transcript, individual transcripts included between 107 and 295 codes. Oftentimes, textual segments were assigned multiple codes.

Academic Self-Confidence and Academic Self-Doubt

All women in this study discussed the positive impact of their academic self-confidence on their persistence in science. Academic self-confidence to them meant believing in their academic competence and their abilities to reach educational goals. When academic self-confidence was threatened, many women reported experiencing academic self-doubt. In other words, they questioned their educational capabilities. A gendered lens is important in making sense of women's academic self-confidence and academic self-doubt. A gendered lens involves recognizing the pervasive social message that women are inferior in the scientific domain (Hill, Corbett, & St. Rose, 2010). A gendered lens allows one to interpret women's experiences of academic self-doubt not as individual neurotic liabilities, but as normal reactions to an invalidating environment.

Academic self-confidence. Many women described their academic self-confidence as rooted in experiences of academic success. For example, women often attributed their educational achievements to always having been "a good student" or being skilled in math and science. For these women, the confidence to continue on their educational path was reinforced

by experiences of recognition for their accomplishments. For example, a woman described deriving confidence from excelling under difficult circumstances while in graduate school:

> I feel like I did pretty well [in a challenging course] even though I didn't have . . . the same background as other people. That made me really happy. . . . I [also placed in a scientific] competition and thought, "Yeah, I do have some talent here."

The relationship between academic self-confidence and achievement was described as one of mutual reinforcement. Women reported that believing in their academic competence allowed them to achieve. As one woman noted, "Academically, I feel very secure. I feel I'm really good at academics. I'm really good at taking tests. I'm really good at doing homework. I'm good at getting a good grade in class." Academic self-confidence, however, encompassed more than belief in one's abilities. It was also characterized by beliefs about the power of effort in reaching one's goals. "If I get a bad grade, I know I put in everything I had," said one woman. As another woman put it, keeping a positive outlook – regardless of outcome – was crucial to her academic success:

> I think I have good confidence. . . . I believe in myself, that when I work hard and I *believe* I work hard and that I did my best at something, when I turn something in like a homework assignment, [I know] I did my best and that's it. That's all I can do, you know? I don't [assume] I'm going to fail at things or what not. I like being optimistic.

Also important to women's persistence in science was that academic self-confidence allowed these women to envision a bright future. As one woman reported, confidence in her academic capabilities motivated her to pursue graduate school. She reflected on her thought process in this way: "I know I'm smart enough for this [graduate school], so I might as well, like, push myself that hard." As another woman noted, "I don't think I have any issues with believing in myself or believing in my success as a student or even just as an individual in general. . . . I know I will go far and I know that this passion of mine . . . will lead me to something great."

Academic self-doubt. Though women in this study reported feeling mostly confident, they also reported self-doubt about their academic capabilities. Academic self-doubt to them meant feeling insecure about their academic aptitude or their abilities to reach their educational and career goals. As one woman explained, "Just overcoming my own fears with my own inadequacies . . . just pushing through even though I feel like maybe I'm not good enough has been the biggest challenge." Another woman said that, although she was surrounded by supportive people, deciding whether or not to pursue graduate school required overcoming academic self-doubt: "It was probably *me* that was the biggest [challenge]. Having to convince myself that this [graduate school] was something I could do and should do."

Many times, feelings of academic insecurity were recognized by the women as baseless in light of their achievements. One woman explained, "I sometimes feel dumber than a lot of people, even though I'm not dumb." As another woman put it, "My own, self-confidence in what I do [is a challenge]. . . . I've gotten good grades and I have no reason to have self-worry that I don't know what I'm doing, but sometimes I do."

For the women in this study, academic self-doubt was described as posing a threat to their persistence in science, particularly during times of transition. For example, in the transition from undergraduate to graduate school, a woman explained that the biggest challenge in her decision to continue on was "mostly [her] own qualms." As she explained, "I just wasn't sure I was good enough." Self-doubt could also be a factor in the decision not to pursue a doctorate after the Masters degree, as this woman explained: "I plan to get a Masters, probably not a doctorate, but maybe if I'm feeling really smart, but probably not." Another woman put it this way: "Maybe that's one of my challenges, why I won't get a Ph.D., is because I don't think I can pass the prelim because I can't think real well on my toes."

For some women, feelings of inadequacy came at the beginning of graduate school with the pressure to perform well academically. As one woman explained, "When I first got here, I kinda felt dumb, but I think grad school makes everybody feel dumb." Academic insecurity could be triggered by pressure to meet professors' expectations. One woman said, "[There's] a lot of pressure to be like 'Okay, [professors] are expecting us to be, like, the top students.' And it's like, I don't think I'm that at all." Another woman experienced self-doubt when evaluating herself against other graduate students: "I think I just have a problem with comparing myself to others, trying to feel like I need to measure up to what, what they're doing [academically]. Yeah. It's hard for me to just be okay with what I do."

Some women explained that such worries lessened with experience. For one woman, progressing in the graduate program alleviated her negative feelings about her academic skills. As she put it, "No real experience with research . . . makes you feel pretty dumb for a while there until you really get into it." Another woman who described herself as "self-conscious of how [she was] doing academically," explained that such feelings were "more of an issue during undergrad." She went on:

> . . . just gaining some more confidence as I went through more schooling and just kind of realizing, like, "I am a really successful person. I'm doing really well," and I shouldn't be self-conscious of myself at all.

For other women, academic self-doubt was described as a constant struggle, ever-present even as graduate school progresses:

> Every time I talk to another student in my department, we all say the same thing. Ever since we started grad school we feel more and more stupid. . . . So it's hard to remind yourself sometimes that there must be some reason, like somebody must have thought you were intelligent to, like, A.) Accept you into grad school, offer to pay you, and then, B.) Keep you around. But there are definitely days where I'm just waiting for my advisor to kick me out because I'm too stupid to be here.

> I feel like I spend a lot of time thinking I'm not very smart, and I'm not smart enough to do this, and I never felt that way until now [graduate school]. . . . I think a big barrier I have is just like, feeling inadequate and not smart enough. . . . It's just the level of, like, "Do I have what it takes to finish this [the Ph.D.]?"

Finally, academic self-doubt was in some cases reason for considering leaving the field altogether. For example, when asked to describe her biggest educational challenge, a woman responded, "Feeling dumb." She went on:

> Unless you're keeping yourself in check, those feelings can develop into, "I'm worthless. I'm too dumb for this." . . . There has been a couple points where . . . quitting was really appealing just so I could, you know, go take an easy job and feel smart everyday.

The gendered context of women's feelings and experiences of academic self-confidence and academic self-doubt. A gendered lens provides critical insights into women's feelings of academic self-confidence and academic self-doubt. Messages about women's inferiority in science are pervasive in the U.S. Research has demonstrated that these messages affect self-confidence, performance, and persistence even when they are dismissed (Steele & Ambady, 2006). Although the majority of women in this study rejected the notion that women are less competent than men in science, a few endorsed it: "Sometimes we'll get homework assignments that are literally over my head. . . . So, that's when, like a lot of the boys come in, and they're, like I guess smarter. And so then they help me."

Many women explained that their sense of self-confidence was not threatened due to being a woman in science. As one woman stated, "I never felt discouraged because I was a woman. I never felt like I couldn't do it." At the same time, women seemed to be aware of the negative stereotypes: "I don't think people expect pretty girls to be smart still." Despite acknowledging that women are at a disadvantage in the scientific realm, another woman

explained that she did not feel hindered by being a minority in her field. Her self-confidence remained unshaken:

> I've always been told that it's a male-dominated field, and so, you've gotta fight harder as a woman to make it in this type of field. I don't necessarily think that will deter you from getting where you wanna go, but, I mean it is male-dominated. But I mean, like all the guys in my classes, like yeah they're smart, but I mean, I think I'm smart too.

Other women reported feeling motivated by being a minority in science. Supported in their persistence by their academic self-confidence, these women perceived their minority position as an opportunity to "prove" that women can succeed in science. As one woman put it:

> [Being a woman in science] has made me a little bit more motivated, maybe, to prove myself, just since I realized kind of early on, like I was probably gonna be in a science field and that tended to be more dominated by men. I kind of always just wanted to show that I was equally able to do that.

Educational Engagement and Educational Detachment

Engagement with science and academics was reported as critical to sustaining persistence in science. Educational engagement to the women in this study meant feeling enthusiastic and committed to their educational and career pursuits. When educational engagement was weak, women described a feeling of detachment from their pursuits. In other words, women reported feelings of indifference and disengagement from science and academics. A gendered lens is important in making sense of women's educational engagement and educational detachment. A gendered lens involves recognizing that women's interest in science is often treated as unconventional or inappropriate (Hill, Corbett, & St. Rose, 2010). A gendered lens allows one to interpret what might appear as women's inconsistent commitment to science and academics not as individual inadequate motivation, but rather as an understandable response to pervasive social messages of discouragement.

Educational engagement. Many women explained that their strong commitment to educational and career pursuits grew out of a passion for science. As one woman noted, "It's just the science that got my interest and I kind of stuck with it." This commitment to science lent itself to a general enjoyment of academic and career-related experiences, as one woman described: "I really enjoy what I'm doing. . . . I could spend the next 40 years just jumping from, you know, energy to research to teaching." Other women explained that positive experiences with scientific coursework or hands-on research fueled their dedication to the discipline:

> My first year, [I took part in] these special sessions in the evenings for students who are interested in doing a little bit more than what we were doing in class. . . . being challenged and enjoying yourself and learning. [The experience] helped me to realize, "Yeah, this is something that I wanna stick with."
>
> I would finish a class and be like, "Yes, this is definitely the field I want to be in." . . . and then I'd go to conferences and I'd get that exact same feeling.
>
> [Being a research assistant], I get to do multiple different things. And, it keeps me busy and . . . *invested* in what I'm doing.

Several women explained that their persistence in science was supported not only by their dedication to science, but also by their enjoyment of learning. As one woman explained, "That's what kinda keeps me going, is learning new things." When asked what factors might influence her decision to pursue her Ph.D. after the Masters, another woman responded:

> A lot of my friends are like, "I'm never gonna take classes again. I'm so done with school," but I don't really feel that way. I like learning and I like the learning environment. . . . I feel like I could do it [the Ph.D.].

One doctoral candidate explained that the "main thing" keeping her on the Ph.D. track was a "desire to keep learning."

Beyond enjoyment of science and learning, several women explained that their continued dedication to ATS stemmed from its applied nature as well as an awareness of the field's importance. As one woman explained, "I have this deep-seated desire to make some kind of

difference in the world. . . . I think it all started from there." Another woman attributed her educational engagement to the potential for the field of ATS to "have a real impact," which distinguished it from her other academic interests. Believing in the relevance of science supported this woman's persistence as well: "If I'd gotten into a different area of research . . . I might have stopped after the Masters degree, but . . . it's something I think is important, so I like doing it a lot."

Educational detachment. Many women in this sample talked about going through periods of detachment and disengagement from science and academics. At these times, they questioned the value of continuing on in the discipline. When asked about the greatest obstacles along their educational path, several women responded as this woman did: "I think all along it's been motivation. That has been a big one. Keeping myself on track." One woman reported that external challenges to her persistence in science were rare, if not absent, but her continued engagement was her greatest challenge: "I don't know that there's really any outside challenges. . . . I mean, my own motivation and just trying to get stuff done . . . is one of the hardest things." At times, this lack of motivation arose despite the enjoyment of academics, as another woman explained: "Just staying motivated has been a little challenging. . . . I do enjoy the whole process of learning and education and classes, but . . . just staying with it."

Some women perceived themselves as having a lower academic ambition than other students. One woman described her lower academic drive in this way: "I don't necessarily feel like I'm as much of an academic as some of [my peers] . . . or quite as school-minded." Another woman explained how her feeling disconnected from science and academics contributed to her decision to not pursue the doctorate. According to her, "I just don't see myself getting [the doctorate]. I don't have that, like 'umph' to go all the way and . . . do another four years of

school." Time commitment was a consideration for several women. When asked what factors may influence her decision to continue on for the doctorate, another woman expressed concerns with motivation over time: "Do I really want to go through school for another, you know, three or four years? . . . If I'm losing motivation to keep going through school . . . that might affect my decision."

Disengagement from science and academics was sometimes attributed to a frustrating experience with the research process, as this woman explained:

> There have been a lot of times where I considered switching [careers]. . . . [I thought], "I'm tired of this project," and you wanna think, "I'm tired of this field.". . . . I've definitely joked about quitting grad school all together and doing something completely different.

Other women also reported having considered switching careers due to being "frustrated with science," but were drawn back due to interest in, or enjoyment of the research:

> I've considered [switching careers], but at the same time I think that might just be because I'm struggling [*laughs*]. . . . I haven't really ever gone further than [thinking about it]. I've decided that I like what I'm doing and I think I'm gonna stick on this path.

> My first year, I was doing . . . tedious and frustrating [work], and I thought, "If this is what my Masters work is going to be like, then I don't want to do this." . . . I didn't end up [switching fields] because my research was starting to get much more interesting.

Most often, women's explanations of their wavering engagement with science and academics centered on their inconsistent enjoyment of their work. As one woman put it, "I think the biggest challenge for me has just been, like trying to figure out if I'm really happy doing what I'm doing, or if there's something I would be happier doing."

The gendered context of women's feelings and experiences of educational engagement and educational detachment. A gendered lens is important in making sense of women's engagement and detachment from science and academics. In the U.S., women's

commitment to science is often treated as unconventional or inappropriate. As a woman explained, "I think people outside the field just in my life are really surprised to hear a woman is in atmospheric science, like it just sounds like something a woman wouldn't do." A gendered lens allows one to interpret women's alternating engagement and disengagement not as individual poor motivation, but as normal reactions to an invalidating environment.

As one woman explained, cultural notions of 'gender-appropriate' careers may have led to her brief stint away from science as an undergrad:

> I've always been really good at math and science, which is why I've ended up, I think, in this field. But when I went into high school and the beginning of college, I actually thought about trying to do something more humanities-based or [in the arts] even. . . . Kinda going away from and coming back to the science could have been, kinda subconsciously . . . something to do with the whole culture, you know, that women shouldn't be scientists or can't do math.

Awareness of the negative stereotypes about women in science was reported by the majority of women in this study. One woman talked about her family's views of her educational and career choices in this way:

> I definitely had that from [one] side of my family . . . a view that science is more of a male's career path. And it's like, you should, like teach or something. . . . It's never been to the point where I've felt, like guilty about it or like I can't do it, you know? I've never felt like they didn't support me. It was just, like I know deep down they're like, "What is she doing?"

As noted by other researchers (Steele & Ambady, 2006), an invalidating environment does not need to be acknowledged to exert its influence. Perhaps not surprisingly then, the majority of women in this study tended to assume that their wavering commitment to science was not influenced by negative social views about women in science. For example, one woman explained her disregard for gendered stereotypes in this way:

> I've never really thought much of other people's opinions [about women in science]. I mean, that's just what they are: they're opinions. I mean if I listened to everything that anybody ever told me . . . I wouldn't have been a scientist.

In fact, for many of the women, negative views of women's engagement in science were experienced as a motivating. For example, when a woman's family questioned her decision to pursue a career in ATS, she said: "[Their doubts] gave me motivation to pursue it and keep going. To say, 'I can do this. It's fine for a woman to do this'." Similarly, a significant proportion of women expressed pride in their identity as women in science, which gave them motivation to achieve: "[Being a woman in science] has been a motivating factor because it's exciting to be a pioneer in the field." Another woman described herself as driven to demonstrate women's capabilities in science:

> [Being a woman in science] has made me more driven to actually want to do what I'm doing because there is a lack of women in the field. So it's kinda like an obstacle that you're trying to get over because there are so limited amounts, and you can show that you have done this and you are getting to where you need to be.

Many women expressed that they felt supported in their commitment to science by local and national programs for women in science. One woman explained that, "[The] four-year summer internship . . . for students from underrepresented groups . . . probably got [her where she is] today." As another woman explained:

> Sometimes I go to meetings or conferences now, and I think, "There's not any women here," but I think of that as a plus, because I think that in some ways being a woman gives you an advantage at the moment in our field, because people are noticing that it's a problem, and they're, like, "We need these women here."

Supportive and Undermining Personal Relationships

Personal relationships were reported by the women in this study as critical to their persistence in science. Personal relationships in this study were defined as relationships with parents, intimate partners, and friends. The women in this study described the positive difference it made for them when parents, intimate partners, and friends nurtured their interest in, and commitment to educational and career pursuits. By contrast, parents, intimate partners, and

friends undermined women's persistence in science when they placed emotional and practical demands on women that interfered with their educational and career pursuits. A gendered lens is important in making sense of women's persistence-related experiences within their personal relationships. A gendered lens involves recognizing the pressures placed on women, for example, to prioritize partners' careers and take upon themselves the bulk of family responsibilities. As noted by Barnett and Hyde (2001), despite dramatic changes in the work and family roles of women and men in recent decades, outdated notions of the relationships between gender, work, and family persist. A gendered lens allows one to interpret women's "agonizing" over family issues and often sacrificing professional goals to give space to family pursuits as a logical response to pervasive social pressures on women to give family priority over professional goals and commitments.

Emotionally and practically supportive personal relationships. The women in this study emphasized how supportive personal relationships nourished their persistence in science. Specifically, emotional encouragement and practical assistance were named as what sustained them along their educational path.

Emotionally supportive parents. Many women reported that their parents nurtured their interest and involvement in science and academics. Parents were described as encouraging their educational achievements, supporting their choice of a scientific career, and being there during times of struggle. As one woman described, her persistence in science was supported by her parents' sense of delight in her achievements: "[My parents] being proud of me has always encouraged me to keep going." Another woman was encouraged by the supportive relationship she has had with her father:

> My dad has always been my cheerleader. . . . You know, helping me figure out what I wanted to do and being really supportive of my path and always telling me that he was proud of me.

Another common theme across women's narratives was that parental encouragement of their career pursuits was unconditional. They said that their parents just wanted them to be happy. When asked what helped them to get to where they were, two women responded:

> Definitely my parent's support because they never really pushed me to do anything I didn't want to do. They knew that I liked the weather and . . . they just want me to be happy and have a job or a career that I like.

> My parents, they're always like, "You should, you should do what you want to do, like if this is something that you're interested in, no matter what anyone else says you should try your hardest to get through it."

A strong positive parental bond was also reported as supporting women's persistence in science, particularly during times of struggle. In the face of educational challenges, parents were commonly described as being women's primary source of solace. As many women described, even though their parents may not fully understand their lives, they often provided a sense of connection and caring communication that was key to their persistence in science:

> I'll call my mom [to say], "I need words of encouragement." . . . It's just nice to hear . . . especially from someone that knows you really well, you know, you always need that little like push . . . when you're falling, to get you back up on your feet.

Practically supportive parents. In addition to emotional support, parents also provided practical support in the form of science-related educational opportunities during formative years as well as financial assistance during the college years. Parents were often described as nurturing their interest and involvement in science by providing them with ways to engage their interests from an early age. For example, a woman described a combination of unconditional support and educational opportunities provided by her parents, which led her to where she is today:

> I always had an interest in science growing up and my parents encouraged that. . . . [They] let me choose classes . . . related to the sciences, and let me choose to go into chemistry in my undergrad, which kind of all just built up [to] . . . studying atmospheric science. . . . [Growing up], my parents got me a kitchen chemistry set . . . and just doing all those things . . . just sparked that interest and I just kind of continued studying that.

Emotionally supportive intimate partners and friends. Emotional support provided by intimate partners and friends was also reported as important to sustaining persistence. The women in this study described reaching out to close relationships for encouragement, to process roadblocks, or simply to take their mind off obstacles. Sometimes, as one woman described, talking out issues with loved ones helped in overcoming obstacles:

> Definitely talking to friends and my fiancé and my family [helps in coping with setbacks]. . . . I can't deal with [most of the challenges] on my own. I need to talk to other people—get support, advice and everything to be able to deal with them.

Making time for personal relationships was reported as key to persistence in science for the women in this study. Investing in partner and friend relationships often provided an outlet which allowed many women to feel rejuvenated and to be more academically productive. As one woman noted, "I think when you get away, you can do a better job." Other women put it this way:

> I think it's really actually helped to be able to have a balance and not get stressed about school or work and be able to . . . relax and have fun and then come back and be ready to be more productive.

> I do a lot better at [academic] things when I spend time outside here and I hike and I socialize with people. It makes going to work not so difficult. It makes me less miserable. So, I'd say it gives me a good balance.

Several women spoke of feeling like more of a "complete person" as a result of making time for personal relationships and outside activities. Striking such a balance, as one women noted, may sustain persistence in science by preventing "burnout." Having opportunities to recharge with friends and partners was emphasized as key to persistence, though the clear message was that

personal relationships must be flexible, and thereby compatible with, women's educational and career responsibilities.

Practically supportive intimate partners. Intimate partners were also reported to support persistence through their being considerate of women's graduate school time demands. One woman explained that her partner was accommodating of her graduate school schedule:

> [My partner] is supportive of me . . . very understanding, like if I stay at school 'til seven o'clock . . . [My partner's] knows, like I had a homework assignment that I couldn't finish, or knows, "Oh my gosh, you have a test tomorrow, I'll leave you alone all night. You can study all night."

As another woman described, the support she received from her partner facilitated her thesis-writing process: "He understands my work habits. He understands the classes I'm going through. During my thesis writing, he did everything around the house for a solid three months so I could just write."

Flexibility to relocate (or temporarily be apart) during the graduate school years was also viewed by many women as a most meaningful support from their intimate partners. One woman explained that, although her partner did not move with her to graduate school, the fact that he was okay with a long-distance relationship freed her to pursue her ATS studies:

> We decided to do a long-distance relationship in favor of . . . what's going to be best for our education and what's best for our careers, and we know we can work it out. I think it's pretty much been positive, [with him] providing the support to lead me into this direction.

Also important to women's persistence in science was anticipated practical assistance from partners, especially when it came to relocating for a future career and planning out future childcare arrangements. As one woman explained, "[My partner is] very supportive of me and my career and is willing to, if I have to move for my career, to move." Another woman's partner has expressed a willingness to assume primary caregiving responsibilities down the road: "My

boyfriend always said if I'm making more money, then he wouldn't mind staying home [with the children]."

Emotionally and practically undermining personal relationships. Several women in this study experienced partners and friends as interfering with their educational commitments. This interference took the form of both emotional and practical demands.

Emotionally undermining intimate partners and friends. The majority of women in this study described situations in which their intimate partners and friends did not understand nor support their prioritization of educational and career responsibilities. For these reasons, several women reported conflict with, and alienation from, partners and friends. As one woman recalled, "I felt like I . . . lost touch with a lot of my non-academic friends when I was writing my Masters, because they just didn't understand." As another woman put it, "I think sometimes relationships have ended for me because I've said, 'This is my career. This is what I'm going for.' And as much as I'm willing to compromise, this is important to me."

Many women reported that the demanding work atmosphere of graduate school could lead partners and friends to feel ignored. According to them, difficulties in meeting the time expectations of partners and friends could have a negative impact on their persistence by creating tension between their personal and professional needs. As one woman described:

> [My partner's] good about keeping regular hours . . . and I'm kind of not [*laughs*]. . . . I think we're still trying to kinda find that balance between, like work and school and home life and . . . he kinda has the expectation that I'll be home for dinner every night and sometimes it's been hard to just turn off what I'm doing here and go home. . . . I guess the [challenge] would be making time for each other.

Many women described having to make difficult choices as a result of friends' demands. For example, as one woman stated, "I don't want to choose work or social life over each other but they, they do conflict, in my case."

According to the women in this study, maintaining a focus in their educational and career-related pursuits helped them to keep a positive outlook when facing pressure from personal relationships to take time away from their studies. As one woman described, giving priority to educational commitments over others' demands was made easier by focusing on her ultimate career goals:

> My friends have always expected me to, to go out more, but I always reassured myself with the idea that I had a greater goal. . . . *My* expectations for myself were greater . . . I think it worked out. I mean, I'm happy with my life.

Practically undermining intimate partners. Many women in this study reported that their partners' professional needs, in many situations, would be a challenge to their persistence in science. A big issue was dual-career concerns, particularly with regard to the choice of geographic location. The women in this study explained that partners made it difficult for them to make a decision about graduate school. One woman, whose partner accompanied her to graduate school, explained:

> You just kind of have to make a decision based on what's gonna work best and that doesn't always work for both people in a relationship. . . . [My partner] came here and I think he started to resent the fact that he didn't have much choice in the matter. That caused some problems.

Another woman said that her partner expected her to prioritize her relationship over her career: "We decided that if I got into a local school and I didn't go, we were gonna break up, 'cause then I wasn't putting my relationship first. I was putting my career first."

In some cases, geographic distance from their partners was reported by respondents as interfering with their educational pursuits. One woman considered herself "lucky [she doesn't] want a Ph.D." for fear that it would end her relationship. She explained, "We'd be apart for four or five years, long distance, and I don't know if either of us would want to do that." For other

women, partners were reported to hinder their educational pursuits by pressuring them to either relocate or to settle in the present location. One woman, whose partner left his former job in order for her to attend graduate school, expressed that he did not want to move again after finding a new job and enjoying the location:

> [My partner] just loves [his job]. And he keeps saying, you know, "You can do whatever you want with your career, as long as it stays in [this location]." . . . He says that a lot. He's like, "I am not leaving this job again, not for a while."

Another woman, whose partner accompanied her to graduate school, described feeling rushed in her academic work because her partner wanted to move: "[My partner] definitely doesn't want to stay [in this location], so [there was] pressure to, you know, not take forever when I'm trying to finish my degree because he's moved here for me. That was definitely [a] challenge."

Finally, some women explained the possibility of leaving graduate school altogether due to their partners' professional needs. In some cases, these practical demands impacted whether or not they would pursue a doctorate. As these women explained:

> I'm honestly facing the biggest problem when [my partner's] going to graduate. I don't know if I gotta move or not. . . . Work's never really affected my relationship. It's more that my relationship affects my work because of that location flexibility.

> [My partner] was unemployed for a little while and . . . if he couldn't find a job by the time I was done with my Masters then we probably would need to move . . . so that he could find a job somewhere else. I would maybe have to put my education on hold so that he could find something to do.

The gendered context of women's experiences in professionally supportive and undermining personal relationships. A gendered lens provides critical insights into women's experiences in their personal relationships in relation to their educational and career pursuits. Many women reported conversations with loved ones who encouraged them to prioritize family

over career. For example, one woman expressed some uncertainty about her professional future in light of such pressures from her mother:

> [My mother] talks about, "Oh, and then we'll make jams and . . . we'll be able to redo your whole house. . . . We'll make the curtains from scratch." . . . I don't know what her visions for my career are like at all. . . . I think she expects me definitely to put the family first, but . . . when it comes down the line, I really don't know how it's going to work out.

At times, the women in this study endorsed gendered expectations placed on women to prioritize their partners' careers. As one woman noted, her partners' needs came first:

> Well, we've already decided that his career is gonna come first, not because of traditional gender roles, but just that I'm very happy doing a whole [lot of] different things, like I would love to go into education. I'd love to do consulting or stay for a Ph.D. My options are fairly broad, whereas, he's really happy doing the one thing he's doing now.

Though this woman explicitly rejected the notion that giving his career priority was influenced by dominant gender ideologies, it is difficult to know for certain, given pervasive social messages about what society values in women.

Other women expressed a desire for a partner who is willing to disregard gender ideologies about women's and men's "roles" and who is open to pursuing alternative home and childcare arrangements. As one woman described, "[My partner and I] have talked about him staying home more or, you know, we kind of share the caregiving side of it." Another woman described her ideal partner in this way:

> [I hope to find] someone who doesn't need you to be the 'female' in the relationship and like, the traditional role of the mother and staying home and the housekeeper. . . . Someone who's willing to have an alternative . . . way of viewing a household and how things run.

As another woman described, she and her partner both came from "very traditional" families, which impacted his outlook on work and family obligations. She explained:

> The idea for him, of like, staying home with kids, was not – I could tell – pleasing at all. It was certainly not something that he'd ever really thought about doing, um, for permanent. Like, I'm sure he thought about helping out, but . . . there will be some challenges, I think from him, when it comes to my career.

Partner relationship dynamics were also described as being impacted by gendered notions about careers and intellectual capabilities. For example, a few women reported feeling unattractive to potential male partners for being smart and career-oriented. For some, this was based on experience. As one woman recalled:

> I had a . . . serious boyfriend. . . . It didn't permeate our whole relationship but it always is like, he is the 'smart one', he is the one that's going to succeed at [science] . . . that he was superior intellectually and I think he needed to be that way in pretty much all of his relationships. And, I think, it was awkward for both of us . . . to start seeing me as a potential equal. Not necessarily, like, an *equal*, but that I had that capability. . . . That definitely had a huge factor in the end of our relationship.

Another woman speculated about the sense of intimidation a male partner might feel being in a relationship with an educated and financially successful woman. According to her:

> It's almost like a "you're too good for me" kind of thing. . . . I think men are intimidated by the smart woman who makes more money than they do. . . . And I feel like, the women . . . just don't care, you know? . . . "I've got degrees and I make more money, but I love *you,* so what's the problem?"

Motivating and Discouraging Professional Relationships

All of the women in this study emphasized the critical role of their professional relationships in sustaining their persistence in science. Professional relationships in this study included mentors, role models, and peers. Motivating professional relationships supported women's persistence through professional guidance and encouraging interactions. Undermining professional relationships challenged women's persistence when they included neglect or discouragement. A gendered lens is important in making sense of women's persistence-related experiences within their professional relationships. First, a gendered lens involves recognizing

the importance of female mentors, role models, and peers in sustaining women's persistence in science through their ability to offer distinct forms of personal and professional advice and encouragement, specifically regarding women's experiences in science (e.g., workplace gender politics, work-family commitment conflict). Much research has documented that women in science often report feeling excluded from influential social networks, highlighting the important role of positive mentors for women's educational and career advancement (Duberley & Cohen, 2009). Second, consistent with research on women's challenges in ATS (Larocque, 1995), a gendered lens allows one to acknowledge the negative impact of gender discrimination on women's persistence in science.

Emotionally and practically motivating professional relationships. Women in this study reported that their persistence in science was supported by their professional relationships. Specifically, women described deriving motivation from the emotional encouragement as well as the practical assistance they received from key professional relationships.

Emotionally motivating mentors and role models. Emotionally motivating mentors and role models were most often graduate advisors, teachers and professors, as well as internship-related ATS field workers and research scientists. Although for the women in this study mentors were largely male, female models and mentors were perceived by some women as critical to sustaining their motivation, confidence, and engagement.

Most often, women described deriving motivation from their mentors' own motivation or enthusiasm for the field. For example, one woman described choosing a career path based on motivating interactions with her graduate advisor and mentor:

> He's kind of the person that sparked my interest in becoming a professor because I could tell he really loved his job and he was really passionate about it. I just thought that that was really great that you could have a job that you love so much.

In other cases, women were motivated by the efforts of mentors pushing them to achieve. One woman described an influential professor who encouraged her along her educational path:

> He's an inspiration. He saw my capabilities long before, years before even I did. And he was like, "You just need to believe in yourself." . . . He'd constantly push me to do better . . . I think he really wanted to see me succeed.

Practically motivating mentors and role models. Mentorship in the form of practical assistance was reported as critical to persistence during both undergraduate and graduate-level science education. For example, the women in this study reported that professional guidance by undergraduate and graduate mentors in the research realm allowed them to experience a diversity of educational and career-related options. As one woman explained:

> Nobody in my family had ever gotten a degree, Masters or Ph.D., so I didn't know what to expect. . . . Just having a mentor who could show me what research was like and guide me but give me a little bit of freedom to do what I was interested in . . . just encouraged me to go on and study more.

A key time period for mentorship was during the year or two preceding graduate school. For most women in this study, undergraduate advisors and professors provided professional guidance in the form of resources and information critical to the transition to graduate school. For example, mentors informed women of the necessary steps to take (e.g., research involvement) in order to get into graduate school, provided opportunities for professional development, or facilitated the process of applying:

> [My undergraduate mentors] were definitely helpful because I wouldn't necessarily know how to go about getting into the field on my own otherwise. . . . Them just showing me the way, like how you start to do research or write papers, or help you get in contact with people.

> Definitely just providing information, like where I can look, what're my possibilities if I'm interested in this field, and where the good schools are. It's something that's hard to find on the internet or through other resources. It's good to talk to someone who knows and I was pretty fortunate to have that advisor to help me out.

At the graduate level, a common theme was the importance of the graduate advisor relationship. Graduate advisors were often considered to be role models in both academic and personal domains. Especially important to persistence were three dynamics of the advisor-advisee relationship: availability, ability to relate, and adaptability. Advisors' availability to meet with students and provide guidance was a key aspect of the advising relationship. Several women expressed an appreciation for advisors' "open-door policy" and dependable presence.

Women also stressed the importance of being able to relate to their advisors. This connection occurred when women felt both understood and supported in their educational and career pursuits, as one woman described:

> [My graduate advisor and I] definitely had that student-professor relationship where they could provide me with the advice, education, knowledge, everything that I needed, but it also kind of became . . . very comfortable, so it made it a lot easier to ask any kind of question related to almost anything, you know, school-wise or [if I] just need help with this life issue, which was good.

Many women also expressed that it was important for their advising relationship to be adaptable, or flexible over time. A flexible working relationship was reported as supportive of evolving needs. As one woman explained:

> [My advisor] is definitely really encouraging and supportive . . . leading me in the right direction. But it's very independent now . . . It's kind of like when I'm stuck in my process or I need some direction, and input of, "What am I doing wrong? What direction do I need to go in?" But it's not like, "I'm gonna watch you do this and just be constantly behind your back watching what you're doing or making sure you're on the right track," so a lot of independence, which is nice.

All three features of the advising style clearly impacted women's experiences in graduate school. One woman, who reported a "50% chance" of pursuing her doctorate, cited her advisor relationship as critical to her continuing through a doctorate. As she explained, "[My

advisor and I] seem to get along really well, but if it ends up being just not a good fit, I probably wouldn't want to keep going."

Finally, some women reported feeling optimistic about their ATS career thanks to a network of mentors who they thought would support their career. One woman derived motivation from receiving a "nice fellowship." She recalled, "That helped because, A.) It was someone saying, 'Hey, we really believe in you', and B.) They introduce you to all sorts of people . . . so you feel like maybe you can have a future." As another woman put it:

> I don't know how hard [finding a job's] gonna be, but even if it is such a challenge, I'm not gonna give up. . . . I've made great connections with [past mentors] and I'm sure I'll make great connections here at [my current graduate program] and I think the foundation I have of people and my experiences will kind of help me overcome that hump and find my job, hopefully, somewhere that I'll be happy.

Emotionally and practically motivating peers. Nearly every woman in this study emphasized the importance of having a supportive peer group during graduate school. As one woman put it, "[My peer group] is the reason I'm still in grad school . . . If I didn't get along with my department, and I just had . . . friends outside the department, I wouldn't be able to be here." Many women reported that emotional and practical forms of motivation by peers were linked. They explained that peers motivated each other in educational and career domains through emotional support during times of struggle as well as practical support in the form of advice and guidance. One woman described the unconditional emotional and practical support she received from her peers, which created a judgment-free environment to discuss both personal and professional matters:

> [My peers and I] can talk about our insecurities, but we can talk about science at the same time. Like, I have a coffee group. I meet with ten people once a week. And, although we sometimes talk about science, we talk about things science-related that aren't our own research, and so it's really good. And there are people I can talk to about computing problems. They're the people I cannot feel like I look stupid to. Like, I can ask them a

> dumb question, and I don't feel like it's a problem. So, it's really good to have them there.

Peers were perceived as a resource for emotional and practical motivation free from the pressure to impress. Another woman described the distinct form of support that peers are able to provide in this way:

> Your advisor, you can't always talk to openly about your insecurities or about, like feeling like a failure, so this is why this [peer relationship] is really good, because I can just walk into his office and be completely frank about how I actually feel about the situation and not having to . . . prove to you that I'm smart enough.

Emotionally and practically discouraging professional relationships. Professional relationships, according to many women in this study, were not always supportive of their persistence in science. At each educational level, from early educational experiences to the graduate program, some women reported a lack of guidance or support, which undermined their educational and career pursuits. Most often, women reported feeling discouraged by professors and advisors. Women also explained that they felt neglected or ignored in their professional relationships with advisors and peers.

Emotionally discouraging mentors and role models. A few women in this study described experiences of discouragement during early education. For example, one woman reported being told by a teacher that she was "stupid at a young age." In eighth grade, another woman "was told by a math teacher that [she] was basically retarded and that [she was] never gonna excel at math." More often, women described discouraging interactions with undergraduate advisors. One woman described her relationship in this way, "I wouldn't say he was helpful when it came to future career [guidance]. Even now, he kind of snubs me." Another woman, upon expressing an interest in science, was told by an undergraduate advisor that, ". . . even if [she] was admitted to the program, that [she] would never graduate." Active

discouragement also came, for one woman, during the transition from undergraduate to graduate school. As she recalled:

> He was a mentor, you know, he was one of my physics professors and he essentially recruited me to be a physics major and then toward the end, he was like, "Well, I don't know, if grad school is the place for you." And I was like, "Why would you put me in this position?"

Practically discouraging mentors and role models. At the graduate level, women reported difficulties in their advisor relationships. Though they typically did not include active discouragement, often the relationships were neglectful of women's needs. One woman described difficulties relating to her advisor as follows: "Trying to get my advisor to understand the person that I am and interact with me in that way is kind of a challenge." As another woman explained:

> One of my barriers is that I think that [my advisor], although he's an amazing guy, is not really good at advising someone like me. He's getting better. We're starting to have a better rapport, but he is used to . . . scientists who are, I feel, pretty confident about themselves and are very male in the way that they have a task and they work on that task, and they don't ponder outside of that task.

Emotionally and practically discouraging peers. Peer relationships were described as mostly supportive of persistence. According to the women in this study, it was primarily when peer relationships were weak or absent that they reported feeling discouraged. In one woman's case, feelings of isolation resulted from the separation that came from being in a slightly different program:

> When I first came [to graduate school] . . . I thought I would develop a closer relationship with everyone in my class, but there is kind of a distance now, because [of my specialization]. I kind of thought we'd develop a closer-knit friendship group with all the other first-year students, but that kind of just hasn't really happened.

Another woman felt disconnected due to arriving to the graduate program at the doctoral level:

> When you don't have to take a bunch of classes, you're not meeting the other graduate students. So, I feel somewhat a disconnect from them because I don't spend much time with them. . . . That definitely creates . . . a division there.

The gendered context of women's experiences in professionally motivating and discouraging professional relationships. Through a gendered lens, an important theme in women's narratives regarding the role of their professional networks was the importance of connecting with other women. Female role models have been identified in research studies as critical to women's persistence in science (Buck et al., 2008; Stout et al., 2011). To the women in this study, female mentors, role models, and peers provided a distinct form of support that positively impacted their persistence in science. The majority of the women in this study reported having had a female mentor or role model at some point along their educational path.

According to the women in this study, female mentors and models had a positive influence on their persistence in science, in some ways, due to the pure fact of being a female scientist. For example, one woman was inspired and motivated by her interactions with a female research scientist during an internship: "She's this very powerful woman and [that] encouraged me 'cause she's made all these awesome discoveries and she's a woman too." Another woman was encouraged by the success of a female professor in her field, particularly in light of the challenges she had faced: "If she can withstand all the politics and all the issues that come with being a professor and being the only one [woman], it's something that I can do as well."

In describing their mentor and role model relationships, the majority of women in this study reflected on the lack of women in the field, which made it difficult for them to find a female mentor. One woman, who reported having had no female mentors or role models in ATS, derived a sense of purpose in her own educational and career path by reflecting on women's underrepresentation in the field. As she explained, "I guess it would have been nice [to

have had a female mentor], but it makes me realize more that what I'm doing is important, because not a lot of other women do it."

Female mentors and role models were described as providing emotional support that was distinct from male mentorship. One woman put it this way, "I think that my advisor or some of the male professors that I've had don't really get it . . . the demands that, that a woman feels and has." Reflecting on her experiences of academic self-doubt, another woman expressed uncertainty about whether her male advisor could relate to her feelings of inadequacy:

> [I have] really low self-confidence when it comes to my intelligence . . . and I feel like there's especially a lot of really cocky men in our science who just, like, never acted like it was ever hard for them. . . . I don't know if [my advisor] ever thought that science was hard. . . . Because sometimes when you tell him things are hard, I don't know if he gets it. I really don't know if he understands feeling inadequate.

Female mentors were also described as offering distinct forms of practical support, including advice and guidance on the gender politics of male-dominated graduate departments and workplaces as well as career-related work-family issues. One woman reported that, to her, having female mentors and role models was "not essential," but in some cases, it could be such as "when you are outnumbered [as a woman]" or when "you can't push an idea through because you're a woman and they don't respect you as much." Similarly, another woman explained that her female mentor was helpful with "learning how to deal with the boy's club."

Female mentors were also described as being a critical resource when it came to advice about work-family issues, as these women explained:

> I try to ask other, like women faculty what they've done [when deciding to have children], and I feel like everyone has done something a little bit different, which means that there is flexibility out there.

> I'm getting closer to getting married and having babies. I need women role models in that sense. Like, "How did you do this?"

Other women recalled being encouraged in their persistence by female mentors who urged them to consider pursuing a doctorate, despite concerns about work and family commitment conflict:

> She's been pushing me from day one. It's, like, "Well, are you going on for your Ph.D.?" I was, like, "Nah," [and she responded] "You'd be really good at it. You, you should do it. . . . You should really consider it." . . . Just showing me that it is a possibility . . . 'cause I was like, "Oh, well, I want to have a family," [and she responded] "Well, you can do that. . . . You can make it happen."

> The only female [ATS] professor I've had . . . was influential because I went to talk to her one day about a homework problem and we ended up talking about what I wanted to do with my life and how I will fit kids in and how she managed that . . . and that made a big difference in my mind in thinking about whether I wanted to stay and get my Ph.D.

According to the women in this study, establishing connections to other female scientists could result from involvement with women in science-focused organizations and online networks, including the *Earth Science Women's Network* and *Women of Wind Energy*:

> It's actually really, a really good resource because, um, it's basically just women in sciences and they post about, like these problems that they have in science. I mean it's kind of encouraging 'cause you see all these women who are dealing with the same problems that I'll be dealing with someday.

Many women felt that these women's networks supported them emotionally by allowing them to reflect on common experiences of women in science. For example, one woman who described herself as having "really low self-confidence when it comes to [her] intelligence" felt encouraged by the knowledge that she was not alone: "It made me realize that a lot of women feel the same as I do about feeling inadequate in science, and it's . . . good to know that other people feel that way."

A majority of women in this study also mentioned the importance of having a female peer support network. One woman explained that, "It wasn't until I was in college and there were no women around that I started seeing that there is definitely, you know, something to

having another woman there to be a cheerleader, to be a support network." Another woman said that during graduate school, she had a mostly-male peer group, which was not ideal, but she preferred it over being alone:

> [My peers are] mostly guys, so it's mostly hanging out and doing what guys wanna do. And, sometimes I don't feel like it, but sometimes I'd rather, you know, hang out with them and do something not-so-fun than be by myself.

Also at the graduate level, discrimination by male peers was reported by a few women in this study:

> There's a couple of guys that . . . were used to being top dog, and they were used to not having women on their level. . . . I've never encountered that actually. That was a little tough. . . . I just, I stopped, I guess, interacting. [They would call my scientific work] "stupid." And, I'm not accustomed to being disrespected actually.

Referring to their graduate department, other women made statements to the effect of, "There are . . . chauvinistic people around."

Gender discrimination was also reported as occurring in professor and advisor relationships, primarily at the undergraduate level. For example, as one woman explained, "I had one professor who told me that I would learn differently than men would, and that women just didn't understand science as well."

Supportive and Undermining ATS Academic/Professional Systems, Expectations, and Practices

Finally, the women in this study emphasized the role that the systems, expectations, and practices of professional and academic ATS played in their desire to complete an education and pursue a career in the field. Under supportive ATS academic/professional systems, expectations, and practices, personal and professional goals were perceived as compatible with one another. Personal goals were defined as including women's expectations for relationships and professional working style, as well as their hopes for the future in terms of family and career.

Professional goals, for the women in this study, were defined as including women's educational and career prospects. When women felt that features of their graduate program and/or future career were congruent with their personal and professional goals, they felt motivated in their professional pursuits. Conversely, when ATS academic/professional systems, expectations, or practices brought about tension between their personal and professional goals, women reported feeling frustrated and limited. A gendered lens is important in making sense of women's perceptions of ATS academic and professional systems, expectations, and practices. A gendered lens involves recognizing that ATS education and careers are not set up around the personal and professional needs of an individual with caregiving commitments and interests. A gendered lens allows one to interpret women's underrepresentation in ATS careers, particularly in leadership and academia, not as evidence for women's inferior aptitude or commitment, but rather as a logical response to systems constructed around "the life experiences of men" (p. 188), which presume "particular domestic arrangements and resources" (e.g., wife-managed home and caregiving responsibilities) (Duberley & Cohen, 2009, p. 193).

Supportive ATS academic/professional systems, expectations, and practices. Many aspects of the ATS graduate program and workplace were referenced by the women in this study as relevant to their persistence, including having a department climate supportive of their needs as well as a career suited to both their personal and professional interests. In describing their notions of supportive ATS academic/professional systems, expectations, and practices, both current and anticipated environmental features were reported as impacting women's educational and career-related experiences and expectations.

Supportive graduate department expectations and practices. Many women underscored the value of having a department climate that was supportive of their needs, which to them

encompassed many aspects of the learning environment, including the department's gender dynamics and funding opportunities as well as women's perceptions of the quality of their interactions with others.

To the majority of women in this study, funding via research assistantships was critical to their persistence in science. For some women, tuition remission and graduate student stipends made graduate school possible: "A big part of coming here was the fact that, like you—anyone who is in the atmospheric science program has a research assistantship. So, that's like the only way I could have ever gone to grad school." Several women described themselves as "fortunate" to be receiving a "free" education. As another woman explained, financial difficulties could be a reason to leave graduate school altogether: "[This university] pays their students very well. I'm very fortunate for that. I know a lot of people who have quit grad school for money reasons, but not at [this university]."

According to the majority of women in this study, comfort level in communicating with others in the department was also key to their persistence, since approaching others could aid in overcoming educational challenges. As one woman explained:

> I feel comfortable going to people and asking for help . . . and then we also socialize together and so it's really the same environment. Even though it is a much bigger school [than my undergrad], the department is still the same—exactly what I was looking for.

When deciding which program to enter, another woman described feeling more suited to her chosen program over an alternative option: "I didn't like [the other program] because I didn't feel like I really fit in with the people . . . but [here] I sort of feel like I do. They're more 'like me' in this program." Many women emphasized the need for a collaborative, rather than competitive, research atmosphere. Satisfied with her program choice, one woman put it this way:

> Everyone's really friendly. . . . I'm very happy to find that it's not a super competitive environment. People are very willing to work together and just help each other out, so that was one of the things that really got me to come here [for graduate school].

According to the women in this study, an incompatible department climate could serve as an obstacle to their persistence in science, as when productivity or morale was inhibited by an unwelcoming environment or poor communication. On the other hand, feeling comfortable in one's surroundings was described as having the potential to boost persistence, as in this woman's experience: "I'm already in a research group that is really awesome. I might as well just stay [for the PhD]."

Supportive career expectations and practices. The majority of women in this study reported that their persistence in science was supported by the knowledge that their educational pursuits would lead them to a career they would enjoy. According to them, in order to find themselves in a career environment suited to both their personal and professional goals, a Masters or doctorate was required. As one woman described, "I feel like to do what I want to do I would need a Ph.D." Graduate degrees were often described as opening up opportunities, as this woman noted: "I thought I would get a Masters, which would open more doors for me in the future as to finding a career that I like." Another woman put it this way:

> That's kinda why I went to grad school is because I figured that would make me more of like a hot commodity, like "You have a Masters from [a top program]." So then, maybe I'll have a better opportunity and a better job.

Many aspects of the expected ATS workplace were also reported as relevant to persistence, particularly in terms of job description. For example, many women in this study described a desire for a career that would make a difference in people's lives: "Societal impact . . . has always been something that has motivated me." Another woman recounted:

> I really liked all the sciences . . . but I couldn't find one that was applied enough or that I could just see myself doing and doing. . . . Once I decided I wanted to do [meteorology] . . . I never doubted it . . . just 'cause of the clear societal impact and practical science.

This practical orientation was clearly relevant to persistence, as one woman described. When asked what might lead her to consider leaving the field, she responded, ". . . if I felt like I wasn't making enough impact, if what I was doing wasn't meaningful enough, I would switch."

Beyond bigger picture career aspects, the women in this study described day-to-day practices and expectations of their future occupations that were important to their persistence in science. For example, several women described the necessity for their careers to allow for their ideal level of autonomy. One woman explained that her decision to pursue graduate school was influenced by a desire to ". . . do [her] own thing and kinda be [her] own boss." Another woman explained that the doctorate did not seem appealing to her because she prefers "being told what to do." With a doctorate-level career, she explained, "You have to . . . find your own money and write grants and do a whole bunch of topics at once." Another woman was ambivalent about the doctorate. Although she "would love to do a Ph.D.", she said:

> I don't think I want any of the jobs that you get once you have a Ph.D. Yeah, I like working for someone and I don't really like the idea of heading my own group. . . . I have a lot of independence in my research . . . but I still have someone to go to when I have problems. . . . I'm sure at some point, you know, I'll wish that I maybe had done a Ph.D.

In describing their need for a supportive professional environment, the women in this study often spoke of their desire for a career that allowed flexibility for having children. While most women anticipated difficulties in this domain, others maintained a positive outlook. One woman summed up her aspirations for congruence between her personal and professional goals in this way: "In my perfect world, I would love to be able to have kids, a husband, a family, and adventure and a job, all be kind of one thing."

Undermining ATS academic/professional systems, expectations, and practices. All of the women in this study described systems, expectations, and practices of the professional ATS environment that would create tension between their personal and professional goals. According to them, such conflict challenged their persistence in science.

Undermining career expectations and practices. Many women believed that having a doctorate might limit their career options because those with doctorates call for a higher salary. As one woman explained, "I've heard that sometimes . . . having a Ph.D. limits you to your jobs because then you're overqualified. And nobody wants to pay you for a Ph.D. when a Masters could do it." Other women felt that having a Ph.D. would limit their flexibility in research:

> Once you go for that Ph.D., you're like, "This is what I'm researching. These are my research interests. I'm researching these for the rest of my life." And I'm not ready to be like, "I'm so terribly interested in one thing for the rest of my life." So, I decided to stop at the Masters and kinda keep my possibilities open.

Steering them away from pursuing doctorates, many women shared the perception that having a Masters degree granted them greater career flexibility and likelihood of finding employment.

Another theme across women's narratives was that limited geographic job availability in ATS made it difficult to envision themselves in their future careers. Several women noted that their uncertainty had led them to be open to a diversity of career options, both within and outside of ATS. As one woman put it, "There's not really a lot of jobs in meteorology, like it's really limited, just 'cause it's not a big field. It's not like a business major, or like a salesman, and so I don't think that I really am gonna have the opportunity to be choosy on what job I get." As another woman put it, "My husband has a job here and my parents are talking about moving out here, and we want to have a family, and for me, if I can't [find a job] very close, then I would have to consider looking at . . . sort of an alternate career path at that point."

The ability to have children was also an important consideration for the women in this study as they envisioned themselves in a future career. Though none of the women in this sample had children at the time interviews took place, most of them planned to at some point in the future. On the whole, women anticipated conflict between their personal and professional goals in light of systems, expectations, and practices within ATS and academia that caused their personal and professional goals to conflict. As one woman explained, "If I am starting a faculty job when I start having kids, I think time will be majorly loaded, so that's something I think about and worry about kind of a lot." Another woman put it this way:

> I haven't really decided on my career choice. . . . If I stay in research, it's great because you have such flexible hours and you basically work for yourself. . . . I can stay home and, you know, if the kid's sleeping, I can knock out three hours on my paper.

Many women expected having children to slow their educational or career progress. For example, one woman who was considering having children while completing her Ph.D. explained that, "[Having children] will definitely set it [earning the Ph.D.] back a little bit, timing-wise." As another woman described:

> . . . [having children is] certainly going to slow down whatever professional career I have . . . because you don't want to be too stressed while you're pregnant and, or even when you come home to toddlers or whatever, you don't want to come home all stressed and mad and you don't want to be on travel so that you never see them.

With family in mind, for many women in this study, a career perceived to be too demanding on their time was seen as unappealing. One woman explained that observing her advisor's lifestyle led her not to wish for an academic career. As she put it:

> My personal life is so important to me, and [my advisor] eats and breathes his work. . . . He has a family, he has a wife, but he is the main breadwinner there and he travels all the time and I just think that that's not what I want in my life.

Another woman described a similar perspective:

> I want to be able to be around as much as possible [for the children], so times when I can work from home is really nice if there's opportunities for that. . . . So I'm open to, to not being a professor right away if it means I can spend more time with children.

The gendered context of women's perceptions of supportive and undermining ATS academic/professional systems, expectations, and practices. A gendered lens offers critical insights regarding women's views of congruence and conflict between their personal and professional goals in the context of dominant academic/professional ATS systems, expectations, and practices. In the U.S., female faculty have lower rates of marriage and fewer children than male faculty (Perna, 2001). As noted by Duberley and Cohen (2009), having a family serves as an impediment to career advancement for female scientists because ". . . as mothers, they [are] no longer seen as dedicated, ambitious, or career-oriented" (p. 195). Consistently, many women in this study perceived conflict between having a successful scientific career, particularly in academia, and being an involved parent.

A theme that emerged across women's narratives was the greater likelihood of male faculty and graduate students to have children. As one woman noted, "Most of the people that I know that have kids in the department that are grad students are all *guys*. And none of the women that I know in, in grad [school] have kids." Many women explained that the time demands of children are different for women and men. Caregiving responsibilities aside, pregnancy and childbirth require more of the mother's time than the father's. As one woman described:

> [In our research group], we have had three . . . male research scientists, who all have had babies while they worked for us, right? 'Cause, that's like, you're at the age. . . . You just got your Ph.D.s, so you're, like almost 30. . . . But, if I'm the female research scientist . . . I can't really have a kid. I mean, a post-doc is like a short-term thing, so you're not going to get, like maternity leave during that.

Several women explained that work and family commitment conflict would become more of an issue as they entered into the working world, most often because they did not plan to have children while in graduate school. One woman explained her anticipation of work-family time demands in this way:

> Down the line you have your marriage, you have your husband to take care of, you have your kids . . . and now you have to be the parent, you have to be the adult. So, I think balancing that type of work and play is a whole different level than the work and play I'm trying to balance now [in graduate school].

The women in this study explained that their observations of ATS professional women informed their career outlook and choices. One woman explained that her anticipation of work and family commitment conflict arose in light of such observations. As she described:

> I see a lot of women in our field, especially faculty . . . and they were married and divorced, or never married . . . and it's like their personal life is not part of who they are as a scientist, and I find that to be . . . a barrier for me in this field.

Reflecting on her participation in a "women in science program" aimed at connecting female science students and professionals, another woman put it this way:

> I don't know if [my involvement] really helped or hurt, like it was really great women achieving in the field I wanted to go into. But, at the same time, we're just still not caught up with the work-life balance. On some degree, it kinda hurts. I was like, you know, "It's great to see that you're succeeding, but you also had to sacrifice a lot that I'm not willing to sacrifice."

Although several women in this study planned to pursue an academic career in ATS, several others saw academia as an unwelcoming environment for women with children, particularly with regard to the tenure clock. These women reported choosing career paths they considered more suited to both their personal and professional goals, namely, in research or consulting. As one woman explained, "If I went into a research field, especially if I went into the government sector, I've heard really good things about women working in labs – that they're

really accommodating in terms of, you know, needing time for family things." Another woman described the possibility of working in research while raising children and pursuing an academic career later on, as her female ATS professor had done:

> I like how she did it. She really wanted to be a professor, but she kind of put that off until her children got older, like around, I d'know, nine or ten. . . . Until then she was a research scientist, which isn't as strict, you know. She could come in early and, and leave early so she could be home when the kids got home and that kind of thing.

Several women in this study described how anticipated or experienced work-family commitment conflict could lead women to leave the field altogether:

> I think the whole 'having a family' thing starts to pull women away from their careers because I don't think atmospheric science as a career has found a way to really work with women and family that well. . . . I'm hoping things will start to change, but it's a little frustrating. . . . But the thing that's kind of interesting as you notice, you know, that many [women] get Masters and then a lot of the women start leaving. . . . So, fewer go on for their PhD. I mean, fewer men stay too, but I think the percentage of women actually decreases . . . even more for post-docs and by the time you get to faculty positions, there's not very many women who are applying.

Another woman stated that she no longer wanted to be in ATS as a result of observing professional ATS women struggle with personal and professional demands:

> When I look at women, it's not necessarily what they've done in the science, but what they do personally as well as the science. . . . Like, you're life isn't necessarily your own. Your life is this academic thing . . . and I think that's wrong. . . . It does make me not want to be a faculty member in places. It does make me think of a consulting job or a research job.

As this woman explained, although non-academic career paths allow women to be "much more involved with life outside of academia," they typically involve sacrificing a leadership career in science. She went on to explain that women in these careers:

> . . . are not necessarily becoming, like really amazing scientists, and in my mind, sometimes I feel like you have to choose. . . . "I'm either going to be this scientist who's, like, well-known for all of their science, and I'm going to publish a lot." Or, "I'm going to have my family be more important, and I'm going to do okay in science, but I'm going

> to be happy with, like my personal life." . . . I don't have to choose right now, but I do think that having to choose one day is going to be a huge problem.

This perceived tension between personal and professional commitments was of serious concern to the majority of women in this study. When describing personal and professional goal conflict, several women responded as this woman did:

> I feel like honestly if I don't put family first, I'm going to feel guilty about it. . . . But I also feel like if I get a Ph.D. in ATS and I have all these great opportunities presented to me . . . that turning away from [them] is going to make me feel guilty. So, it's going to be one of those situations that you just gotta . . . do the best you can and hope that everybody understands why you make the decisions that . . . you make.

CHAPTER IV: Discussion

This study explored how women in an ATS graduate program explained their persistence in the field, including what they perceived as current, past, and future supports and challenges to their persistence. These women's narratives highlighted individual factors (i.e., academic self-confidence and academic self-doubt; educational engagement and educational detachment), interpersonal factors (i.e., supportive and undermining personal relationships; motivating and discouraging professional relationships), and institutional factors (i.e., supportive and undermining ATS academic/professional systems, expectations, and practices) relevant to their persistence in science.

Emergent Model of Women's Persistence in Science

For the women in this study, influences on their persistence in science were interconnected (e.g., opposing or reinforcing of one another) (see Figure 1). As several women noted, persistence influences would sometimes operate in opposition to one another. For example, motivating professional relationships (e.g., with positive mentors) were especially supportive of women's persistence in science in their ability to mitigate feelings of academic self-doubt. In addition, several women emphasized the positive impact of educational engagement (e.g., commitment to science and academics) on their persistence in science in the face of undermining personal relationships (e.g., emotionally and/or practically demanding intimate partners). The women in this study also described instances of factors reinforcing one another to either support or challenge persistence. For example, several women described that sustained educational engagement (e.g., through hands-on research) over time boosted their academic self-confidence. Many women also described the especially negative impact of undermining professional relationships (e.g., discouraging professors) on their educational

detachment (e.g., lack of motivation). These findings suggest that supportive and challenging influences on women's persistence in science are best viewed holistically—rather than individually—as a complex range of persistence-influencing experiences and interactions that often shape women's perceptions of their educational and career pursuits (and vice versa). As noted by Levine et al. (2007), projects aimed to recruit and retain individuals from underrepresented groups (e.g., women) in the geosciences should consider a diversity of factors (i.e., student, teacher, and institutional factors) at each educational level to improve project effectiveness.

The women in this study also reported that conceptually-opposed influences on persistence (e.g., educational engagement and educational detachment) may occur simultaneously. For example, several women felt enthusiastic about science and academics, yet at the same time, expressed a lack of motivation for their educational and career pursuits. Similarly, many of the women in this study explained that they experienced academic self-doubt despite a steady record of success. To these women, positive and negative persistence influences within a single thematic category appeared to exist on separate planes altogether, rather than representing two opposite ends of a spectrum. This finding suggests that conceptually-aligned supports and challenges to women's persistence in science may not directly oppose one another. Instead, increasing women's persistence in science may require unique and concentrated efforts to combat negative influences on persistence, rather than to merely strengthen known positive influences.

Finally, the women in this study reported that challenges to their persistence in science (e.g., negative stereotypes about women in science) were at times experienced as motivating. As many women in this study noted, being confronted with societal messages purporting women's

inferior abilities in science inspired their dedication to educational and career pursuits. Moreover, some women explained that their observations of few or no women in ATS fueled their ambitions to one day be amongst the leaders in the field and to serve as role models to other women. Such findings, also documented in previous research as supportive of persistence in the geosciences (e.g., Baber et al., 2010), suggest that assumed supportive and challenging influences on women's persistence in science cannot always be interpreted at face value. In sum, the model of women's persistence in science resulting from this study represents a dynamic process, whereby interrelated supportive and challenging influences on persistence are understood to operate simultaneously and often in opposition to one another over time.

Women's Persistence in Science by Educational Level

For the women in this study, critical influences on their persistence in science appeared at every educational level following their initial choice to pursue ATS. A chronology of commonly reported influences on persistence, occurring at each educational level, is presented here.

Early and high school education. During early and high school education, parents and teachers were most commonly referenced as supportive of persistence, through their nurturing of women's interest in science. Parents and teachers were often described as encouraging women in their educational pursuits by offering them opportunities to engage their interest through science-related activities. This finding is consistent with a critical incident study conducted by Levine et al. (2007), which identified involvement in hands-on research activities as playing an important role in geoscience career-choice. Across STEM fields, including engineering (Lawrence &Mancuso, 2012) and computer science (Gürer & Camp, 2001), early education and high school programs designed to nurture girls' interest and continued participation in STEM

have emphasized the importance of incorporating hands-on workshops to engage students with key science concepts and applications.

During early and high school education, the women in this study described influences on their persistence that were mostly supportive. It is possible that, during this stage, educational and career choices are most flexible, and young female students who are not encouraged in their interest in science at this level may be prevented from pursuing science education and careers altogether (Hill, Corbett, & St. Rose, 2010). For the several women in this study who were discouraged at a young age (primarily by teachers), supportive parents and other educators were cited as their most critical sources of encouragement along their science educational path. An important finding from this study is that none of the women reported being discouraged—nor did they report being pressured—in their choice of science education and careers by their parents. Rather, the women in this study said that they had been supported in their own personal interest in science.

Parents and teachers have been recognized as important to interest, persistence, and success in science during early and high school education (Gürer & Camp, 2001; Hill, Corbett, & St. Rose, 2010). During these years, supporting women's persistence may require the breaking down of gender stereotypes which consider women's interest in science as unconventional or inappropriate (Canetto et al., 2012), particularly among parents and educators. In fact, programs aimed at increasing young girls' interest and participation in STEM fields have begun to incorporate components (e.g., panels, workshops, or discussions) to increase parent, teacher, and guidance counselor awareness of gender issues in the STEM classroom (e.g., Gürer & Camp, 2001; Lawrence & Manusco, 2012).

Undergraduate-level education. During undergraduate science education, the women in this study emphasized the supportive influence of positive role models and mentors, most commonly professors and academic advisors, on their persistence in science. The significant role of models and mentors has been documented in a wide variety of career development models and interventions, including in the geosciences (e.g., Brock et al., 2006; Hallar et al., 2010; Huntoon & Lane, 2007; Levine et al., 2007; Pandya et al., 2007; Windham, Stevermar, & Anthes, 2004). Undergraduate education, according to the women in this study, is a critical time period for mentorship—particularly during the year or two preceding graduate school—since mentors provide information and resources necessary to pursue graduate studies. As noted in previous research on women's persistence in STEM disciplines (e.g., Myers & Pavel, 2011), science faculty and academic advisors are essential in bridging the gap between undergraduate and graduate level education.

Given the value of positive role models and mentors in supporting women's STEM educational and career pursuits, significant are the numerous occurrences of neglect and discouragement on the part of undergraduate professors, as reported by the women in this study. This finding is consistent with Larocque's (1995) retrospective study on challenges faced by women in the geosciences, with 45% of women experiencing active discrimination and harassment by faculty and male peers. Similarly, in a study exploring factors leading undergraduate students to leave STEM majors, female students reported experiencing hostility and alienation from male peers in their science courses as well as neglectful faculty (Seymour & Hewitt, 1997). As noted by Nettles and Millet (2006), in their survey of more than nine thousand students from 21 top-ranking U.S. doctorate-granting universities, women science majors tended

to give lower ratings to their interactions with male professors, perhaps a consequence of the predominance of male faculty in STEM fields.

Women's persistence in science is likely to benefit from the increased availability of positive mentors and role models. A key finding of this study was that female mentors and role models were perceived as important in women's persistence. Many women in this study described female mentors and models as inspiring and motivating because seeing successful women in science made them optimistic about their own educational and career pursuits. This finding is consistent with previous research (e.g., Lockwood, 2006; Lockwood & Kunda, 1997; Stout, Dasgupta, Hunsinger, & McManus, 2011) demonstrating that students derive particular benefits (e.g., inspiration, self-enhancement/efficacy, commitment to STEM) from seeing members of their own group (e.g., women) succeed in a self-relevant domain (e.g., science), particularly when this group is a stereotyped minority in their chosen career field. Given that, in 2006, women represented fewer than 15% of ATS/space scientists (Gonzales, 2010), finding a female role model or mentor can be difficult for female students in ATS. Indeed, one third of this study's participants reported having had no female ATS role models or mentors. It has been suggested that the shortage of female mentors and models may play a role in women's underrepresentation in ATS education and careers due to the demotivating effect on female ATS students of seeing few or no women serving as role models to them in the field (Canetto et al., 2012). As the women in this study communicated, having professional ATS women to look up to is critical to their persistence in science.

Graduate-level education. At the graduate level, the women ATS students in this study underscored the negative impact of academic self-doubt on their persistence in science. As noted by Ferreira (2003), female students often enter STEM graduate studies with high grades and

self-confidence, which can both be challenged in the graduate school environment. The negative repercussions of academic self-doubt, for the women in this study, ranged from questioning their abilities to reach their educational goals, to those of giving serious consideration to leaving the field altogether. This finding is consistent with Larocque's (1995) study of women geoscientists' experiences of educational challenges. She found that "lack of self-confidence" (p. 130) was the most common problem faced by female geoscience graduate students. Sonnert's (1995) study of women and men with prestigious post-doctoral fellowships in science also noted that women reported feeling less confident and ambitious than their male peers, due to "fight[ing] tough inner battles . . . to overcome profound self-doubts" (p. 55). Sonnert's finding, as in the present study, suggests that academic self-doubt may persist despite ample evidence to the contrary. Sonnert's finding is consistent with a study conducted by Mueller and Dweck (1998), which found that praising students' intellectual abilities could actually have a negative impact on their persistence, enjoyment, and task performance, as well as a loss of self-confidence following future failures. One strategy in reducing academic self-doubt among STEM women was demonstrated in an intervention by Dweck (2006), whereby female math students—instead of receiving accolades for a job well done—were trained on the expandable nature of intellectual skills. Dweck's research (2006, 2008):

> . . . provides evidence that a 'growth mindset' (viewing intelligence as a changeable, malleable attribute that can be developed through effort) as opposed to a 'fixed mindset' (viewing intelligence as an inborn, uncontrollable trait) is likely to lead to greater persistence in the face of adversity and ultimately success in any realm (Hill, Corbett, & St. Rose, 2010, p. 30).

In diversifying the geosciences specifically, Baber and colleagues (2010) have called for a geosciences pipeline model (based on successful programs such as the Summer Experience in Earth and Mineral Sciences and the Summer Research Opportunity Program) that emphasizes

self-efficacy-building through "opportunities to alter perceptions of stress indicators" (p. 40) (e.g., negative stereotypes).

During the graduate school years, male intimate partners were commonly reported by the respondents as interfering with their pursuit of the doctorate. Specifically, partners' professional needs were reported to challenge women's persistence, whether by drawing them away from their graduate studies at the Masters level, or by limiting their perceptions of their career options post-graduation in light of the limited geographic job availability of ATS. Women's socialized tendency to prioritize partners' careers over their own has been documented in research studies, especially when it comes to job relocation (Bielby & Bielby, 1992; Challiol & Mignonac, 2005). Women in this study who prioritized their educational responsibilities reported weakened or lost relationships with intimate partners. Demographic findings from Larocque (1995) are consistent with women's relationship experiences and concerns in this study. Not only were a third (33%) of the female geoscientists over age 40 single (in comparison to only 3% of men), but also a full 44% of all female respondents reported that their partners were also earth scientists (in comparison to 11% of men). A more recent study by Mason and Goulden (2002) found that 82% of academic men were married, versus 62% of academic women—with tenured women in science being twice as likely to be single as tenured men in science. Moreover, 50-70% of academic women in science were married to other academics, suggesting the greater likelihood of women to face dual-career conflict in their relationships. Indeed, many women in this study reported that their partners' professional needs would be their greatest challenge to persistence in the field.

Career expectations. Looking ahead to their future careers, the majority of women in this study highlighted the importance of finding a career with the potential for societal impact.

The value attached to incorporating a service orientation into STEM research (e.g., Espinosa, 2011; McGee & Keller, 2007) and careers (e.g., Sax, 1994) has been documented by previous research on women's educational and career-related persistence in STEM (Conrad, Canetto, MacPhee, & Farro, 2009; Margolis, Fisher, & Miller, 2000; Shapiro & Sax, 2011). A recent study by Diekman and colleagues (2011) demonstrated women's tendency to endorse communal goals and found that STEM careers perceived as incompatible with such goals were not of interest to women. These findings suggest that, by accentuating the social applications inherent in ATS careers, diversity initiatives aimed at boosting women's interest and participation in ATS may be more effective.

Finally, as the female graduate students in this study envisioned themselves in a future career, their biggest anticipated challenge to persistence was concerns about work-family commitment conflict. These apprehensions have been documented in previous studies of women's experiences in the geosciences (e.g., Larocque, 1995), including ATS (Canetto et al., 2012; Tucker, Ginther, & Winkler, 2009). In a recent study of educational and career motives, plans, and challenges of ATS graduate students (Canetto et al., 2012), women's primary concern regarding their future career was "fitting in both family and career goals" (p. 414). In the present study, women especially perceived an inherent incompatibility between pursuing an academic career and being an involved parent. Demographic studies (e.g., Tucker et al., 2009) have documented that far fewer female ATS assistant and associate professors (33% and 43%, respectively) than male ATS assistant and associate professors (58% and 76%, respectively) had children under age 18, whereas more female (53%) than male (37%) ATS full professors had young children. According to the same survey, only 11% of tenure-stream faculty in ATS were women. It is thus not surprising that the women in this study reported such concerns, usually as

a result of observing first-hand the small proportion of female faculty in their academic departments, let alone female faculty with children. Analyses of women's underrepresentation in geoscience academic careers (e.g., de Wet et al., 2002; Libarkin & Kurdzeil 2003) have suggested a number of modifications to the academic environment aimed at reducing the observed gender gap, including increasing the flexibility of the tenure system, providing more flexible work time and family-leave policies, and providing access to quality (on-site) childcare facilities.

Limitations and Strengths

The purpose of this study was to gain an understanding of how women in ATS graduate school explain their persistence in ATS education and careers, including what supports and what challenges their persistence in the field. One limitation of the present study was that its sample may have been selective in unknown ways. It could be that students who agreed to participate were the ones who experience the most doubts and/or problems with regard to their persistence in science since the study's goal to understand persistence factors was clearly communicated in recruitment materials. Another limitation of the study is that its data was collected via interviews, thus relying on verbal expressiveness. Some participants were articulate while others were reserved, which may have resulted in less complete information from some participants. Moreover, students who did not feel comfortable being interviewed likely did not participate. Additionally, this study's data was collected from a single institution, which may have limited the diversity of views and experiences represented in this study's sample. Another limitation of the present study is that, despite exercising research reflexivity, potential assumptions and biases may have been introduced in the analysis process. For example, one member of the research team reported that her mother was an employed Masters-level atmospheric scientist, which may

have impeded an impartial interpretation of the data. Finally, challenges to women's persistence may be underrepresented in the findings of the present study, due its sample consisting only of women who have so far persisted in ATS graduate studies.

Still, there is strong evidence to suggest that the influences on persistence described by the women in this study may characterize experiences of a more general population of women in science and in ATS due to the present study's correspondence with the broader literature on women's persistence-related experiences across science disciplines (Hill, Corbett, & Rose, 2010; NAS, 2006; Shapiro & Sax, 2011). Moreover, women in ATS, as in other STEM fields, share a similar context in their exposure to gendered messages about women in science and in features of the graduate department (e.g., fewer women; Ferreira, 2002, 2003) and future career environments (e.g., work-family concerns; Trower & Chait, 2002).

The present study should also be viewed in light of its methodological strengths. First, a qualitative approach to this new area of inquiry was warranted, as no other study had explored female graduate students' persistence within the field of ATS. Moreover, in-depth, semi-structured interviews allowed participants to elaborate on experiences they felt were important to their educational and career path, without limitations posed by a more structured questionnaire.

Future Research

Based on what was learned from this study, several directions for future research are recommended. First, this study's method should be replicated across additional ATS graduate departments, as the present study's findings stem from a single institution. Second, quantitative confirmation of persistence influences might be sought out using structured, anonymous questionnaire methods, with a larger sample of participants and perhaps focusing on other specific subsets of women in science (e.g., professional ATS women; women who have left the

field). Future studies might specifically test directional hypotheses regarding psychological constructs (e.g., academic self-efficacy or achievement motivation) to examine their relationship with specific persistence-related outcomes (e.g., degree completion). Finally, future studies should longitudinally examine the relative impact of various supports and challenges to women's persistence in science. For example, a question raised by this study's findings is whether the perceived importance of female role models and mentors changes over the course of women's progress in STEM higher education, and if so, why. Examining persistence influences longitudinally would lead to an increased understanding of which factors tend to have the greatest impact on persistence at each educational level, allowing researchers and educators to prioritize areas for program development and intervention.

Applications for Supporting Women's STEM Persistence

The supports and challenges to women's persistence in ATS education and careers identified in this study could inform strategies to support women's pursuit of education and careers in science. For instance, knowing about the importance of mentorship, particularly mentorship of women by women, can help scientists and academics committed to the diversification of ATS to understand one important contributing factor (i.e., the lack of female mentors) to women's underrepresentation in the field.

Findings from the present study also highlight actionable opportunities to support women's persistence in science, along with critical periods for intervention. For example, parents and teachers seem to be most influential during early education, whereas ATS mentors and role models play an especially meaningful role for female ATS students during the two years preceding graduate school. Armed with this knowledge, programs aimed at supporting women's persistence in ATS can utilize more targeted efforts to maximize their effectiveness.

Conclusions

Women's underrepresentation in STEM education and careers has wide-reaching social and economic implications (OECD, 2012). In an age of increasing global demands for scientific leadership and innovation, the U.S. continues to fall short in producing STEM graduates (NSF, 2010a). If the U.S. is to remain a "leading global economy and competitor in technology-based industries" (NSF, 2010a, p. 6-57), women are essential to the growth of the STEM labor force. Supporting women's persistence in STEM education and careers requires strong commitment, leadership, and coordinated efforts among educators, legislators, and organizations. Recent initiatives by the National Science Foundation (2010b) to support women's interest, participation, and success in science (e.g., the Research on Gender in Science and Engineering Program) suggest that new research is beginning to guide policy and influence institutional reform. This research, along with empirically-based interventions, are aimed at transforming the academic, social, and institutional landscape to support women's STEM educational and career aspirations. Findings from the present study further contribute to this important initiative.

The influences on persistence described by the women in this study consisted of many factors identified in previous research on women's persistence in other STEM fields, positioning this study's findings within the broader literature on gender issues and experiences in STEM education and careers. Thus, findings from the present study extend the persistence literature to an additional STEM field, ATS, while also reinforcing the findings of previous studies on women's persistence in STEM (Hill, Corbett, & St. Rose, 2010). The present study also contributes unique findings on women's educational and career persistence, stemming from distinctive dimensions of ATS as a field and a career (e.g., its geographic job availability) (BLS, 2011; Canetto et al., 2012; Hartten & LeMone, 2010). Given that women are not uniformly and

universally underrepresented across STEM fields (Ma, 2011), with subfields presenting diverse configurations of supports and challenges facing women, findings from this study provide emphasis as to the value of discipline-grounded analyses of gender issues and experiences in STEM.

This study is among the first to apply questions and methods used to understand the gender gap in other STEM fields to the understudied field of ATS. Beyond raising awareness of women's underrepresentation in ATS, findings from this study provide unique insights into what drives women—as well as what may drive them away—along their path to pursuing higher education and careers in this important science field.

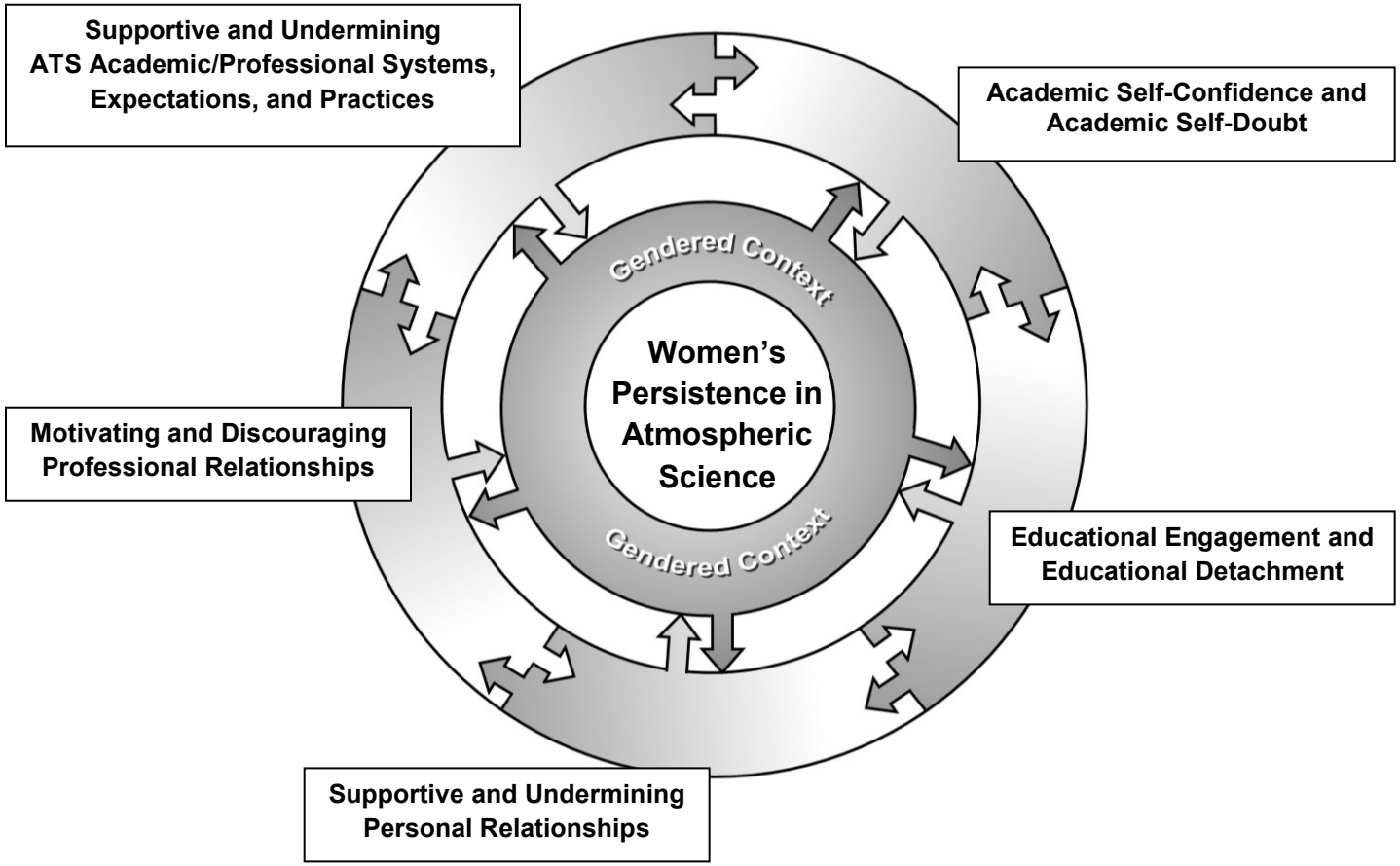

Figure 1. Emergent model of supports and challenges to women's persistence in atmospheric science. Arrows represent the interconnectedness between the five main thematic categories and the gendered context of women's persistence-related experiences.

REFERENCES

Amelink, C. T., & Creamer, E. G. (2010). Gender differences in elements of the undergraduate experience that influence satisfaction with the engineering major and the intent to pursue engineering as a career. *Journal of Engineering Education, 99*, 81-92.

Ampaw, F. D., & Jaeger, A. J. (2011). Understanding the factors affecting degree completion of doctoral women in the science and engineering fields. *New Directions for Institutional Research, 152*, 59-73.

American Meteorological Society. (1993). *Challenges of our changing atmosphere: Careers in atmospheric research and applied meteorology.* Retrieved from http://www.ametsoc.org/pubs/careers.html#careers

Baber, L. D., Pifer, M. J., Colbeck, C., & Furman, T. (2010). Increasing diversity in the geosciences: Recruitment programs and student self-efficacy. *Journal of Geoscience Education, 58*(1), 32-42.

Barnett, R. C., & Hyde, J. S. (2001). Women, men, work, and family. *American Psychologist, 56*, 781-796.

Bernstein, B. (2011). Managing barriers and building supports in science and engineering doctoral programs: Conceptual underpinning for a new online training program for women. *Journal of Women and Minorities in Science and Engineering, 17*(1), 29-50.

Bielby, W. T., & Bielby, D. D. (1992). I will follow him: Family ties, gender-role beliefs, and reluctance to relocate for a better job. *American Journal of Sociology, 97*(5), 1241-1267.

Bong, M., & Skaalvik, E. M. (2003). Academic self -concept and self efficacy: How different are they really? *Educational Psychology Review, 15,* 1–40.

Brainard, S., & Carlin, L. (1998). A six year longitudinal study of undergraduate women in engineering and science. *Journal of Engineering Education, 87*(4), 369-375.

Brantlinger, E., Jimenez, R., Klingner, J., Pugach, M., & Richardson, V. (2005). Qualitative studies in special education. *Exceptional Children, 71*(2), 195-207.

Brock, L., Fuhrman, M., González, R., & Levine, R. (2006). Strategies for recruiting and retaining geoscience majors: Voices from the field. *Geological Society of America Abstracts with Programs, 38,* 461.

Bureau of Labor Statistics. (2011). *Occupational outlook handbook, 2010-11 edition*: *Atmospheric scientists*. U.S. Department of Labor, Washington DC: Author. Retrieved from http://www.bls.gov/oco/ocos051.htm

Buzzetto-More, N., Ukoha, O., & Rustagi, N. (2010). Unlocking the barriers to women and minorities in computer science and information systems studies: Results from a multi-methodological study conducted at two minority serving institutions. *Journal of Information Technology Education, 9,* 115-131.

Byars-Winston, A., Estrada, Y., Howard, C., Davis, D., & Zalapa, J. (2010). Influence of social cognitive and ethnic variables on academic goals of underrepresented students in science and engineering: A multiple-groups analysis. *Journal of Counseling Psychology, 57*(2), 205-218. doi:10.1037/a0018608

Callister, R. R. (2006). The impact of gender and department climate on job satisfaction and intentions to quit for faculty in science and engineering fields. *Journal of Technology Transfer, 31*(3), 367-375.

Canetto, S. S., Trott, C. D., Thomas, J. J., & Wynstra, C. A. (2012). Making sense of the Atmospheric Science gender gap: Do female and male students have different career motives, goals, and challenges? *Journal of Geoscience Education, 60*(4), 408-416. doi:10.5408/12-296.1

Cech, E., Rubineau, B., Silbey, S., & Seron, C. (2011). Professional role confidence and gendered persistence in engineering. *American Sociological Review, 76*(5), 641-666. doi:10.1177/0003122411420815

Challiol, H., & Mignonac, K. (2005). Relocation decision-making and couple relationships: A quantitative and qualitative study of dual-earner couples. *Journal of Organizational Behavior, 26*(3), 247-274.

Charlevoix, D. (2010). *Gender and atmospheric sciences: A snapshot of demographics of atmospheric science students.* Paper presented at the 19th Symposium on Education, American Meteorological Society Annual Meeting, Atlanta, GA. Abstract retrieved from: ams.confex.com/ams/pdfpapers/164257.pdf

Chemers, M. (2011). The role of efficacy and identity in science career commitment among underrepresented minority students. *Journal of Social Issues, 67*(3), 469-491.

Chubin, D. E., & Malcom, S. M. (2008). Making a case for diversity in STEM fields. *Inside Higher Education.* Retrieved from http://www.insidehighered.com/views/2008/10/06/chubin

Concannon, J. P., & Barrow, L. H. (2010). Men's and women's intentions to persist in undergraduate engineering degree programs. *Journal of Science Education and Technology, 19*(2), 133-145. doi:10.1007/s10956-009-9187-x

Conefrey, T. (2000). Laboratory talk and women's retention rates. *Journal of Women and Minorities in Science and Engineering, 6*(1), 251-264.

Conefrey, T. (2001). Sexual discrimination and women's retention rates in science and engineering programs. *Feminist Teacher, 3*(13), 170-192.

Conrad, S., Canetto, S. S., MacPhee, D., & Farro, S. (2009). What attracts high-achieving, socioeconomically disadvantaged students to the physical sciences and engineering? *College Student Journal, 43(4) Part B,* 1359-1369.

Creswell, J. W. (1994). *Research design: Qualitative and quantitative approaches*. Thousand Oaks, CA: Sage.

Creswell, J. W. (1998). *Qualitative inquiry and research design: Choosing among five traditions*. Thousand Oaks, CA: Sage.

de Wet, C. B., Ashley, G. M., & Kegel, D. P. (2002). Biological clocks and tenure timetables: Restructuring the academic timeline. *GSA Today, 12*(11), 1-7. Retrieved from http://www.geosociety.org/gsatoday/archive/12/11/0211clocks/0211bio_clocks.pdf

Dean, D. (2009). *Getting the most out of your mentoring relationships: A handbook for women in STEM*. New York, NY: Springer Science + Business Media. doi:10.1007/978-0-387-92409-0.

Denofrio, L. A., Russell, B., Lopatto, D., & Lu, Y. (2007). Linking student interests to science curricula. *Science, 318*, 1872-1873.

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

Downing, R. A., Crosby, F. J., & Blake-Beard, S. (2005). The perceived importance of developmental relationships on undergraduates' pursuit of science. *Psychology of Women Quarterly, 29*, 419-426.

Duberley, J., & Cohen, L. (2009). Gendering career capital: An investigation of scientific careers. *Journal of Vocational Behavior, 76,* 187-197.

Dweck, C. (2006). Is math a gift? Beliefs that put females at risk. In S. J. Ceci & W. M. Williams (Eds.), *Why aren't more women in science? Top researchers debate the evidence* (pp. 47–55). Washington, DC: American Psychological Association.

Dweck, C. (2008). *Mindsets and math/science achievement.* New York: Carnegie Corporation of New York, Institute for Advanced Study, Commission on Mathematics and Science Education.

Ely, R. J. (1995). The power in demography: Women's social constructions of gender identity at work. *Academy of Management Journal, 38,* 589–634.

Espinosa, L. L. (2011). Pipelines and pathways: Women of color in undergraduate STEM majors and the college experiences that contribute to persistence. *Harvard Educational Review, 81*(2), 209-240.

Estrada, M., Woodcock, A., Hernandez, P. R., & Schultz, P. (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

Etzkowitz, H., Kemelgor, C., Neuschatz, M., & Uzzi, B. (1994). Barriers to women's participation in academic science and engineering. In W. Pearson Jr. & A. Fechter (Eds.) *Who will do science? Educating the next generation* (pp. 43-67). Johns Hopkins University Press.

Ferreira, M. M. (2002). The research lab: A chilly place for graduate women. *Journal of Women and Minorities in Science and Engineering, 8*(1)*,* 85-98.

Ferreira, M. M. (2003). Gender issues related to graduate student attrition in two science departments. *International Journal of Science Education, 25*(8), 969-989.

Ferreira, M. M. (2009). Trends in women's representation in science and engineering. *Journal of Women and Minorities in Science and Engineering, 15,* 191-203.

Ferrer de Valero, Y. (2001). Departmental factors affecting time-to-degree and completion rates of doctoral students at one land-grant research institution. *Journal of Higher Education, 72*(3), 341-367.

Fetterman, D. M. (1989). *Ethnography: Step by step*. Newbury Park, CA: Sage.

Fouad, N., & Singh, R. (2011). *Stemming the tide: Why women leave engineering.* Retrieved from the University of Wisconsin, Milwaukee, Center for the Study of the Workplace website: http://www.studyofwork.com/wp-content/uploads/2011/03/NSF_Women-Full-Report-0314.pdf

Fox, M. F. (2001). Women, science, and academia: Graduate education and careers. *Gender and Society, 15,* 654-666.

Fried, T., & MacCleave, A. (2009). Influence of role models and mentors on female graduate students' choice of science as a career. *Alberta Journal of Educational Research*, *55*(4), 482-496.

Golde, C. M. (2000). Should I stay or should I go? Student descriptions of the doctoral attrition process. *Review of Higher Education, 23*(2), 199-227.

Gonzales, L. (2010). Participation of women in geoscience occupations. *Geoscience Currents, 33*(1). Retrieved from http://www.agiweb.org/workforce/Currents/Currents-033-GenderOccupations.pdf

Griffith, A. L. (2010). Persistence of women and minorities in STEM field majors: Is it the school that matters?. *Economics of Education Review, 29*(6), 911-922. doi:10.1016/j.econedurev.2010.06.010

Gumbiner, J. (1998). Professors as models and mentors: Does gender matter? *Psychological Reports*, *82*(1), 94-94. doi:10.2466/PR0.82.1.94-94

Gürer, D., & Camp, T. (2001). *Investigating the incredible shrinking pipeline for women in computer science.* Final Report NSF 9812016. Retrieved from http://women.acm.org/archives/documents/finalreport.pdf

Hallar, A. G., McCubbin, I. B., Hallar, B., Levine, R., Stockwell, W. R., Lopez, J. P., & Wright, J. M. (2010). Science in the mountains: A unique research experience to enhance diversity in the geosciences. *Journal of Geoscience Education, 5*, 95-100.

Hartten, L. M., & LeMone, M. A. (2010). The evolution and current state of the atmospheric sciences 'pipeline'. *Bulletin of the American Meteorological Society*, *91*(7), 942-956. doi:10.1175/2010BAMS2537.1

Hazari, Z., Sonnert, G., Sadler, P. M., & Shanahan, M. (2010). Connecting high school physics experiences, outcome expectations, physics identity, and physics career choice: A gender study. *Journal of Research in Science Teaching, 47*(8), 978-1003. doi:10.1002/tea.20363

Hernandez, P. R., Woodcock, A., Schultz, P., Estrada, M., & Chance, R. C. (2013). Sustaining optimal motivation: A longitudinal analysis of interventions to broaden participation of underrepresented students in STEM. *Journal of Educational Psychology, 105*(1), 89-107. doi:10.1037/a0029691

Hill, C., Corbett, C., & St. Rose, A. (2010). Why so few? Women in science, technology, engineering, and mathematics. Washington, DC: AAUW. Retrieved from: http://www.aauw.org/learn/research/upload/whysofew.pdf

Holmes, M.A., & O'Connell, S. (2003). Where are the women geoscientist professors? *EOS*, *84*(50), 564.

Huang, P. M., & Brainard, S. G. (2001). Identifying determinants of academic self-confidence among science, math, engineering, and technology students. *Journal of Women and Minorities in Science and Engineering*, *7*(4), 315–337.

Huntoon, J. E., & Lane, M. J. (2007). Diversity in the geosciences and successful strategies for increasing diversity. *Journal of Geoscience Education, 55*(6), 447-457.

Knox, J. A. (2008). Recent and future trends in U.S. undergraduate meteorology enrollments, degree recipients, and employment opportunities. *Bulletin of the American Meteorological Society, 89*, 873–883.

Koenig, R. (2009). Minority retention rates in science are a sore spot for most universities. *Science, 324,* 1386–1387.

Kuck, V. J., Marzabadi, C. H., Nolan, S. A., & Buckner, J. (2004). Analysis by gender of the doctoral and postdoctoral institutions of faculty members at the top-fifty ranked chemistry departments. *Journal of Chemical Education, 81*(3), 356-363.

Larocque, A. C. L. (1995). Challenges and rewards of graduate studies in the geosciences: A woman's perspective. *Geoscience Canada, 32*(3), 129-132.

Lawrence, D. A., & Mancuso, T. A. (2012). Promoting girls' awareness and interest in engineering. *Technology and Engineering Teacher, 72*(1), 11-16.

Lent, R. W., Lopez, F. G., Sheu, H., & 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*, 184–192.

Levine, R., González, R., Cole, S., Fuhrman, M., & Le Floch, K. C. (2007). The geoscience pipeline: A conceptual framework. *Journal of Geoscience Education*, *55*(6), 458-468.

Levine, R., González, R., & Martínez-Sussmann, C. (2009). Learner diversity in earth system science. Retrieved from the National Academies website: http://www7.nationalacademies.org/bose/NOAA%20Diversity.pdf

Libarkin, J. C., & Kurdziel, J. P. (2003). Research methodologies in science education: Gender and the geosciences. *Journal of Geoscience Education, 51*, 446-452.

Lincoln, Y., & Guba, E. (1985). *Naturalistic inquiry*. Beverly Hills, CA: Sage.

Lockwood, P. (2006). "Someone like me can be successful": Do college students need same-gender role models? *Psychology of Women Quarterly, 30*(1), 36–46.

Lockwood, P., & Kunda, Z. (1997). Superstars and me: Predicting the impact of role models on the self. *Journal of Personality and Social Psychology, 73*, 91–103.

Lovitts, B. E. (2001). *Leaving the ivory tower: The causes and consequences of departure from doctoral study*. Lanham, MD: Rowman and Littlefield.

Ma, Y. (2011). Gender differences in the paths leading to a STEM baccalaureate. *Social Science Quarterly, 92*(5), 1169-1190. doi:10.1111/j.1540-6237.2011.00813.x

Macfarlane, A., & Luzzadder-Beach, S. (1998). Achieving equity between women and men in the geosciences. *Geological Society of America Bulletin, 110*(12)*,* 1590-1614.

Mallinckrodt, B., & Leong, F. T. L. (1992). Social support in academic programs and family environments: Sex differences and role conflicts for graduate students. *Journal of Counseling and Development, 70*, 716-723.

Maranto, C. L., & Griffin, A. C. (2011). The antecedents of a 'chilly climate' for women faculty in higher education. *Human Relations, 64*(2), 139-159. doi:10.1177/0018726710377932

Margolis, J., Fisher, A., & Miller, F. (2000). The anatomy of interest: Women in undergraduate computer science. *Women's Studies Quarterly*, *28*(1/2), 104–127.

Mason, M. A., & Goulden, M. (2002). Do babies matter?: The effect of family formation on the lifelong careers of academic men and women. *Academe*, *88*(6), 21–27.

McGee, R., & Keller, J. L. (2007). Identifying future scientists: Predicting persistence into research training. *CBE - Life Sciences Education, 6*(4), 316-331.

Morrow, S. L., & Smith, M. L. (2000). Qualitative research for counseling psychology. In S. D. Brown & R. W. Lent (Eds.), *Handbook of counseling psychology* (3rd ed., pp. 199–230). New York: Wiley.

Mueller, C. M., & Dweck, C. S. (1998). Intelligence praise can undermine motivation and performance. *Journal of Personality and Social Psychology, 75*, 33-52.

Myers, C. B., & Pavel, D. (2011). Underrepresented students in STEM: The transition from undergraduate to graduate programs. *Journal of Diversity in Higher Education, 4*(2), 90-105. doi:10.1037/a0021679

National Academy of Sciences. (2006). *Beyond bias and barriers: Fulfilling the potential of women in academic science and engineering.* Washington, DC: National Academies Press. Retrieved from http://www.nap.edu/openbook.php?record_id=11741

National Science Foundation. (2006). Scientists and Engineers Statistical Data System SESTAT Data Tool. Retrieved from https://sestat.nsf.gov/sestat/sestat.html

National Science Foundation. Division of Science Resources Statistics. (2008). *Atmospheric sciences degrees awarded, by degree level and sex of recipient: 1966–2006* (Detailed Statistical Tables). Arlington, VA: Author. Retrieved from http://www.nsf.gov/statistics/nsf08321/pdf/nsf08321.pdf

National Science Foundation, National Science Board. (2010a). *Science and Engineering Indicators 2010.* NSB 10-01. Retrieved from nsf.gov/statistics/seind10/pdf/seind10.pdf

National Science Foundation (2010b). *Research on gender in science and engineering FY 2010 (GSE).* Retrieved from http://www.nsf.gov/funding/pgm_summ.jsp?pims_id=5475

National Science Foundation. Division of Science Resources Statistics. (2012a). *Bachelor's degrees awarded, by field and sex: 2001–09* (Detailed Statistical Tables). Arlington, VA: Author. Retrieved from http://www.nsf.gov/statistics/wmpd/pdf/tab5-2.pdf

National Science Foundation. Division of Science Resources Statistics. (2012b). *Master's degrees awarded to women, by field: 2001–09* (Detailed Statistical Tables). Arlington, VA: Author. Retrieved from http://www.nsf.gov/statistics/wmpd/pdf/tab6-2.pdf

National Science Foundation. Division of Science Resources Statistics. (2012c). *S&E doctoral degrees awarded to women, by field: 2001–09* (Detailed Statistical Tables). Arlington, VA: Author. Retrieved from http://www.nsf.gov/statistics/wmpd/pdf/tab7-2.pdf

Nettles, M. T., & Millett, C. M. (2006). *Three magic letters: Getting to Ph.D.* Baltimore, MD: The Johns Hopkins University Press.

Organisation for Economic Co-operation and Development (OECD). (2012). *Gender equality in education, employment and entrepreneurship: Final report to the MCM 2012.* Retrieved from http://www.oecd.org/general/50452859.pdf

Paglis, L. L., Green, S. G., & Bauert, T. N. (2006). Does adviser mentoring add value? A longitudinal study of mentoring and doctoral student outcomes. *Research in Higher Education, 47*(4) 451-476.

Pandya, R.E., Henderson, S., Anthes, R.A., & Johnson, R.M. (2007). BEST practices for broadening participation in the geosciences: Strategies from the UCAR Significant Opportunities in Atmospheric Research and Science (SOARS®) program. *Journal of Geoscience Education, 55,* 500-506.

Pender, M., Marcotte, D. E., Sto. Domingo, M. R., & Maton, K. I. (2010). The STEM pipeline: The role of summer research experience in minority students' Ph.D. aspirations. *Education Policy Analysis Archives, 18*, 1-36.

Perna, L. (2001). The relationship between family responsibilities and employment status among college and university faculty. *Journal of Higher Education, 72*, 584-611.

Ritchie, B. S., Fassinger, R. E., Linn, G. S., Johnson, J., Prosser, J., & Robinson, S. (1997). Persistence, connection, and passion: A qualitative study of the career development of highly achieving African American–Black and White women. *Journal of Counseling Psychology, 44,* 133–148.

Russell, S. H., Hancock, M. P., & McCullough, J. (2007). Benefits of undergraduate research experiences, *Science, 316,* 548-549.

Sandler, B. R. (1991). *The Campus Climate Revisited: Chilly Climate for Women Faculty, Administrators, and Graduate Students.* Washington, DC: Association of American Colleges.

Sawtelle, V., Brewe, E., & Kramer, L. H. (2012). Exploring the relationship between self-efficacy and retention in introductory physics. *Journal of Research in Science Teaching, 49*(9), 1096-1121. doi:10.1002/tea.21050

Sax, L. J. (1994). Retaining tomorrow's scientists: Exploring the factors that keep male and female college students interested in science careers. *Journal of Women and Minorities in Science and Engineering, 1,* 45-61.

Seymour, E., & Hewitt, N. M. (1997). *Talking About Leaving*. Boulder, CO: Westview Press.

Shah, S. K., & Corley, K. G. (2006). Building better theory by bridging the quantitative-qualitative divide. *Journal of Management Studies, 43*(8), 1821-1835.

Shapiro, C. A., & Sax, L. J. (2011). Major selection and persistence for women in STEM. *New Directions for Institutional Research, 152*, 5-18. doi:10.1002/ir.404

Singh, K., Allen, K. R., Scheckler, R., & Darlington, L. (2007). Women in computer-related majors: A critical synthesis of research and theory from 1994 to 2005. *Review of Educational Research, 77*(4), 500-533. doi:10.3102/0034654307309919

Sonnert, G. (1995). Gender equity in science: Still an elusive goal. *Issues in Science and Technology, 12,* 53-58.

Steele, J. R., & Ambady, N. (2006). "Math is hard!" The effect of gender priming on women's attitudes. *Journal of Experimental Social Psychology, 42*, 428–436.

Stout, J. G., DasGupta, N., Hunsinger, M., & McManus, M. A. (2011). STEMing the tide: Using ingroup experts to inoculate women's self-concept in science, technology, engineering, and mathematics (STEM). *Journal of Personality and Social Psychology, 100*(2), 255-270. doi:10.1037/a0021385

Stout, J. G., Ito, T. A., Finkelstein, N. D., & Pollock, S. J. (2013). How a gender gap in belonging contributes to the gender gap in physics participation. *AIP Conference Proceedings, 1513*(1), 402-405. doi:10.1063/1.4789737

Strauss, A. L., & Corbin, J. (2nd Ed.). (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory.* Newbury Park, CA: Sage.

Strenta, A. C., Elliot, R., Adair, R., Matier, M., Scott, J. (1994). Choosing and leaving science in highly selective institutions. *Research in Higher Education*, *35*(5), 513–547.

Trower, C. A., & Chait, R. P. (2002). Faculty diversity: Too little for too long. *Harvard Magazine*. Retrieved from http://harvardmagazine.com/2002/03/faculty-diversity.html

Tucker, D., Ginther, D., & Winkler, J. A. (2009). Gender issues among academic AMS members: Comparisons with the 1993 membership survey. *Bulletin of the American Meteorological Society*, *90*, 1180-1191.

Vogt, C. M. (2008). Faculty as a critical juncture in student retention and performance in engineering programs. *Journal of Engineering Education, 97*(1), 27-36.

Wallace, J., & Hobbs, P. (2006). *Atmospheric science*. Amsterdam: Elsevier Academic Press.

Wentling, R. M., & Camacho, C. (2008). Women engineers: Factors and obstacles related to the pursuit of a degree in engineering. *Journal of Women and Minorities in Science and Engineering, 14*(1), 83-118.

Windham, T. L., Stevermer, A. J., & Anthes, R. A. (2004). SOARS: An overview of the program and its first 8 years. *Bulletin of the American Meteorological Society, 85,* 42-47.

Winkler, J. A., Tucker, D., & Smith, A. K. (1996). Salaries and advancement of women faculty in atmospheric science: Some reasons for concern. *Bulletin of the American Meteorological Society*, 77, 473-490.

Zydney, A. L., Bennett, J. S., Shahid, A., & Bauer, K. W. (2002). Impact of undergraduate research experience in engineering. *Journal of Engineering Education, 91*(2), 151-157.

APPENDIX I: Interview Script

Questions about factors influencing career choice:

1. What are the events in your life that led you to where you are now in your education and on your career path?

    a. Why *Atmospheric Science*?
    b. What factors have constrained your choice?
    c. What resources have helped to open up your choices?

2. What individuals were most influential to you in making this decision and why? (a and b are possible follow up questions)

    a. What was role of parents?
    b. Who were your [female] role models (if any), [and how important was/is it to you to find role models and mentors who were also women?]*
    c. What types of mentorship experiences have you had in the past? What mentorship experiences have you had specifically in *Atmospheric Science*?
    d. At what stage in your education were your most important mentoring experiences?
    e. Do you currently provide mentorship to anyone else?

    **parts in brackets should be omitted initially, but asked as follow up if the interviewee does not come up with any female role models*

3. What non-academic activities do you participate in? How has your participation in these activities affected your academic experiences and/or career choices?

4. What groups/clubs do you belong to that are specifically for scientists/*Atmospheric Scientists*? For women in science/*Atmospheric Science*?

    a. What made you choose to join/not join these clubs and how have they affected your experience here?

5. On your demographic form, you list the culture you most identify with as _____. How are women in science, and women in *Atmospheric Science* in particular, viewed within this culture?

    a. How common is it for a woman to be a scientist/*Atmospheric Scientist* in this culture?

Questions about challenges/factors influencing resiliency:

Individual factors:

6. What are the biggest challenges you have faced so far? (FIRST ALLOW THEM TO ANSWER UNPROMPTED, THEN GO THROUGH ONE AT A TIME)
    a. Economic
    b. Interpersonal
    c. Family
    d. Relationships
    e. Health
    f. Social expectations
    g. Time
    h. Self Image

7. How do you cope with setbacks you encounter in life in general and in your *Atmospheric Science* training in particular?

    a. How did you learn/develop these coping strategies?

8. Who are the major sources of support for you in dealing with such setbacks?

    a. Who are the people that you rely on most heavily for personal/academic support within the *Atmospheric Science* department?
    b. Describe your relationship with your peers in your graduate program and how they have impacted your educational experience.
    c. Describe the impact that you have had on your peers in your graduate program.

9. Have you ever considered switching field of study/careers, and if so, why?

    a. How difficult would it be for you to give up your current field of study and/or career aspirations and what factors could lead you to make such a change?

Relational factors:

10. If you are currently in a romantic relationship, describe how this partnership enhances and how it challenges your educational and career goals. If not currently in a romantic relationship, describe how you envision such a partnership enhancing or challenging your career goals, based on past experience or observation of others.

    a. At what career stage is your partner? How do you think this has influenced/may influence your education and future career plans?

11. Do you have, or plan to have, children? How do you think these plans have been or will be affected by your career choice?

Institutional/societal factors:

12. How has your educational experience been shaped by being a woman/man?

13. You said on your demographic form that you identify as _____. How has your educational experience been shaped by this culture?

14. What do you plan to do in terms of future education and career within the field of *Atmospheric Science* and what are the biggest challenges to achieving these goals that you think you may face in the future?

    a. FOR UNDERGRADS: Do you plan to go to graduate school? What factors have affected/will affect this decision? What obstacles to getting into graduate school do you face?
    b. For MS students: Do you plan to complete a Ph.D. after you finish your M.S.? What factors have affected/will affect this decision?
    c. How do you think you compare to others in your program or others in this career in terms of your intelligence, skills, and abilities?
    d. Discuss the differences in the challenges you think you have faced/will face in your academic career versus your career after graduation.

Optional Question (if time allows):

15. If you can remember one, tell me a joke you have heard related to Atmospheric Science or science.

Final Question (to encourage exploration of additional areas):

16. Is there anything else you can tell me that might be interesting or useful that I did not ask about?

APPENDIX II: Demographic Form

1. ID Number*: _____

**Note: for confidentiality purposes, demographic forms and interview transcripts will be labeled only with a randomly assigned ID number and a student-selected alias. A coding form linking student names with ID numbers/aliases will be stored separately from the demographic forms and transcripts, for the purpose of contacting students and linking data for follow up interviews in future years.*

2. Alias (for use in interview transcripts):_____
(Pick a name you like!)

3. Age:_____ 4. Sex: _____

Relationship Information:

5. Current Relationship Status (select ALL that apply):

___Single and Unattached ___Single and Attached
___Married/Commitment Ceremony ___Cohabiting (i.e., living with a partner)

Cultural Background Information:

6. Citizenship:_____
(please indicate dual citizenship, if applicable)

7. Please indicate your ethnicity (select all that apply):
___Black/African American ___American Indian/Native American
___Asian American or Pacific Islander ___White/European American
___Latino/a or Hispanic American
___Other (please specify)_____

8. Please specify your ethnicity as it would be described in your country of origin:
_____

9. Please describe your residency status: _____

10. Please indicate your visa status: _____
11. What culture do you most identify with? _____

Education:

12. Current Level in School (please check one):
____Undergraduate Junior _____Master's Program _____Post-doctoral Position
____Undergraduate Senior _____Doctoral Program

13. Indicate number of years in current program: _____

14. If you are currently enrolled in a Master's or undergraduate program, do you think you will continue your engineering education to earn a Ph.D.?

___definitely yes
___probably yes
___probably no
___definitely no

15. Please list schools you have attended, location, degree, and major (include anything post-high school or equivalent, and include current enrollment):

School (e.g., Colorado State University)	***Location (e.g., Fort Collins, CO, U.S.A.)***	***Degree (e.g., B.S.)***	***Major (e.g., Chemical Engineering)***