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Professional Role Confidence and Gendered Persistence in Engineering

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Abstract

Social psychological research on gendered persistence in science, technology, engineering, and mathematics (STEM) professions is dominated by two explanations: women leave because they perceive their family plans to be at odds with demands of STEM careers, and women leave due to low self-assessment of their skills in STEM's intellectual tasks, net of their performance. This study uses original panel data to examine behavioral and intentional persistence among students who enter an engineering major in college. Surprisingly, family plans do not contribute to women's attrition during college but are negatively associated with men's intentions to pursue an engineering career. Additionally, math self-assessment does not predict behavioral or intentional persistence once students enroll in a STEM major. This study introduces *professional role confidence*—individuals' confidence in their ability to successfully fulfill the roles, competencies, and identity features of a profession—and argues that women's lack of this confidence, compared to men, reduces their likelihood of remaining in engineering majors and careers. We find that professional role confidence predicts behavioral and intentional persistence, and that women's relative lack of this confidence contributes to their attrition.

Keywords

professional role confidence, expertise confidence, career-fit confidence, gendered persistence in science and engineering

In addition to discriminatory and cultural factors such as biased hiring (Reskin 2003) and chilly climates (Sandler, Silverberg, and Hall 1996), social psychological factors contribute to gender segregation in male-dominated professions. Such factors begin early in the professional education process and continue through one's career, and include individually held beliefs about one's abilities, competencies, anticipated roles, and personal fit (Cech 2007; Xie and Shauman 2003). Social psychological determinants of persistence are an important research focus because much of the difference in men's and women's persistence in male-dominated professions emerges out of seemingly voluntary individual decisions to stay or leave (Correll 2001).[1]

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This study focuses on several factors influencing gendered persistence in professional careers during the process of credential acquisition. Credential acquisition refers to the education and training processes required to obtain the requisite certifications (e.g., MD, PhD, and BS) that allow prospective professionals to enter practice in the workforce.

We test two prominent social psychological explanations of persistence (family plans and self-assessment), and introduce a third, professional role confidence, likely to be salient during credential acquisition. We ask whether family plans and self-assessments, shown in other research to be important in individuals' decisions to take advanced math and science courses in high school and to select STEM majors in college, continue to affect persistence once students enroll in an engineering major. We then investigate the importance of professional role confidence on men's and women's persistence.

The *family plans* explanation suggests that women's expectations that they will assume primary responsibility for family care lead them to abandon their ambitions in male-typed professions for more family-friendly, female-typed ones (Eccles 1987; Fiorentine 1987, 1988; Frome et al. 2006). We find no evidence that women's family plans lead to their attrition from engineering once they enter engineering training. Family plans may have a later effect on women's career plans (as shown by copious literature on work-family balance) but do not deter women from earning their engineering degree. We do find, unexpectedly, that men with strong family plans seeking an engineering degree are less likely to pursue a career in engineering.

The *self-assessment* explanation argues that women's low self-assessment of the skills required for the core intellectual tasks of a profession (e.g., mathematics in the case of engineering), net of their actual performance, leaves them less likely to pursue and persist in male-dominated professions (Correll 2001, 2004). Although women in our sample succeeded in overcoming mathematics hurdles in high school and entering an undergraduate engineering program, women nonetheless assess their math skills more negatively than men assess their math skills. However, we find that math self-assessment does not significantly predict persistence in an engineering major or intent to be an engineer in the future. Once students matriculate into this math-intensive field, more complex, profession-specific self-assessments appear to replace math self-assessment as the driving social psychological reasons for attrition.

To explain gendered persistence in engineering education and gendered intentions to pursue a career in engineering, we introduce a third explanation: professional role confidence. *Professional role confidence* refers to individuals' confidence in their ability to fulfill the expected roles, competencies, and identity features of a successful member of their profession. Becoming a successful professional involves not just mastery of a profession's core intellectual skills (e.g., mathematics), but also the cultivation of confidence in, identification with, and commitment to the profession. We argue that women and men develop different levels of professional role confidence in heavily gender-typed professions and therefore are differentially likely to persist. We examine two dimensions of professional role confidence: *expertise confidence*, or confidence in one's ability to wield the competencies and skills required of practice in the profession, and *career-fit confidence*, or confidence that a profession's career path is consonant with one's individual interests and values. We find that professional role confidence is cultivated more successfully in men than in women engineering students, leaving women less likely to plan to complete an engineering major or pursue a career in engineering.

We test these three explanations of persistence with a longitudinal sample of engineering students. Engineering is an ideal laboratory to test these theories because it requires only a bachelor's degree, making the decision timeframe more condensed than for students interested in professions that require post-baccalaureate education. On the other hand,

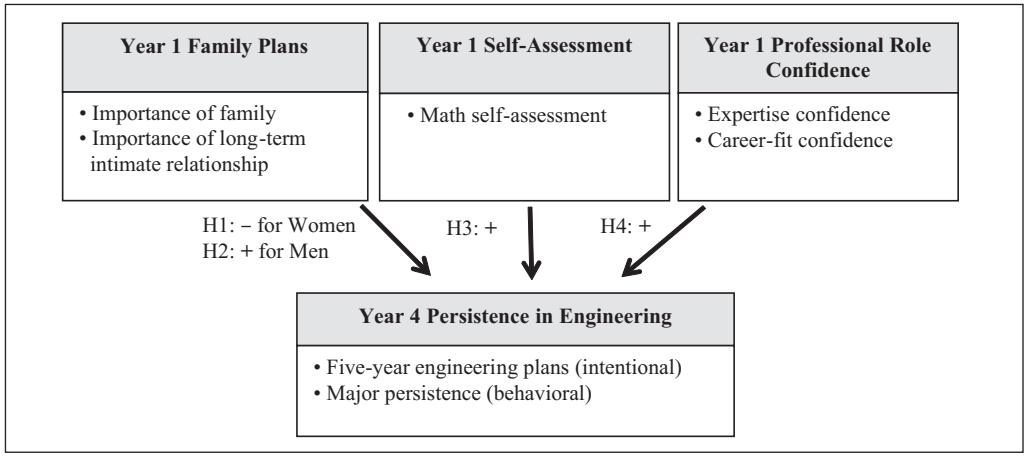

Figure 1. Schematic of Theoretical Model and Expected Relationships between Family Plans, Math Self-Assessment, Professional Role Confidence, and Persistence in Engineering

college is a time of great career decision-making flexibility, with little cost of time or training for switching career tracks, relative to the costs of making such changes once in the workforce. These truncated yet comparatively flexible decision-making conditions should sharply focus the effects of the factors we study. Additionally, engineering is the most sex-segregated nonmilitary profession in the United States (National Science Foundation 2009) and among industrialized societies more generally (Charles and Bradley 2009). Young men and women who initially select engineering majors have already weathered pervasive effects of gendered stereotyping of early adolescence (Leslie, McClure, and Oaxaca 1998; Xie and Shauman 2003), allowing us to focus our attention on issues of persistence rather than recruitment.

We use original panel data of engineering students from four schools (i.e., MIT, Franklin Olin College of Engineering, Smith College, and the University of Massachusetts-Amherst) at two time periods: Year 1 (freshman year) and Year 4 (senior year).[2] These data are appropriate for our analysis because they trace students' commitment to engineering careers from the beginning to the end of their undergraduate years. Furthermore, our data come from institutions illustrative of the range of engineering programs in the United States: a land-grant college typical of the public institutions where 80 percent of U.S. engineers are educated (UMass); the highest-ranked engineering school in the nation (MIT); and two small innovative programs developed to challenge the standard engineering education offered at elite and conventional engineering schools (Olin College and Smith College).

THEORETICAL FRAMEWORK

Our conceptualization of persistence captures two theoretically important dimensions: students' persistence in engineering majors from freshman to senior year (i.e., behavioral persistence) and their future career plans (i.e., intentional persistence). We seek to explain these two dimensions of persistence as a result of students' family plans, self-assessment, and professional role confidence; see Figure 1 for a schematic of our theoretical model.

Persistence

Persistence in a profession requires development of requisite skills, which are certified through credentials, and a commitment to stay the course. We conceptualize achievement of

the requisite credential (in this case, an undergraduate engineering degree) as *behavioral persistence*. In contrast to studies that employ a dichotomous conceptualization of persistence (i.e., stay/leave), we conceptualize behavioral persistence as a trichotomous process by differentiating three paths: (1) leaving engineering majors for other STEM majors (i.e., biological and physical sciences, math, or other technology-related majors), (2) leaving engineering for non-STEM majors (i.e., arts, humanities, business, education, social sciences, or other non-STEM related professional degrees such as nursing), or (3) persisting in an engineering major and earning a degree. If students move from engineering into another STEM major, the switch could reflect features of the structure and culture of the engineering profession specifically, whereas the decision to leave STEM altogether suggests factors that perpetuate gender segregation across STEM professions.

Majoring in engineering is a necessary but not a sufficient condition to explain career choice and career plans. Once a college student declares an engineering major, she must think about whether she will leverage her degree to secure employment in the engineering workforce. We conceptualize development of a commitment to work as an engineer in the near future as *intentional persistence*. Whereas behavioral persistence captures the more objective prerequisites of persistence, intentional persistence taps into its subjective dimensions. We measure intentional persistence at the end of respondents' college years. It is, therefore, a projection of whether students will pursue an engineering career.

Family Plans

Women and men make major life decisions in the context of multiple social forces, with pressures that pull them in directions tangential—or even opposite—to their career goals. Career goals may therefore depend on the extent to which students perceive professions as consistent with their anticipated future roles. The family plans explanation posits that women who strongly value their future parenting and spousal support roles are likely to resolve current or future work-family conflicts in favor of those roles (Eccles 1987; Eccles, Adler, and Meece 1984; Farmer 1997; Feather 1988).[3] Researchers find, for instance, that women who place a high priority on their future families are less likely to enter science majors than are their female peers with weaker commitments to family roles (Burge 2006; Ware and Lee 1988). Women's desires for family-flexible professions are also negatively associated with their intentions to persist in male-dominated careers (Frome et al. 2006, 2008).

These analyses suggest that women's considerations of their future family roles could be causally related to their exit from STEM career paths (for counter-arguments, see Frehill 1997; Seymour and Hewitt 1997). Consistent with the family plans explanation, we expect that students' family plans at college entry will influence their behavioral and intentional persistence. We hypothesize these relationships separately for women and men, because the family plans literature largely ignores effects of men's family plans on their persistence in male-dominated professions.

Hypothesis 1a: The importance of women's family plans (i.e., having a long-term committed relationship and raising children) is negatively related to intentional persistence in engineering.

Hypothesis 1b: The importance of women's family plans is positively related to their attrition from engineering majors into non-STEM majors.

This literature is inconclusive as to how family plans are related to women's decisions to leave engineering for another STEM major. Because engineering has a reputation for creating even more work-family conflict than other STEM professions (Eccles 1987, 1994), we expect women with strong family plans will leave engineering for other STEM majors.

Hypothesis 1c: Importance of women's family plans is positively related to switching into another STEM major.

The relationship between family plans and persistence is unclear for men. Seymour and Hewitt (1997) suggest that family plans may have a positive effect on persistence for men, inducing them to intend to persist in highly paid STEM careers. It is an open question whether men with strong family plans are more likely to persist in engineering rather than switch to another STEM major.

Hypothesis 2a: The importance of men's family plans is positively related to their intentional persistence in engineering.

Hypothesis 2b: The importance of men's family plans is positively related to their behavioral persistence in engineering.

Self-Assessment

Self-assessments are self-referenced evaluations that individuals develop about themselves. In this study, we are interested in assessments of one's professionally associated abilities rather than, for example, students' assessments of their basketball skills or physical attractiveness (Owens, Robinson, and Smith-Lovin 2010). Most research examining effects of self-assessments study the influence of gendered math self-assessment on persistence in male-dominated career paths (e.g., Correll 2001; Seegers and Boekaerts 1996). Although gender differences in math performance are nonexistent once math preparation is controlled (Hyde et al. 1990),[4] research repeatedly finds differences in men's and women's self-assessment of their math abilities (Correll 2001, 2004). Whether due to young men's and women's internalization of gender stereotypic views of math or their belief that others may hold them accountable to such stereotypes, gender-typing of certain tasks means that men, *ceteris paribus*, assess their math skills more positively than women assess their own math skills (Correll 2001, 2004; Ma and Johnson 2008).[5]

Self-assessment differentials are produced by gendered experiences within the math discipline itself (Correll 2001; Ridgeway 1997) and can accumulate over time (Hyde et al. 1990), even controlling for comparable preparation and performance (Correll 2001; Seymour and Hewitt 1997). Furthermore, low math grades have a more negative effect on women's persistence than on men's at the point of transition from high school to college (Correll 2001).

Math self-assessments, furthermore, affect students' selection of college majors: "maladaptive cognitions regarding math-related capabilities may be at least as important as math ability per se in influencing major choices" (Betz and Hackett 1983:332). Correspondingly, Correll (2001) finds that math self-assessment is significantly associated with the likelihood of choosing a quantitative major after high school among men and women. The importance of math self-assessments, paired with documented gender differences in such self-assessments, contributes to gender disparities in the decision to choose a quantitative major (Correll 2001).

Scholars have studied self-assessment dynamics on and across the high school–college juncture. Students in our sample, however, entered college as high achievers in math and have higher-than-average math self-assessment.[6] Whether math self-assessment remains a salient factor once students select math-intensive majors is an empirical question we seek to answer.

Hypothesis 3a: High math self-assessment at college entry is positively related to intentional persistence for men and women.

Hypothesis 3b: High math self-assessment at college entry is negatively related to switching out of engineering for a non-STEM major for men and women.

Consistent with theories of self-assessment, we hypothesize enduring gender differences in mathematical self-assessment during credential acquisition. Such differences may contribute to gender disparities in the decision to persist in an engineering major and intentions to enter an engineering career.

Hypothesis 3c: Even among mathematically high-achieving students, men assess their

math abilities more positively than women assess their math abilities.

Professional Role Confidence

Most research on social psychological impediments to women's persistence in male-dominated professions examines consequences of women's internalization of cultural beliefs about gendered skills and competencies. Such research pays insufficient attention to factors that emerge from men's and women's direct exposure to and immediate experiences with the profession itself. We argue that in addition to widespread normative gender beliefs influencing career choices (Eccles 1994), interactive, cognitive, and embodied experiences during professional training lead women and men to form different levels of confidence in their abilities to fulfill the role of a successful member of their profession.

We begin by asserting that becoming—and being—a successful professional is more than mastery of technical skills or expert knowledge (Becker et al. 1961; Schleef 2006). Professional socialization involves development of hands-on and tacit understandings of a diverse range of circumstances, especially where ambiguous or messy problems call for discretionary expert judgment (Hughes 1971). In addition, socialization promotes identification with and commitment to a profession's sentiments, values, and collectively espoused norms (Merton, Rosenblatt, and Gieryn 1982; Sullivan et al. 2007). To complete requisite training and pursue a professional career, prospective professionals must develop confidence in their ability to enact expected role performances of that profession.

We call this concept *professional role confidence*. It involves confidence in wielding practical competencies of day-to-day professional work, and identifying with the professional role and believing that one will enjoy this role, with all the complexity, uncertainty, and responsibility that accompany its fulfillment.

Students' development of professional role confidence is an important part of successful professional socialization and begins in earnest upon entry into a profession's credentialing process. During credentialing, men and women have their first experiences as profession members rather than aspirants. Through interaction with faculty, mentors, and peers inside and outside the classroom, students engage in anticipatory professional behavior as they begin to master technical knowledge and practical competencies, identify with valued symbols, espouse professional truisms, and learn to project a confident, capable image to others (Becker et al. 1961; Dryburgh 1999; Granfield 1992; Schleef 2006).

Professional role confidence is likely salient for persisting in credential acquisition because this is the first time young men and women are expected to perform actions that define them as professionals (Dryburgh 1999; Schleef 2006). Individuals who develop confidence in their ability to perform the professional role should be more likely to persist in their pursuit of that professional career; those who have little professional role confidence should be weeded out through self-selection or through various sorting processes of their credentialing programs.

We expect that men and women develop different levels of professional role confidence during the professional socialization process. This variation in confidence likely emerges from two sources: cultural beliefs about appropriate professions for men and women, and factors specific to the profession in question. First, women are less likely to develop professional role confidence in male-dominated occupations because such confidence has to overcome cultural biases that men are "naturally" fit for and better at male-typed professions (Charles and Bradley 2009; Ridgeway 2009).

Second, women are less likely to develop professional role confidence in professions where socialization processes and work cultures are historically gendered masculine. In male-typed professions, especially those where the professional role is nurtured primarily through group socialization rather than specific task instruction, women have a harder

time than men internalizing and confidently performing the requisite professional role (Dryburgh 1999; see also Haas and Shaffir 1991; McIlwee and Robinson 1992). Furthermore, faculty and fellow students often deem individuals as unfit whom they see as deviating from the conventional embodiment or model of a professional—an experience more likely for women in male-typed professions than for men (McIlwee and Robinson 1992; Trice 1993). For these reasons, women likely express lower levels of professional role confidence than do men in male-typed professions such as engineering. In professions where the professional role aligns more with female-typed tasks and competencies (e.g., nursing), men may have less professional role confidence than women.

We conceptualize two dimensions of professional role confidence that are active during the credential acquisition process: (1) expertise confidence, or confidence in tasks and competencies required of this kind of professional and (2) career-fit confidence, or confidence that the professional role will suit a person's particular interests, needs, values, and sense of self.[7]

As professionals gain more experience in their field, their understanding of the professional role likely becomes more complex and nuanced. Thus, salience of these or other dimensions of professional confidence may vary as professionals progress through their careers. We return to this point in the Discussion section and suggest an additional dimension of professional role confidence that may be salient once men and women complete their credentials and enter the workforce. Here, we investigate the expertise and career-fit dimensions of professional role confidence as it develops during the credentialing process.

Expertise confidence refers to the confidence students have in the set of techniques, logics, and competencies required to successfully participate in their chosen profession. Expertise confidence is distinct from a single task-specific measure, such as math self-assessment, because it encompasses the broad range of cognitive orientations and problem-solving tasks associated with a profession. Expertise confidence should be particularly important to persistence during credential acquisition because this is when neophytes become aware of and begin to practice profession-specific competencies as they rehearse their future professional roles.

At least two factors challenge women's development of expertise confidence in male-dominated professions such as engineering. First, on top of navigating an often grueling and emotionally charged professional socialization process, women face the additional challenge of negotiating engineering's hegemonic culture, which often valorizes displays of masculinity (Dryburgh 1999). Most engineering role competencies are male-typed within this culture, and women bear the burden of proving to others that, despite gendered expectations, they are skilled engineers. By contrast, men's expertise confidence is consistent with cultural ideologies that stereotype technical engineering skills as masculine domains (Faulkner 2000).

Second, men are more likely than women to participate in informal tinkering and gaming activities as adolescents (McIlwee and Robinson 1992). These activities can serve as a form of anticipatory socialization (Merton 1968; Schleef 2006) to the competencies considered relevant in engineering. Women entering engineering with disproportionately less exposure to such anticipatory socialization may have a more difficult time developing or displaying levels of expertise confidence necessary for success.

Without adequate confidence that they have the appropriate level of expertise to be a successful professional, women will be less likely than men to persist in engineering majors and to see themselves as engineers in the future.

Hypothesis 4a: Expertise confidence is a significant and positive predictor of intentional and behavioral persistence in engineering.

Hypothesis 4b: Women have significantly less expertise confidence than do men.

The second component, career-fit confidence, captures students' confidence that their

chosen profession is appropriate for them and will provide them with interesting and worthwhile employment over time. It encompasses students' beliefs that their chosen profession will lead to a fulfilling career, and their certainty that the professional identity involved in such a career is consonant with their self-perceptions. Career-fit confidence is less about students' assessments of their own abilities and competencies, which is captured by expertise confidence, than about students' assessments of their alignment with a profession's ethos and culture.[8]

Career-fit confidence is likely an important component of persistence. For most contemporary U.S. students, the purpose of higher education is to develop expertise through academic disciplines that align with an existing, distinct self in preparation for a career that, in turn, fosters self-expression and self-realization (Charles and Bradley 2009; Schoon 2001). Students with confidence in their career choice should be more likely to persist because they believe their selected profession fits their individual interests and values. Students who are unsure that their professional credential provides them with the opportunity for a satisfying career or if they question the organizational routines, professional relations, or professional they will be expected to become, may be more likely to leave.

Like expertise confidence, career-fit confidence is partly contingent on successful professional socialization processes. Professional training and education programs must convince students that the profession is deserving of their commitment and that it serves interests and goals with which they can identify. Faculty and administrators market the profession to prospective students and work to persuade current students of the profession's virtues and the desirable status accorded practitioners in that field (Lichtenstein et al. 2009). Students who develop confidence in their fit with the engineering profession will be more likely to persist in an engineering major and intend to persist in an engineering career.

Hypothesis 5a: Career-fit confidence is a significant and positive predictor of intentional and behavioral persistence in engineering.

Processes of professional socialization, especially developing a conventional engineering identity, may leave women in engineering with less career-fit confidence than men. As men and women proceed through credential acquisition, they try on "provisional selves" corresponding to their understandings of the professional role (Ibarra 1999). As students experiment with profession-specific provisional selves, they gradually internalize a corresponding professional identity. Provisional selves congruent with individuals' self-schemas (i.e., organized generalizations about one's self-defining and personal attributes) likely increase students' confidence that engineering fits them; provisional selves discordant with self-schemas likely undermine students' confidence that they made the correct career decision (Howard 2000; Rosenthal et al. forthcoming).

Self-schemas are, of course, deeply gendered (Markus et al. 1982). Women's self-schemas are likely less consistent with professional identities in engineering than are men's, increasing potential for discord between women's self-schemas and provisional selves they try on in the process of developing a professional identity. Furthermore, the perception of engineering as "gender inauthentic" for women (Faulkner 2009:169) may foster a feeling of incongruence between their gender and developing professional identities—an incongruence that likely reduces confidence in their fit with the profession.

Professional identity development, as with development of more general conceptions of identity, depends on verification from relevant others in one's social milieu (Burke 2004; Cooley 1902; Huntington 1957; Rosenthal et al. forthcoming). If others view the professional identities of male-typed fields as more appropriate for men than for women, then women will have fewer opportunities than men for this verification (Seron

et al. 2011). We thus expect women and men to develop different levels of career confidence in engineering. Such differences may lead to gendered intentional and behavioral persistence.

Hypothesis 5b: In engineering, women have significantly less career-fit confidence than do men.

The gendered persistence literature does not lend itself to clear hypotheses about effects of expertise and career-fit confidence on switching into other STEM majors versus non-STEM majors.

DATA AND METHODS

Data

We use original panel data to analyze gender differences in persistence in engineering. Our sample consists of 288 students who entered engineering programs in 2003 at four institutions of higher education: Massachusetts Institute of Technology (MIT), the University of Massachusetts at Amherst (UMass), the Franklin W. Olin College of Engineering (Olin)[9] and Smith College (Smith). Our analysis draws from the 2003 and 2007 waves of our longitudinal survey data. We invited the entire freshman classes at MIT, Olin, and Smith, along with 332 randomly selected UMass freshman, to participate in the study (overall response rate was 35.8 percent).[10] Response bias analyses run between the sample and the 2003 population data at each school show that the sample marginally overrepresents Asian students at MIT (p = .08) and marginally underrepresents African American students at UMass (p = .09). We found no other gender or race/ethnicity differences.

We collected data through online surveys sent to students via e-mail. Although the full sample includes students from many different majors, our analysis includes only students enrolled in—or intending to enroll in—an engineering major in Year 1. We tracked students from freshman to senior year whether they remained in engineering, changed to another major, or left college altogether. The Year 1 to Year 4 retention rate of the subsample we use is 73 percent.

Dependent Variables

We test two measures of persistence: behavioral persistence (i.e., students' completion of an engineering major, Year 1 to Year 4) and intentional persistence (i.e., students' Year 4 belief that they will be an engineer in five years). Behavioral persistence is a variable with three values corresponding to three theoretically important possible outcomes: (1) respondents remained in an engineering major, (2) respondents left engineering for another STEM major, or (3) respondents left engineering for a non-STEM major. Intentional persistence asks students to describe the likelihood they will "be an engineer in five years" (1 = very unlikely to 4 = very likely). Table 1 shows the operationalization of all variables.

Independent Variables

To measure family plans, we average the centered responses to the following two questions asked in Year 1: "importance to me: building a family" and "importance to me: building a satisfying, long-term intimate relationship" to create an *importance of family plans* variable (alpha = .721). We measure math self-assessment with a Year 1 variable asking respondents to rate their math ability compared to an average person their age: 1 = lowest 10 percent, 2 = below average, 3 = average, 4 = above average, 5 = highest 10 percent.

We capture professional role confidence with measures that ask about students' confidence as a result of their initial exposure to engineering (i.e., during the spring semester of their first year in college).[11] All questions making up the professional role confidence scale measures began with, "As a result of

your engineering courses . . ," prompting students to respond in the context of their initial experiences with the profession. The expertise confidence measure (alpha = .809) combines Likert-scale responses where students were asked to rate their confidence on the following three indicators as a result of their engineering courses: "developing useful skills," "advance to the next level in engineering," and "my ability to be successful in my career."[12] The *career-fit confidence* measure (alpha = .751) combines Likert-scale responses where students were asked to rate their confidence on the following four indicators as a result of their engineering courses: "engineering is the right profession for me," "selecting the right field of engineering for me," "finding a satisfying job," and "my commitment to engineering, compared to my engineering classmates."

The success of professional socialization in facilitating students' professional role confidence may depend on the institutional setting. Our sample represents diverse institutional arrangements. MIT, the gold standard of engineering education, has been committed to increasing the number of women engineers for four decades; Smith and Olin have made formal commitments to do a better job of improving the success rate of women engineering students. The University of Massachusetts is a large land-grant state university with significant resource constraints relative to the more resource-rich MIT. These and other factors may produce institutional effects on persistence behaviors, or even gendered persistence. On the other hand, much evidence suggests that pressures to conform to external standards and credentialing trump differences in educational missions and goals (DiMaggio and Powell 1983; Sauder and Espeland 2009; Seron and Silbey 2009).

To measure potential institutional and environmental differences at each school, we include dummy variables for Olin, Smith, and UMass where appropriate (MIT is the reference category). From supplemental analyses using interaction terms between gender and school (not shown here but available upon request), we found that none of the school influences on persistence were gendered. Table 1 lists the operationalization of the other individual-level controls in our model.

Analytic Strategy

We use separate modes of analysis for the two dependent variables: Multinomial Logistic Regression (MLR) for behavioral persistence and Ordinal Logistic Regression (ordered logit) for intentional persistence.[13] Independent variables and controls are identical across the two types of regression models. Our first model includes only gender and relevant controls. Our second model adds family plans and self-assessment measures, and our third model adds professional role confidence variables. Our final model adds an interaction term between family plans and gender. Table A1 in the Appendix presents correlations among variables included in our analyses.

RESULTS

Table 2 summarizes the dependent and independent variables, for all respondents and separately for men and women. The final column indicates whether values are significantly different between men and women. Consistent with the persistence literature described earlier, men have higher levels of behavioral persistence than do women. Women are twice as likely as men to switch to other STEM majors. When men switch out of engineering, however, they are more likely than women to switch to non-STEM majors. Men report higher levels of intentional persistence; that is, they are more likely than women to intend to be an engineer in five years. This school-to-work juncture is critical and, according to some research (e.g., Xie and Shauman 2003), has the highest attrition rate of any point in a STEM career.

Men and women find raising a family and developing a long-term intimate relationship equally important. These similarities speak to the importance of considering women's *and*

Table 1. Operationalization and Measurement of Study Variables

Key Independent Variables

Importance of Family Plans (alpha = .721)

Importance to me (0 = very unimportant to 3 = very important):

Building a satisfying, long-term intimate relationship

Building a family

Math Self-Assessment

Rate your math ability compared to an average person your age (1 = lowest 10%, 2 = below average, 3 = average, 4 = above average, 5 = highest 10%)

Professional Role Confidence: Expertise Confidence (alpha = .809)

As a result of my engineering courses (1 = not confident at all to 4 = very confident):

Developing useful skills

Advancing to the next level in engineering

My ability to be successful in my career

Professional Role Confidence: Career-Fit Confidence (alpha = .751)

As a result of my engineering courses (1 = not confident at all to 4 = very confident):

Engineering is the right profession for me

Selecting the right field of engineering for me

Finding a satisfying job

My commitment to engineering

Behavioral Persistence (DV)

Persisted as an engineering major = 0 (Year 1 to 4)

Left engineering for another STEM major = 1 (Year 1 to 4)

Left engineering for a non-STEM major = 2 (Year 1 to 4)

Intentional Persistence (DV)

"How likely is it that you will be an engineer in 5 years?" (1 = very unlikely to 4 = very likely)

Institutional Variables

Attends Smith College (1 = yes)

Attends Olin College (1 = yes)

Attends UMass (1 = yes)

MIT is the comparison category

Individual-Level Control Variables

Gender (women = 1)

Hispanic or Latino (yes = 1)

African American (yes = 1)

Asian or Asian American (yes = 1)

Cumulative GPA (Year 4)

Mother's education (3 = some elementary or grammar school; 10 = graduate degree)

Father's education (3 = some elementary or grammar school; 10 = graduate degree)

SAT math score (self-reported)

SAT verbal score (self-reported)

Writing self-assessment

Rate your writing ability compared to an average person your age (1 = lowest 10%, 2 = below average, 3 = average, 4 = above average, 5 = highest 10%)

men's experiences as they try to reconcile their professional and personal goals.

Table 2 also presents descriptive statistics for respondents' math self-assessments, and their career and expertise confidence. As expected, men in our sample rate their math skills significantly more positively than women rate their own math skills (Hypothesis 3c). However, women and men do not earn significantly different grade point averages in college; their SAT math and verbal scores at the end of high school, although well above average, are also statistically similar.

Consistent with hypotheses about professional role confidence, men in our sample have significantly more expertise confidence (Hypothesis 4b) and career-fit confidence (Hypothesis 5b) than do women. If these measures of self-assessment and confidence are significantly related to persistence, then these differentials could explain gendered persistence.

We find few differences by race/ethnicity on our key variables. Hispanic and Latino students have stronger traditional family plans than do other students (2.65 versus

Table 2. Means and Standard Deviations of Dependent and Independent Variables, and the Significance of the Difference in Men's and Women's Values

	All (N = 288)		Women (N = 125)		Men (N = 163)		
	Mean	SD	Mean	SD	Mean	SD	t-test
Percent women	.437						
Percent Hispanic or Latino	.083		.058		.109		
Percent African American	.044		.079		.020		*
Percent Asian American	.245		.315		.198		*
Intentional persistence, Year 4	2.795	1.129	2.716	1.164	2.929	1.064	*
Behavioral persistence, Year 4	.796		.772		.825		*
Switched to another STEM major[a]	.108		.167		.063		*
Switched to non-STEM major	.096		.061		.112		*
GPA	3.383	.447	3.412	.395	3.357	.490	
SAT math	738.127	64.590	733.149	62.612	742.730	68.777	
SAT verbal	697.001	84.837	698.043	78.911	696.024	93.221	
Mom's education	8.150	1.871	8.104	1.898	8.271	1.800	
Dad's education	8.525	1.999	8.540	1.923	8.526	2.050	
Importance of family score	2.349	.823	2.393	.812	2.313	.833	
Importance of raising a family	2.175	.962	2.185	.998	2.167	.936	
Importance of a long-term relationship	2.524	.788	2.603	.745	2.460	.816	
Math self-assessment, Year 1	4.142	.786	4.044	.762	4.220	.799	*
Writing self-assessment, Year 1	3.603	.910	3.580	.979	3.619	.979	
Expertise confidence, Year 1	3.285	.507	3.093	.482	3.441	.474	***
Career-fit confidence, Year 1	2.861	.598	2.667	.559	3.013	.586	***

[a]Other STEM majors include biological sciences, physical sciences, and other technology-related majors. Non-STEM majors include those in the arts and humanities, business, education, social sciences, and other non-STEM professional degrees such as nursing.
†$p < .10$; *$p < .05$; **$p < .01$; ***$p < .001$ (two-tailed test).

2.31, $p < .05$). White respondents also have significantly higher math self-assessments than do non-white respondents (4.21 versus 4.01, $p < .05$). However, there are no significant differences in expertise or career-fit confidence by race or ethnicity (results not shown; available upon request).

Turning to the multivariate results, columns I and II of each model in Table 3 represent the MLR behavioral persistence models (where column I represents likelihood of persisting in engineering versus switching to another STEM major and column II represents likelihood of persisting in engineering versus leaving STEM entirely). Each column in Table 4 presents results from the corresponding ordered logistic regression models for intentional persistence.[14] Model 1 in Tables 3 and 4 includes the gender coefficient (female = 1) plus controls for parents' education, SAT math and verbal scores, GPA, and institution. Consistent with the bivariate statistics, women are more likely than

men to leave engineering for another STEM major (Model 1_I in Table 3: $B = -1.46$, $p < .05$) and less likely to intend to persist in engineering in five years (Model 1 in Table 4: $B = -.878$, $p < .05$).

We find no strong differences in schools' nurturance of intentional persistence.[15] We also find no significant differences in mean expertise and career-fit confidence by school (analysis not shown but available upon request), suggesting that students develop professional role confidence similarly across the different institutional contexts in our sample. African Americans are significantly more likely than white respondents to intend to persist in engineering. This is an interesting finding that requires further research with larger samples.[16]

Model 2 adds family plans and self-assessment measures. Family plans are a marginal negative predictor of behavioral persistence, versus leaving STEM entirely (Model 2_{II} of Table 3: $B = -.701$, $p < .10$). We return to family plans explanations below with Model 4, which includes an interaction term between family plans and female. Contrary to hypotheses based on the self-assessment literature (Hypotheses 3a and 3b), math self-assessment is not a significant predictor of behavioral or intentional persistence at the stage of credential acquisition. Interaction terms (estimated in separate analyses but available on request) between gender and self-assessment variables are also insignificant.

Inclusion of family plans and self-assessment measures in the model does not reduce gender's relation to a predictor of persistence: the gender coefficient remains significant in Model 2 for both categories of the dependent variable (see Table 3). Controlling for family plans actually makes the gender coefficient in 2_{II} fully significant, suggesting that family plans may suppress the relationship between gender and behavioral persistence (versus leaving STEM entirely). Gender differences in persistence remain, net of respondents' family plans and gender differences in math self-assessment.

Model 3 adds professional role confidence effects along with family plans, self-assessments, and relevant controls. As Table 3 shows, expertise confidence is a significant and positive predictor of persisting in an engineering major, compared with switching to another STEM major (supporting Hypothesis 4a). The more confident students are in their professional expertise, the more likely they are to persist in an engineering major. However, women have significantly less of this expertise confidence than do men (see Table 2). *Ceteris paribus*, a woman with expertise confidence of 3.4 (the mean expertise confidence for men) rather than 3.1 (the mean expertise confidence for women) would be 9.3 percent more likely to persist in an engineering major rather than switching to another STEM major. Similarly, a man with expertise confidence of 3.1 instead of 3.4 would be 8.1 percent less likely to persist in an engineering major.

As Table 4 shows, career-fit confidence is also a significant and positive predictor of intentional persistence: the higher students' confidence that they will find engineering work personally satisfying and congruent with their interests and values, the greater their intentions to remain in engineering five years after graduation. As Table 2 shows, women's levels of career-fit confidence in their first year are significantly lower than men's confidence levels. *Ceteris paribus*, a woman with career-fit confidence of 3.0 (the mean career-fit confidence for men) rather than 2.7 (the mean career-fit confidence for women) would be 9.2 percent more likely to intend to persist in engineering. Similarly, a man with expertise confidence of 2.7 instead of 3.0 would be 8.6 percent less likely to intend to persist in engineering.

Gender is no longer a significant predictor of persistence once professional role confidence measures are included. Specifically, the gender coefficient is reduced by 31.8 percent (between 2_I and 3_I in Table 3) and 35.3 percent (between Models 2 and 3 in Table 4) and is no longer significant in either of these models. Gender remains significant for one persistence option in Model 3 of Table 3: men are more likely than women to leave STEM entirely.

Table 3. Coefficients from MLR Models Predicting Behavioral Persistence in Engineering Majors (Compared to Switching to Another STEM Major [I] or Leaving STEM Altogether [II]) with Family Plans, Self-Assessment, and Professional Role Confidence

	Model 1		Model 2		Model 3		Model 4	
	1_I	1_{II}	2_I	2_{II}	3_I	3_{II}	4_I	4_{II}
Female	−1.460*	1.047	−1.357*	1.452*	−.926	2.057*	−3.358	−1.691
Family Plans								
Importance of family plans (family + relationship)			−.128	−.701†	−.205	−.946†	−.914	−1.362*
Family plans × female							.982	1.440
Self-Assessment								
Math self-assessment			.014	.643	−.116	.575	−.160	.670
Writing self-assessment			−.275	−.508	−.365	−.235	.394	−.272
Professional Role Confidence								
Expertise confidence					1.781*	−.263	1.849*	−.311
Career-fit confidence					−.625	−.624	.652	−.750
Institutional Effects (MIT is reference category)								
UMass	−.266	−.041	−.211	−.027	−.123	−.006	−.034	−.059
Smith	.128	−.288	.083	−.417	.045	−.947	.102	−1.015
Olin								
Individual Controls								
Hispanic or Latino	.263	−.345	.245	−.659	.588	−.362	−.555	−.313
African American	−.884	−1.172	−.777	−.666	−.731	−1.154	−.698	−1.144
Asian	−.912	.526	−.812	.292	−.822	.336	−.888	.272
GPA	.237	.836	.348	.747	.315	1.161†	.486	1.240†
SAT math	.003	−.001	.002	−.004	.002	−.003	−.003	−.004
SAT verbal	.007†	.007	.009†	.011*	.010†	.008	.011	.009
Mother's education	−.183	.144	−.237	.165	−.181	.343	−.146	.385
Father's education	−.284	−.271	−.236	−.322	−.282	−.348	−.311	−.372
Intercepts	1.236	2.607	.889	1.863	2.827	4.772	2.610	5.099
Pseudo *R*-Squared	.212		.258		.314		.332	

Note: $N = 205$. We exclude Olin students from the behavioral persistence analyses because Olin is an engineering-only college. Model 1 = controls only; Model 2 = Model 1 + family plans and self-assessment measures; Model 3 = Model 2 + professional role confidence measures; Model 4 = Model 3 + interaction term between family plans and female. The first column in each model (I) predicts persisting in an engineering major, compared to switching to another STEM major (positive values = increases likelihood of persisting); the second column in each model (II) predicts persisting in an engineering major, compared to leaving STEM entirely (positive values = increases likelihood of persisting). Results on math self-assessment and family plans remain the same whether they are included in the model separately or together. Expertise confidence and career-fit confidence measures retain the same significance levels even if they are included in the models separately and when self-assessment and family plans measures are removed.
†$p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$ (two-tailed test).

Expertise and career-fit confidence work similarly for men and women (i.e., interaction terms with gender are insignificant), but we find interesting differences in the effectiveness of these types of confidence by race/ethnicity. Expertise and career-fit confidence are significant predictors of persistence for white students (the reference group). For Hispanic and Asian/Asian American students, effects of professional role confidence measures on

Table 4. Coefficients from Ordered Logit Models Predicting Intentional Persistence in Year 4 with Family Plans, Self-Assessment, and Professional Role Confidence

	Model 1	Model 2	Model 3	Model 4
Female	−.878**	−.834*	−.540	−3.787**
Family Plans				
Importance of family plans (family + relationship)		−.136	−.276	−1.167**
Family plans × female				1.554**
Self-Assessment				
Math self-assessment		.155	.145	.343
Writing self-assessment		−.176	−.061	−.150
Professional Role Confidence				
Expertise confidence			.060	.139
Career-fit confidence			1.063*	1.196**
Institutional Effects (MIT is reference category)				
UMass	−.397	−.186	−.605	−1.224
Smith	−.461	−.299	−1.069	−1.004
Olin	−.684	−.607	−.594	−.295
Individual Controls				
Hispanic or Latino	−.159	−.315	−.486	−.021
African American	20.623***	20.578***	19.564***	19.769***
Asian	−.095	−.158	−.158	−1.000*
GPA	.218	.106	.093	.612
SAT math	−.009*	−.009*	−.008†	−.004
SAT verbal	.000	.001	−.002	−.002
Mother's education	−.035	−.055	−.019	.114
Father's education	.006	.023	−.048	−.139
Thresholds: 1	−9.873	−9.927	−8.686	−4.341
2	−8.467	−8.856	−7.306	−3.039
3	−7.155	−7.211	−5.870	−1.824
Pseudo *R*-Squared	.151	.159	.238	.262

Note: N = 288. Model 1 = controls only; Model 2 = Model 1 + family plans and self-assessment measures; Model 3 = Model 2 + professional role confidence measures; Model 4 = Model 3 + interaction term between family plans and female. We also performed versions of this analysis stratified by sex, to investigate whether there are any significant differences in effects of the variables between men and women. The only significant difference we identified is for the importance of traditional family plans. As a result, we include that interaction term in the model presented, but not other interaction terms. Results on math self-assessment and family plans remain the same whether they are included in the model separately or together. Expertise confidence and career-fit confidence measures retain the same significance levels even if they are included in the models separately and when self-assessment and family plans measures are removed.
†$p < .10$; *$p < .05$; **$p < .01$; ***$p < .001$ (two-tailed test).

persistence are significantly stronger. (Interactions between expertise confidence and the Hispanic identification measure in intentional persistence regressions, and interactions between career-fit confidence and the Asian/Asian American indicator in engineering major persistence, are significant and positive; results available on request.) Effects of expertise and career-fit confidence on persistence for other racial/ethnic groups do not differ significantly from the reference category. As noted earlier, there are no significant differences in expertise

and career-fit confidence by race/ethnicity, so these interaction terms suggest different degrees of the importance of professional role confidence across racial/ethnic groups. Expertise confidence, for example, may be particularly important for Hispanic students, who may face additional stereotypes that they are less technically inclined than white or Asian students (Eglash 2002). We hope these racial/ethnic differences in effectiveness of professional role confidence will encourage future work with larger samples.

Model 4 adds an interaction between family plans and female. For both persistence measures, we see an opposite trend than that expected from Hypothesis 1a. For men (whom the family plans coefficient now represents), the importance of family plans has a negative impact on their persistence in an engineering major versus switching to another STEM major (4_{II} in Table 3: $B = –1.362$, $p < .05$) and on their intentions to be an engineer in five years (Table 4: $B = –1.167$; $p < .01$). The significant family plans × female interaction ($B = 1.554$, $p < .01$) in Table 4 means that the effect for women's family plans is much closer to zero ($B = .387$, not significant) than that for men, and with the opposite sign.

To better understand the nature of this interaction effect, we plot predicted intentional persistence using Model 4 coefficients in Table 4 by gender and high or low levels of traditional family plans (determined by a median split). As Figure 2 illustrates, men with low levels of traditional family plans have higher levels of intentional persistence, and women with low levels of traditional family plans have lower levels of intentional persistence. Men and women with high levels of traditional family plans do not differ in their intentional persistence. For behavioral persistence, although no coefficients are significant, they follow the same pattern as that for intentional persistence. This pattern is the opposite of that predicted by Hypothesis 1b.

DISCUSSION

This study examines two prominent social psychological explanations for women's attrition from male-dominated professions, family plans and math self-assessment, and introduces professional role confidence as a third explanation. We find no evidence that women's traditional family plans lead to their attrition during credential acquisition, nor that math self-assessment predicts persistence in engineering once men and women have selected into this major. Instead, we find that professional role confidence is significantly associated with engineering persistence, and that its differential distribution between men and women contributes to gender segregation in engineering.

We began this investigation by asking whether explanations for the differential persistence of men and women in male-dominated professions derived from research on high school students or students transitioning from high school to college apply similarly during credential acquisition. There is little consideration in the persistence literature regarding how these factors may be contingent on career stages—that is, the sequence of phases in a standard career trajectory (e.g., secondary education, credential acquisition, workforce entry, and promotion).[17] Although not directly tested, we speculate that factors that segregate at one stage (e.g., math self-assessments during the transition from high school to college) may not have strong effects at other stages. Likewise, the determinants that are important during credential acquisition may be less salient at later career stages.

Family Plans

Although family plans likely influence women's careers plans (as copious literature on work-family balance shows), we find no such effects during engineering credential acquisition. Conceivably, young women's early family plans may have already filtered them out of the pipeline before college entrance (Burge 2006). Our data call this explanation into

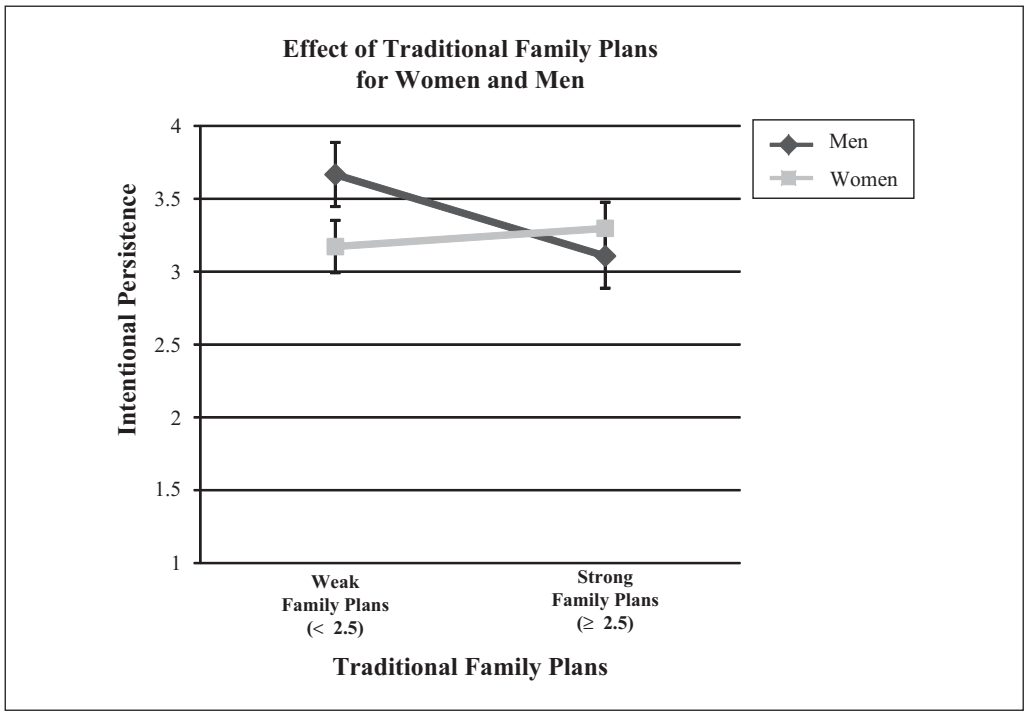

Figure 2. Intentional Persistence and the Interaction between Gender (Female = 1) and Traditional Family Plans

Note: Family plan values determined by median split. We estimated intentional persistence predictions for the four groups separately (strong and weak family plans for men and women) using Model 4 in Table 4; variables other than family plans were set to the mean of each group.

question, however, as family plans at college entry are not significantly different for women who began college as engineering majors versus those who began college as non-engineering majors.[18] It is possible, however, that effects of family plans for women emerge at a later career stage. Women in our sample have yet to face challenges of motherhood or professional work and thus may remain optimistic about their ability to effectively balance both.

By contrast, family plans appear salient for men at the stage of credential acquisition. We find that family plans are negatively associated with men's intentions to persist in engineering. Perhaps placing a lower importance on their long-term relationships and family concerns allows men to focus more fully on their engineering studies. It is also possible that men with traditional family plans expect to bear the financial burden of their households and intend to leave engineering for more lucrative professions (e.g., law or finance). This surprising finding requires more research.

Prior research suggests that the work-family balancing act weighs more heavily on women than on men (Epstein et al. 1999; Presser 1994). Our research suggests that the weight of this balancing act may hit at different career stages for men and women. More speculatively, our family plans findings may corroborate a historical shift in how men and women weigh the importance of work-family balance; compared with previous generations, men today may be thinking more seriously

about work-family balance issues (Gerson 2010). We recommend that researchers examine how family plans affect men's—as well as women's—persistence in male-dominated professions.

Math Self-Assessments

Our findings challenge the math self-assessment explanation in important ways. Even after enrolling in an undergraduate engineering program, women in our sample have significantly lower math self-assessment than do men (see Table 1). Nonetheless, math self-assessment does not predict persistence in engineering at the credential acquisition stage. The lack of effect is not necessarily surprising, given the importance of math self-assessment for choosing STEM majors in the first place. Indeed, the finding that math self-assessment is significantly and positively related to whether students enter college as engineering majors (Correll 2001) is present in our data as well.[19] However, once students matriculate into a math-intensive major, profession-specific assessments, such as expertise and career-fit confidence, seem to replace math self-assessment as predictors of persistence. Findings reported here may foreshadow students' evolving understanding of the demands of work in a professional field.

Professional Role Confidence

We identify professional role confidence, and its components of expertise and career-fit confidence, as important to students' behavioral and intentional persistence during credential acquisition. Confidence in their ability to successfully perform the professional role and to enjoy and find fulfillment in that role predicts students' behavioral and intentional persistence in engineering, respectively. We find that these dimensions of professional role confidence are cultivated more successfully among men than among women, leaving women less likely than men to continue in an engineering career. We find no difference in levels of expertise and career-fit confidence by race and ethnicity for either men or women (results not shown; available upon request). Expertise confidence, however, may be particularly important for Hispanic students' intentional persistence, and career-fit confidence may be important for Asian students' behavioral persistence.

The concept of professional role confidence has implications for explaining gendered persistence in engineering more generally. Research shows that once credentialed in engineering, women are significantly more likely to leave compared to their male counterparts (Jacobs 1989; Xie and Shauman 2003). As men and women with engineering credentials transition from school to work, our findings suggest that differential expertise and career-fit confidence, developed through formal education and training experiences, may help explain this pattern.

Although more research is required, we speculate that professional role confidence may be important for explaining gendered persistence in other male-dominated professions as well. For example, men and women have been entering medical school at relatively equal rates for some time (Institute of Education Sciences 2009); nonetheless, the distribution of men and women by medical specialty remains highly gendered. Women tend to cluster in what are seen as softer, more nurturing areas of practice (e.g., pediatrics and family care) and are underrepresented in other areas (e.g., surgery) (Boulis and Jacobs 2008). Similarly, women tend to cluster in certain basic science fields (e.g., biology and chemistry) and are underrepresented in other fields (e.g., physics) (Xie and Shauman 2003). Professional role confidence presents an opportunity to help explain these gendered patterns.

In addition to expertise and career-fit confidence, research on physicians' professional socialization suggests another potential dimension of professional role confidence that may be important as men and women begin work as practicing professionals. Fox

(1957) and Light (1979) suggest that learning to cope with uncertainty is an important part of professional socialization. If we consider the ability to cope with uncertainty as a form of confidence, several types of uncertainties Light (1979) identifies among medical students map onto our expertise and career-fit confidence constructs.[20] Notably, however, two types of uncertainty do not: uncertainties in interacting with instructors and patients.

Although professions vary in their degree and nature of interactions with clients, instructors, and other professionals, we suggest that *relational confidence* is likely an important additional dimension of professional role confidence. Relational confidence may have components depending on whether an interaction is with other members of the profession (e.g., in informal intraprofessional joking [Faulkner 2000] or formal patient hand-offs [Kellogg 2009]), with clients (e.g., a physician's bedside manner [Becker et al. 1961] or a lawyer's personal touch [Seron 1996]), or with the general public (see Cahill's [1999] discussion of morticians' emotional capital). Relational confidence may also include role-appropriate mannerisms, demeanor, and dress that are expected in professional settings (e.g., cursing and masculine norms of dress on oil rigs [Miller 2003]). A professional's confidence in navigating across these role interactions, and being able to present oneself in a role-appropriate manner, may be a critical confidence needed to continue and succeed in a career.

If a profession's norms of interaction are highly masculine or perhaps even antifeminine (as Turco [2010] documents among professionals in the leveraged buyout industry), it may be more difficult for women to gain this type of confidence. The finding that men engineering students can develop their engineering identity via interactions with a randomly selected same-gender engineering student, while women engineering students cannot (Rubineau 2007), could indicate that relational confidence contributes to gendered engineering persistence even during credential acquisition. Just as relational dimensions of professional role confidence may become more important at later stages of a career trajectory, expertise confidence and career-fit confidence may become less important. Future research should explore professional role confidence, its constituent dimensions, and whether, when, and how these dimensions develop and affect persistence.

Engineering Persistence

A strength of this study's analytic approach is its multifaceted measurement of engineering persistence. By examining behavioral and intentional measures of persistence, we can be more certain of how theorized antecedents of persistence actually influence decisions to stay or leave. In addition, our use of a three-category measure of behavioral persistence presents a refinement for explaining gendering of STEM majors and shows that destinations of students exiting one major and transferring to another are important beyond students' decisions to leave. We find a gendered pattern in students' attrition from engineering majors. Women who leave engineering majors are more likely to end up in another STEM major rather than to leave STEM entirely. Men are less likely than women to leave engineering, but when they leave, they are more likely to leave STEM majors entirely than to switch over to another STEM major. These gendered patterns in exiting students' destinations present an important topic for future research.

CONCLUSIONS

This study contributes to our understanding of gendered persistence in male-dominated, math- and science-intensive professions by introducing the concept of professional role confidence. Through professional education, students are expected to develop views of themselves as competent, skilled, successful professionals and to become committed to and enthusiastic about their future careers. Present findings show that early professional role

confidence predicts persistence measured three years later. If women develop less confidence about their abilities to be successful professionals and express more ambiguity about their fit or comfort within the discipline, then women will remain in engineering at lower rates than men.[21]

Our approach shows that different social psychological factors matter for different measures of persistence; factors are not similarly salient for short-term decisions (i.e., persistence in a major) as they are for decisions about career launch (i.e., intent to persist in a profession in five years). Expertise confidence matters for persistence in an engineering major rather than leaving for another STEM major, but it has little impact on plans for a future career in engineering. By contrast, career-fit confidence is strongly and positively related to future career plans. It appears that concerns about how one expects to fit with conventional occupational norms is a strong determinant of career plans, more so than students' confidence in their engineering competencies.

Findings reported here have important policy implications. How might professional role confidence be fostered in young women (and men)? Professional socialization available through class lectures, lab exercises, and group activities alone seems unlikely to help students develop adequate professional role confidence, and, as discussed previously, likely aggravates gender discrepancies in this confidence. Engineering programs may more effectively develop professional role confidence through direct discussion about professional roles, expertise, and career fit.

One approach might be to offer a directed internship seminar that places students with working engineers on a real-world engineering project. This experience would integrate explicit learning objectives related to advancement in an engineering career with a broad range of skills required for success as an engineer. This form of practical integrated learning, designed in part by educators familiar with gender biases in the profession, could help broaden students' often narrow conceptions of the engineering role to include a wider breadth of competencies (e.g., communication and teamwork) that are actually part of professional expertise. Such experiences could also increase students' awareness of the spectrum of careers available under the umbrella of engineering, allowing more students to find their fit within the profession.

In conclusion, we note important caveats: our results are based on a small, longitudinal sample of students at four U.S. institutions. Although our sample allows us to examine effects of family plans, math self-assessment, and professional role confidence on persistence with an appropriate time lag, there are several limitations to our study. First, our sample is not representative of all institutions of higher education in the United States. We hope questions capturing professional role confidence will be included in future nationally representative samples to ensure these trends are generalizable. Second, due to time constraints in survey administration, we were not able to ask respondents about their professional role confidence and family plans at multiple points, making it difficult to track whether and to what extent their views changed over time. Finally, we would have liked to have a multidimensional scale for math self-assessment to enhance construct validity (see, e.g., Correll 2004).

We hope others will continue this research with larger samples and extend it to other professions, taking seriously how the structure of normative career trajectories and institutionalized decision points influence the social psychological factors in play. Attention to stage-specific factors may not only help research more accurately capture determinants of persistence, but could be key to developing outreach and policy initiatives tailored to specific stages in professional careers.

APPENDIX

Table A1. Pearson Correlations between Variables Used in the Analyses ($N = 288$)

	1. Behav. Persist.	2. Intentl. Persis.	3. Impt. of Family	4. Math Self-Assess	5. Writing Self-Assess	6. Female	7. MIT	8. UMass	9. Olin	10. Smith	11. GPA	12. SAT Math	13. SAT Verbal	14. Mom Edu.	15. Dad Edu.	16. Expert. Conf.	17. Career-Fit Conf.	18. Hisp. or Latino	19. African Amer.	20. Asian Amer.
1.	NA																			
2.	−.310***																			
3.	−.005	.027																		
4.	−.032	.041	.103																	
5.	−.016	−.085	.004	.200**																
6.	.013	−.095	.048	−.113	−.020															
7.	−.060	.001	.068	.119	.010	−.051														
8.	−.004	−.027	−.058	−.135*	−.061	−.224***	NA													
9.	−.016	.001	−.086	.005	.087	−.053	NA	NA												
10.	.006	.036	.082	−.047	−.069	NA	NA	NA	NA											
11.	−.086	.069	.025	.231**	.052	.061	.096	−.190*	.013	.063										
12.	−.139	−.068	−.003	.331***	.092	−.073	.407***	−.574***	.188**	−.276***	.282**									
13.	−.156*	−.094	−.024	.274**	.374***	.012	.285***	−.468***	.243**	−.278***	.283**	.566***								
14.	−.018	−.073	.133*	.206**	.105	−.027	.086	−.198**	.068	−.005	.055	.262***	.271***							
15.	.026	−.100	.167*	.228**	.210***	.002	.145*	−.198***	.028	−.048	.027	.272***	.328***	.637***						
16.	.006	.207**	.109	.357**	.188**	−.342***	.002	−.034	.057	−.048	−.055	.032	.151	.131	.162*					
17.	−.049	.360**	.065	.055	.067	−.287**	.045	.039	−.062	−.043	−.123	−.105	−.018	−.039	−.004	.633***				
18.	−.070	−.087	−.069	.200**	.182**	.042	−.121	.066	.131*	−.060	.197*	.118	.255**	.077	.056	−.039	−.162*			
19.	.105	.018	.022	−.035	−.035	.087	.075	−.084	−.039	.033	−.059	−.109	−.064**	−.040	−.077	−.003	.065	.055		
20.	−.058	−.122	−.050	.042	−.064	.126	.288***	−.182**	−.094	−.157**	.075	.379***	.197**	.029	.149*	−.076	−.096	.157*	.080	NA

Note: NA = not applicable.
†$p < .10$; *$p < .05$; **$p < .01$; ***$p < .001$ (two-tailed test).

Authors' Note

These data will be archived through ICPSR once the authors have completed their planned analyses.

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Notes

1. A rich literature addresses perpetuation of gendered career interests throughout childhood, secondary and higher education, and careers (Charles and Bradley 2009; Eccles 1994; Kilbourne et al. 1994). Here, we examine issues that emerge after men and women express interest in a STEM profession.
2. Per our IRB approvals at each institution, we have permission to use the names of each school.
3. This explanation has roots in neoclassical economics and psychology (e.g., Becker 1964; Ceci and Williams 2011; for a critique, see England 1984). We focus here on recent social psychological scholarship that emphasizes cultural foundations of these choices rather than rational calculation of long-term costs and benefits.
4. Women in STEM majors often outperform men: women take fewer math and science courses in high school, on average, but they do better in these courses and have higher high school GPAs than do men (Xie and Shauman 2003).
5. Women often internalize the fear that others judge their math abilities along popular misconceptions of gender (Steele 1997). This stereotype threat encourages women to disidentify with math-related realms, reconceptualizing their values so as to remove math-related areas as domains for self-evaluation (Spencer, Steele, and Quinn 1999).
6. The subsample of students in our study who entered college as engineering majors have significantly higher math self-assessment at college entry ($p < .05$) than do the subsample of non-engineering students.
7. Decomposition of our professional role confidence construct into an expertise/competence component and a fit/normative component is consistent with and similar to a convention from the large and related literature on self-concept, esteem, and identity (Cerulo 1997; Owens et al. 2010). In this literature, confidence-related concepts such as self-esteem (here, more similar to specific self-esteem than global self-esteem [Rosenberg et al. 1995]) are often decomposed into competence and worth dimensions (Cast and Burke 2002).
8. Psychological concepts of intrinsic value, utility value, and attainment value appear to capture similar aspects of confidence as our notion of career-fit confidence, but these measures are conceptualized and empirically studied at the task level (e.g., Watt 2008).
9. Olin is an engineering-only college, thus students may not switch to a non-engineering major and remain enrolled in the institution. We therefore exclude Olin students when testing for behavioral persistence.
10. Students entered the panel in a two-step process: first, we invited students to participate, next, we distributed the survey. The resulting panel consists of students who completed this first survey. At UMass, we oversampled students who indicated an interest in engineering. The response rate at each institution is as follows: 29.2 percent at MIT, 39.6 percent at Smith, 73.3 percent at Olin, and 40.1 percent at UMass. The high response rate at Olin is advantageous, given the small size of each cohort.
11. Engineering and pre-engineering students at all four schools take at least one introductory engineering course in their first year.
12. Although "my ability to be successful in my career" references students' "career," this question captures students' confidence that they have the requisite skills to succeed in an engineering career (a component of expertise confidence) rather than their confidence that they personally fit in engineering.
13. We included interaction terms between gender (female = 1) and each of the key independent variables in the model one at a time to identify whether family plans, math self-assessment, or the professional role confidence measures predict persistence differently for men and women. Only the family plans × female interaction term is significant.
14. Tolerance values are not directly calculated for MLR, so we ran diagnostic OLS models to check for possible multicollinearity. We ran OLS regression models representing the right- and left-hand columns of each behavioral persistence model. We also found tolerance statistics for the intentional persistence logits. For all models, VIF values for noninteracted independent variables do not exceed 3, and VIF values for interacted variables are within the standard tolerance cutoff of 10 (Robinson and Schumacker 2009).
15. Our previous research using this sample found that which school students attend affects persistence only if students come into the program unsure of their commitment to engineering (see Rubineau et al. 2008).

16. While a larger and more representative sample is required, we speculate that this result may be driven by socioeconomic status differences between African American and white respondents. Although not a significant difference, the mean family income of African American students is about $20,000 less than that of white students. Consistent with Ma's (2009) finding that lower-income students are more likely to select undergraduate majors that lead directly to high-income, economically secure employment, African American students in our sample may be more inclined to persist in an engineering career, where stable, well-paying jobs are relatively abundant. Why this effect occurs for intentional but not behavioral persistence is a question for future research.
17. We do not intend to invoke a lock-step career path similar to the pipeline analogy. Rather, we define stages by the credentials and experience required to advance. One must have a high school degree (or GED) to advance to college, a college degree to go to professional school, a credential to advance to the workforce, and workplace experience to advance in the professional hierarchy.
18. Importance of family plans among women who entered college as engineering majors (mean = 2.39) is not significantly different from the importance of family plans for women who entered college as non-engineering majors (mean = 2.31). The same is true for men: mean traditional family score for men entering as engineering majors is 2.31; mean traditional family score for men entering as non-engineering majors is 2.21.
19. Year 1 math self-assessment is significantly and positively associated with Year 1 engineering enrollment (0 = no, 1 = yes) in a logistic regression model (results available upon request) with the relevant control variables (i.e., gender, SAT math and verbal scores, school, and parents' education).
20. Diagnosis and treatment uncertainty involve the technical knowledge and expertise needed in the profession. Resolution of these types of uncertainties (by either tolerance or reduction of uncertainty) corresponds to the development of expertise confidence. Professional knowledge uncertainty, which is resolved by gaining sufficient knowledge about the profession to allow students to identify the medical specialty that is the best fit for them personally (Light 1979), is analogous to our career-fit confidence component.
21. In developing these ideas, it is important to underscore that women in this study are at the far end of the high achievement continuum. A similar study design at less elite institutions would probably reveal even greater differences between men's and women's professional role confidence.

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