

Examining the minimal combined effects of gender and minoritized racial/ethnic identity among academic entrepreneurs

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Abstract

Purpose – This study examined differences related to gender and racial/ethnic identity among academic researchers participating in the National Science Foundation's "Innovation-Corps" (NSF I-Corps) entrepreneurship training program. Drawing from prior research in the fields of technology entrepreneurship and science, technology, engineering and mathematics (STEM) education, this study addresses the goal of broadening participation in academic entrepreneurship.

Design/methodology/approach – Using ANOVA and MANOVA analyses, we tested for differences by gender and minoritized racial/ethnic identity for four variables considered pertinent to successful program outcomes: (1) prior entrepreneurial experience, (2) perceptions of instructional climate, (3) quality of project team interactions and (4) future entrepreneurial intention. The sample includes faculty ($n = 434$) and graduate students ($n = 406$) who completed pre- and post-course surveys related to a seven-week nationwide training program.

Findings – The findings show that group differences based on minoritized racial/ethnic identity compared with majority group identity were largely not evident. Previous research findings were replicated for only one variable, indicating that women report lower amounts of total prior entrepreneurial experience than men, but no gender differences were found for other study variables.

Originality/value – Our analyses respond to repeated calls for research in the fields of entrepreneurship and STEM education to simultaneously examine intersecting minoritized and/or under-represented social identities to inform recruitment and retention efforts. The unique and large I-Corps national dataset offered the statistical power to quantitatively test for differences between identity groups. We discuss the implications of the inconsistencies in our analyses with prior findings, such as the need to consider selection bias.

Keywords Academic entrepreneurship, Technology commercialization, Entrepreneurship education, Gender, Race, Ethnicity

Paper type Research paper

Introduction

Academic entrepreneurship, or the involvement of faculty and graduate students in the establishment of startup companies originating from university research, is considered by many to be a critical vehicle for economic and social development (Audretsch, 2014; Hayter *et al.*, 2018; Shane, 2004). To advance these activities at research-intensive universities,



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resources are being directed at training and initiatives designed to position institutions as hubs of entrepreneurial activity (Feola *et al.*, 2021; Siegel and Wright, 2015). As a result, entrepreneurship is increasingly viewed as a favorable activity in which academic researchers can become involved, given its potential benefits to universities and society (Civera *et al.*, 2020; Huang-Saad *et al.*, 2017).

Because women and members of minoritized racial/ethnic groups are less well represented than majority group men in science and engineering fields where new technology innovations originate (Marra *et al.*, 2012), attention is being paid to ensuring that involvement in academic entrepreneurship is equitable across a range of social identity groups (Abreu and Grinevich, 2017; Fechner and Shapanka, 2018; Parker *et al.*, 2017). Most academic entrepreneurs work in science and engineering fields, from which minoritized groups have long been excluded because of structural barriers (Jackson *et al.*, 2022; Marra *et al.*, 2012). Concerns about diversity and inclusivity are grounded in research indicating that women, immigrants, and people of color continue to experience bias in the entrepreneurial domain (Carter *et al.*, 2021; Marlow and McAdam, 2015), particularly within technology entrepreneurship (Wheadon and Duval-Couetil, 2019).

Historically, studying demographic disparities in academic entrepreneurship has been challenging because most datasets are not sufficiently large or diverse to allow us to examine group differences across key variables that impact participation and outcomes. However, the National Science Foundation's Innovation-Corps (NSF I-Corps) program in the United States offers a unique opportunity to use quantitative analyses to examine participant subgroups, given its national scale and standardized curriculum. Launched in 2011, I-Corps is a multi-week, cohort-based training program designed to prepare faculty and graduate students in science and engineering fields (hereafter referred to as STEM fields) to conduct market research and develop business models, thus enabling them to commercialize technologies based on their academic research (for a full description of the program see Huang-Saad *et al.*, 2017).

Given efforts to broaden participation in academic entrepreneurship, we explore the intersecting effects of gender identity and racial/ethnic identity on four variables that are important for participation and persistence in technology commercialization training and entrepreneurship. These variables include: (1) how participants differ in terms of prior experience that are precursors to interest and activity in technology commercialization; (2) perceptions of the instructional context and climate; (3) quality of team interactions; and (4) the degree to which training impacts the intention to pursue entrepreneurial activity. Given our results, we also highlight the practical and methodological issues associated with studying a highly self-selected population of academic researchers.

Gender and academic entrepreneurship

Not only are women underrepresented in STEM faculty positions (Sheltzer and Smith, 2014), but women in academia also engage at a lower rate than their male peers in academic entrepreneurship activities, such as patenting, licensing, consulting, and developing social connections with private industry (Abreu and Grinevich, 2017; Goel *et al.*, 2015). Recent reviews of the literature on gender differences in academic entrepreneurship document a variety of possible contributing factors to this trend (Karataş-Özkan and Chell, 2015; Parker *et al.*, 2017; Poggesi *et al.*, 2020), including inequalities in family time constraints (Busolt and Kugele, 2009), experiences of institutional bias (Giuri *et al.*, 2020), a lack of experience and familiarity with the topic (Woolley, 2019b), and lower access to resources such as incubators (Marlow and McAdam, 2012).

Women in STEM also face negative stereotypes about their competence similar to those associated with women entrepreneurs (Gupta *et al.*, 2009), leading scholars to describe

technology entrepreneurship as involving a “doubly masculine stereotype” (Cohoon, 2011). For example, both men and women hold the view that feminine traits are incompatible with entrepreneurial traits (Ahl and Marlow, 2012). Risk taking, in particular, is stereotyped as an ability that is less present among women but important for success as an entrepreneur (Patterson *et al.*, 2012). Research has revealed that repeated experiences with these negative stereotypes can lower women’s confidence in their abilities and eventually lead to disengagement from these fields (Marlow and McAdam, 2012).

Delivering technology entrepreneurship training and professional development courses to women represents an avenue for academic institutions to this group’s unique challenges (Byrne and Fayolle, 2010; Wheadon and Duval-Couetil, 2017). Scholars have pointed out that curriculum, pedagogy, and recruitment efforts must minimize gender-based structural biases and negative stereotypes that can lead to program designs that perpetuate existing disparities (Joensuu *et al.*, 2013; Westhead and Solesvik, 2016). At worst, educational programs in entrepreneurship that portray the abilities needed for success as incompatible with stereotypically feminine gender roles, or that inadvertently exaggerate the lack of women in these fields, can discourage women from participating (Achtenhagen and Welter, 2011; Westhead and Solesvik, 2016).

Program administrators and instructors considering the value or even appropriateness of customizing entrepreneurship training for specific social identity groups, must be aware that results are mixed, which many researchers attribute to context. Some scholars have found stronger positive effects on entrepreneurial self-efficacy for female students (Wilson *et al.*, 2007), some report that they benefit less (Joensuu *et al.*, 2013; Shinnar *et al.*, 2014; Westhead and Solesvik, 2016), and others have found no significant gender differences (Bae *et al.*, 2014). Because of these inconsistent results, researchers highlight the need for research to identify the characteristics of educational programs that are particularly effective for women (Bullough *et al.*, 2015). For example, evidence suggests that participating in “social entrepreneurship” is less incongruent with feminine gender stereotypes than other subdisciplines of entrepreneurship (Dimitriadis *et al.*, 2017; Lortie *et al.*, 2017; Nicolás and Rubio, 2016) and can be effective if specifically designed to improve women’s entrepreneurial self-efficacy (Rosca *et al.*, 2020; Wilson *et al.*, 2007). Investigating the factors that moderate the effects of instruction is challenging in the field of entrepreneurship due to the diverse instructional approaches and varying contexts (Yi and Duval-Couetil, 2021).

A substantial body of literature has analyzed barriers to the participation of women and minoritized groups in entrepreneurship activities; however, research on specific gender disparities within academia is more limited (Abreu and Grinevich, 2017; Miranda *et al.*, 2017). Many individual, contextual, and cultural factors are believed to limit access and success for minoritized entrepreneurs. To capture these barriers, Wheadon and Duval-Couetil (2019) created a “capital framework” to communicate the forms of *external* and *internal capital* associated with success in technology entrepreneurship. These include often-cited disparities in *social* and *financial capital* (external capital), with the addition of *human* and *cognitive capital* (forms of internal capital). The latter comprises self-efficacy beliefs and motivation, which are strongly affected by contextual factors and influence whether one views themselves as a technology entrepreneur. Our study uses this framework as a foundation to examine the extent to which participants face select barriers in the I-Corps training program. The theoretical and practical foundations associated with these forms of capital and their role in this study are described below.

Human capital refers to resources represented by skills and abilities developed through education, training, and other accumulated experience such as employment. Individuals who start businesses usually have prior work experience in a related field (Klyver and Schenkel, 2013; Millán *et al.*, 2014), and research has found that academics have more positive attitudes toward entrepreneurship if they have prior business experience (Abreu and Grinevich, 2013;

Neves and Brito, 2020). Therefore, differences in education and early career experiences are often proposed as contributing factors to overall disparities in entrepreneurship engagement (Dohse *et al.*, 2021; Hayter *et al.*, 2021).

Cognitive capital describes psychological resources beyond skills that influence task success, such as confidence and motivation. In fields where identity groups are underrepresented or experience negative stereotypes, they often have lower self-efficacy than majority group members (Dohrman, 2010; Fox and Xiao, 2013; MacPhee *et al.*, 2013), even when they demonstrate high levels of achievement or performance (Kay and Shipman, 2014; Wilson *et al.*, 2007). In entrepreneurship, women usually report lower self-efficacy than men (Dempsey and Jennings, 2014), which is also related to lower entrepreneurial intention (Nowiński *et al.*, 2019; Westhead and Solesvik, 2016).

Social capital refers to the resources and assistance that individuals gain through their interpersonal connections, including their number of contacts, the extent to which assistance may be withheld due to bias, and the climate of the immediate social context. Social and financial capital have long been cited by researchers as barriers to participation in technology entrepreneurship (Robb *et al.*, 2014). For example, studies of academic entrepreneurship have found that women have fewer relevant business and industry contacts than men (Stephan and El-Ganainy, 2007), which may explain why female faculty members seek more help from university technology transfer offices (TTOs). Further, proposed disparities in social capital include a lack of female mentors, which is a major challenge in technology entrepreneurship (Robb *et al.*, 2014), as well as “solo status”, or the state of being the only representative of one’s social identity group on a team (Sekaquaptewa, 2018).

Finally, *financial capital* or monetary resources represent an essential form of capital in technology entrepreneurship. Although not addressed specifically in our analyses, barriers to obtaining financial resources are closely connected to other forms of capital. For example, female entrepreneurs receive less private investment than male entrepreneurs with equal levels of previous experience and begin companies with less initial capital overall (Tinkler *et al.*, 2015).

Racial and ethnic identity in academic entrepreneurship

Racial/ethnic identity groups in the United States other than “White/European American” and “Asian/Asian American” identification are currently considered “minoritized” or underrepresented in the field of technology entrepreneurship. It is clear that minoritized racial/ethnic groups participate at disproportionately lower rates in innovation activities such as patenting (Cook, 2020; Lawton Smith *et al.*, 2017; Milli *et al.*, 2016), a difference that is greater in academia than in industry (Lawton Smith *et al.*, 2017; Sugimoto *et al.*, 2015). The use of the term “minoritized” rather than “minority” recognizes that systemic inequalities, oppression, and marginalization place individuals into “minority” status rather than their own characteristics.

With academic entrepreneurship requiring advanced STEM education, a significant challenge to broadening participation is the lower enrollment of minoritized racial/ethnic groups in STEM doctoral programs (National Center for Science and Engineering Statistics, 2023). A wide range of barriers to participating and persisting in STEM have been described (Grossman and Porche, 2014; Schmader, 2023). These include institutional discrimination (Casad *et al.*, 2021; McGee, 2020; Zhao and Yang, 2021), a lack of supportive mentors and peers (Assenova, 2020), racial microaggressions (Lee *et al.*, 2020; Ometto and Offidani-Bertrand, 2022), and higher levels of stress (Burt *et al.*, 2018; Niemann and Sanchez, 2015). Researchers have portrayed STEM fields as being characterized by beliefs that success depends on innate ability, leading to the reinforcement of stereotypes that members of minoritized racial/ethnic groups lack competence (Thébaud and Charles, 2018).

Classes that help participants develop a scientific identity have been found to encourage interest in STEM career paths (Maton *et al.*, 2016). Similarly, experiential programs such as I-Corps can provide the education and social support that can encourage interest in entrepreneurship. As in the case of gender disparities, education and professional development programs are positioned to either mitigate or exaggerate existing stereotypes and biases associated with minoritized racial/ethnic identities. When individuals experience conflict between racial/ethnic and scientific identity (McCoy *et al.*, 2015), social support becomes particularly important (Fries-Britt and Holmes, 2012; Harper and Porter, 2012; Ong *et al.*, 2018).

Need for an intersectional approach

An “intersectional” approach to the study of social identities reflects a need to explore the experiences of individuals who identify with more than one historically disenfranchised group simultaneously (Cho *et al.*, 2013). For example, rather than assume that the implications of identifying with a minoritized racial/ethnic group in a particular context will be similar for both men and women, an intersectional approach starts from the assumption that individuals with each combination of gender and racial/ethnic identity will have unique experiences (Essers *et al.*, 2010). While research in entrepreneurship has considered the influence of intersecting racial/ethnic, gender, social class, and religious identities (Dy and Agwunobi, 2019; Romero and Valdez, 2016; Vorobeve, 2022), only a few studies have focused on academic entrepreneurship, specifically (Jackson *et al.*, 2022; Mickey and Smith-Doerr, 2022; Nelson, 2020). One focusing on women of color found that barriers to program effectiveness included institutional hurdles, negative interpersonal interactions during instruction, and challenges to entrepreneurial identity (Jackson *et al.*, 2022).

Both racial/ethnic identity and gender identity exert an influence on every step needed to become an academic entrepreneur, including one’s choice to study a STEM discipline, becoming a professor, creating social networks, engaging with industry, and completing the patenting process (Mickey and Smith-Doerr, 2022). In the growing body of research on women of color in academia, studies show that graduate students (Ong *et al.*, 2011) and faculty in STEM disciplines (Hurtado *et al.*, 2012) frequently experience gender and racial/ethnic bias. Black/African American women face the stereotype of being “loud, aggressive, and unintelligent” (McGee, 2016) and express low levels of feelings of belonging (Ong, 2005), factors that ultimately negatively impact their mental health (McGee, 2020; Perry *et al.*, 2012).

Given the barriers described above, successful academic entrepreneurship outcomes among women and minoritized racial/ethnic group members may emerge from exceptionally high performers, a pattern similar to the “overqualification” effect (Campbell and Hahl, 2020). This refers to cases where women appear “overqualified” compared to their male peers at the same level of seniority in an organization, and reflects the discounting of women’s credentials and abilities in hiring and performance evaluations (Botelho and Abraham, 2017; Quadlin, 2018; Sarsons *et al.*, 2021). In these situations, women must be more experienced and better prepared to compensate for negative stereotypes about their abilities. Women in male-dominated fields also employ various strategies to avoid becoming the target of negative ability stereotypes. For example, women in STEM fields report attempting to minimize the importance of gender when interacting with colleagues (Britton, 2017; Rhoton, 2011). Similarly, women act like “honorary men” to gain the respect of their peers, a strategy described as “game playing” (Marlow and McAdam, 2015).

To complement the primarily qualitative nature of research in this area to date, scholars have called for additional quantitative studies to address intersecting social identities in entrepreneurship participation (Bowleg and Bauer, 2016; Dy and Agwunobi, 2019; Jackson *et al.*, 2016). Addressing the topic of intersectionality using quantitative analyses presents

methodological challenges present at every stage of the research process, from study participation and survey measures to response and social desirability biases, which can distort or mask the ability to detect group differences. Notably, a “selection effect” caused by barriers in the sequence of events required to join a profession or institution may limit the generalizability of the results to a broader population. Furthermore, differences in the results of qualitative and quantitative studies could mean that the measures being used are not adequate to document institutional biases and subsequently address them.

NSF I-Corps program

This study uses data from the NSF I-Corps program, a nationwide entrepreneurship training program targeting faculty and graduate students in science and engineering disciplines. First piloted in May 2011 (Nnakwe *et al.*, 2018), the program was designed to address two critical challenges associated with academic entrepreneurship: a lack of understanding of the need for product-market fit, and the disconnect between universities and the social and professional networks required for commercialization activity. The curriculum is based on Steve Blank’s Lean LaunchPad approach to startups and a methodology called “customer discovery,” which requires entrepreneurs to speak with 100 potential customers and stakeholders to determine whether their products are commercially viable (Nnakwe *et al.*, 2018).

According to the NSF, over 2,500 teams have participated in the program to date, with most of the grants being awarded through the NSF’s Directorate for Engineering (National Science Foundation). Faculty who received NSF research grants within a prior five-year period are eligible to apply to I-Corps in teams of three (VentureWell, 2019). The Principal Investigator (PI), usually a faculty member or academic researcher, represents the primary source of technical expertise. The Entrepreneurial Lead (EL) is considered the primary full-time leader of a project and is usually a graduate student or postdoctoral researcher. The I-Corps Mentor (IM) is typically a volunteer advisor from a relevant industry (Blank and Engel, 2016). During the study period, the intensive training involved in-person classes at the beginning and end of a seven-week period, with online instruction in between. Teams complete market research interviews during this period, most of which are conducted by the ELs. Teams receive \$50,000 grants to be used for travel associated with conducting customer discovery and salary support for the EL. Participants report that the program requires full-time immersion, precluding other major commitments such as teaching or taking classes (Duval-Couetil *et al.*, 2021).

Given its size, the I-Corps dataset presents a unique opportunity to examine demographic variables because it offers sufficient statistical power to detect differences based on intersectional group identities. It also reflects the experiences of individuals across the U.S. who were exposed to a standardized curriculum and approach, which is a pervasive methodological challenge in measuring the impact of educational interventions (Yi and Duval-Couetil, 2021). Most institution-specific programs do not have the number of participants necessary to examine these differences, and cross-institutional studies are challenging because of the heterogeneity of education and training programs.

Hypothesis development

Identifying factors underlying the differential participation of women and minoritized racial/ethnic group members in technology entrepreneurship has important implications for recruiting diverse participants, creating an environment and culture that promotes belonging, developing effective pedagogy, and measuring the impact of training. Given efforts to broaden engagement, we explored the intersecting effects of gender identity and racial/ethnic identity on four variables important for participation and persistence in

academic entrepreneurship. We focus our hypotheses on well-documented barriers described by the “capital framework” that are pertinent to academic entrepreneurship and the I-Corps team-based training format specifically (see Figure 1). Based on the literature, we propose that pervasive barriers exist for historically disenfranchised groups in obtaining each type of capital, implying that significant differences will be found in all study variables. Therefore, confirming the predictions of this framework would be represented by finding significantly lower levels of each of the following three forms of capital among women and minoritized racial/ethnic group members. Conversely, null results could either represent a lack of the proposed structural barriers, unique characteristics of the sample population, or methodological concerns in this area of study.

First, we examined human capital to understand the relevance of professional activities that are not strictly aligned with traditional academic work and in which women and minoritized groups participate less. Second, we explored the instructional climate, which may include biases conveyed by curricula, instructor exchanges, or participant interactions consistent with stereotyping in STEM and entrepreneurship communities. Third, given I-Corps’ collaborative team-based training format, we examined social capital in the form of perceptions of team interactions, based on research showing that social support can influence entrepreneurial and educational outcomes. Fourth, we examined cognitive capital based on research findings showing that underrepresentation and negative stereotypes lead to lower self-efficacy and entrepreneurial intention. Our hypotheses are as follows:

Prior entrepreneurial experience

Representing human capital, prior experience is established as a critical element of effective entrepreneurial projects (Klyver and Schenkel, 2013; Millán *et al.*, 2014). For example, previous research has demonstrated that controlling for prior experience partially explains gender differences in entrepreneurial self-efficacy (Chowdhury *et al.*, 2019). However, given the barriers facing women (Bianco *et al.*, 2017; Cabrera and Mauricio, 2017) and minoritized racial/ethnic group members (Fairlie *et al.*, 2022; Fairlie and Robb, 2010; Sabbaghi, 2019) at multiple stages of entrepreneurship participation, the opportunity available to acquire such

	Forms of Capital	Description	Prior Research Findings	Study Measures
SYMBOLIC RESOURCE (Less visible, value and access determined by perceptions and social/cultural norms and perceptions)	Cognitive	Psychological resources beyond skills that influence task success, including confidence and motivation	- Where identity groups are underrepresented or experience negative stereotypes, they have lower self-efficacy - Lower self-efficacy is related to lower entrepreneurial intention	Entrepreneurial Intention (inclination to engage in entrepreneurial activity)
	Social	Resources and assistance that individuals gain through their interpersonal connections	- Assistance and access may be withheld due to bias and climate of a context - Being only representative of one's social identity group on a team can influence outcomes	Perceptions of team interactions and instructional climate
EXPLICIT RESOURCE (Visible and concrete)	Human	Skills and abilities developed through education, training, and employment	- Entrepreneurs have prior work experience in a related field - Prior business experience leads to more positive attitudes towards entrepreneurship	Prior entrepreneurship and professional experiences
	Financial	Monetary resources deemed critical for technology entrepreneurship	- Underrepresented group members receive less private investment with equal levels of experience - Begin companies with less initial capital than majority group members	Not explicitly addressed in this study but proposed to be influenced by other forms of capital

Source(s): Derived from Wheadon & Duval-Couetil (2019)

Figure 1.
Capital framework and
study hypotheses

experience is constrained among these groups (Carpenter and Loveridge, 2018). Therefore, our hypotheses are as follows:

- H1a. Women will report less prior entrepreneurial experience.
- H1b. Minoritized racial/ethnic group members will report having less prior entrepreneurial experience.
- H1c. Participants with both minoritized racial/ethnic identity and female gender identity will report non-additive differences in study constructs compared with the other groups.

Instructional climate

A form of social capital, “instructional climate” refers to the degree to which students’ experiences during instruction are emotionally positive or negative. Among women, a positive climate within STEM education has been linked to STEM career aspirations (Gayles and Ampaw, 2016; Kezar and Holcombe, 2017), self-efficacy, and ultimately academic achievement (Beyer, 2008; Morris and Daniel, 2008). However, research has found that STEM instructors demonstrate gender biases, such as giving more praise to male students (Milkman et al., 2015; Moss-Racusin et al., 2012). Similarly, minoritized racial/ethnic group members in STEM report more negative experiences in the classroom or in social interactions with their instructors than non-minoritized racial/ethnic group members (Parsons and Dorsey, 2015). Furthermore, qualitative evidence indicates that some early I-Corps participants described elements of the training as “harsh” (Duval-Couetil et al., 2021), and female participants and women of color have reported negative interpersonal interactions during instruction (Jackson et al., 2022). Therefore, our hypotheses are as follows:

- H2a. Women will report a harsher instructional climate.
- H2b. Minoritized racial/ethnic group members will report a harsher instructional climate.
- H2c. Participants with both minoritized racial/ethnic identity and female gender identity will report non-additive differences in study constructs compared with the other groups.

Team interactions

Another example of the social capital needed for entrepreneurship is effective team interactions, which are a critical part of entrepreneurship activities. Several studies in STEM have demonstrated that gender is an important predictor of team performance and the quality of social interactions among project team members (Kuschel et al., 2018; Neumeyer and Santos, 2020; Woolley, 2019a). Similarly, organizational research shows that minoritized racial/ethnic group members in academia face bias in team decision-making (Stanley, 2006; Wood et al., 2015). For example, women and minoritized racial/ethnic group members are less likely to assume leadership roles (Born et al., 2018; Gündemir et al., 2014) or feel like important contributors to a team (Dingel and Wei, 2014). Therefore, our hypotheses are as follows:

- H3a. Women will report less favorable views of team interactions.
- H3b. Minoritized racial/ethnic group members report less favorable views of team interactions than majority racial/ethnic group members.
- H3c. Participants with both minoritized racial/ethnic identity and female gender identity will report non-additive differences in study constructs compared with the other groups.

Entrepreneurial intention

Finally, cognitive capital is tested by examining entrepreneurial intention (EI), a research construct referring to one's plan to engage in entrepreneurship in the future (Ajzen, 1985). Although entrepreneurial self-efficacy, which has an established positive relationship with EI, is often lower among women and members of minoritized racial/ethnic groups, research findings have not shown a consistent pattern in demographic differences. For example, some reviews demonstrate minimal differences between genders in EI (Haus *et al.*, 2013; Shneor and Jenssen, 2014). Similarly, while some studies show that minoritized racial/ethnic group members report lower entrepreneurial intentions (Piperopoulos and Dimov, 2015), other research finds no difference (Edelman *et al.*, 2010). However, based on the established sociocultural barriers described in the capital framework, we hypothesize:

H4a. Women will report lower entrepreneurial intention.

H4b. Minoritized racial/ethnic group members will report lower levels of entrepreneurial intention.

H4c. Participants with both minoritized racial/ethnic identity and female gender identity will report non-additive differences in study constructs compared with the other groups.

Method

Sample

The data for our analyses were drawn from surveys administered to 39 cohorts of the national I-Corps Teams training program between spring 2012 and fall 2016. Surveys were distributed by the NSF in collaboration with VentureWell. The data were obtained through a memorandum of understanding between the authors and VentureWell and are consistent with the de-identified VentureWell 2.1 public-use data release, with the addition of gender and racial/ethnic identity data. The dataset includes 1,755 participants, including 843 Principal Investigators (PI – faculty) and 912 Entrepreneurial Leads (EL – graduate students). The remaining participants were in the I-Corps Mentor (IM) team role, which was not included in our study because of the small number of women of color represented in this role. When restricted to participants with both gender identity and racial/ethnic identity information available, the sample for this study consisted of participants in two distinct team roles: 434 PIs and 406 ELs (for further sample information, see Table 1).

Team role	Gender and URM identification	MANOVA		ANOVA	
		Frequency	Percent	Frequency	Percent
PI	Female, Majority	34	16.8	80	18.4
	Female, URM	6	3	17	3.9
	Male, Majority	136	67.3	292	67.3
	Male, URM	26	12.9	45	10.4
	Total	202	100	434	100
EL	Female, Majority	40	19.9	67	16.5
	Female, URM	5	2.5	16	3.9
	Male, Majority	132	65.7	269	66.3
	Male, URM	24	11.9	54	13.3
	Total	201	100	406	100

Table 1.
MANOVA and
univariate ANOVA
sample by gender and
URM identification

Measures

Participants completed two online surveys distributed via email: one before the course (“pre-course survey”) and one immediately following the seven-week course (“post-course survey”; see [Appendix](#)). Response rates were 96 and 74% for the pre-course and post-course surveys, respectively. VentureWell developed the survey instruments internally, and information such as convergent and discriminant validity was not available for the scales used in this study. Although this is a methodological limitation, these surveys were the primary surveys used by the NSF to evaluate the national I-Corps program for many years. This dataset is the only one we are aware of that can address important gaps in the literature, given its size, national scope, standardization, and elevated response rates. Furthermore, many survey items included in our analyses closely resemble measures used in prior research to assess entrepreneurial outcomes.

Prior experience: This construct consisted of 14 questions from the pre-course survey that asked participants to indicate the number of times they had participated in 14 types of entrepreneurship or commercialization activities before participating in the I-Corps program (see [Appendix](#)). To address the extreme skew of these variables, the numeric responses were recoded into a dichotomous variable that represented whether the participant had indicated any experience or none for each question.

Instructional climate: This variable was created by averaging responses to five survey questions ($\alpha = 0.84$; see [Appendix](#)), such as whether the course was “harsh” or “stressful”.

Team interactions: The team interaction variable was treated as a scale, averaging responses to five survey questions related to participants’ perceptions of the quality of interaction and cooperation in their project teams ($\alpha = 0.85$; see [Appendix](#)).

Entrepreneurial intention: EI describes participants’ plans to pursue commercialization or entrepreneurial activities. This variable consisted of the average of 4 survey questions and was treated as a scale ($\alpha = 0.72$, see [Appendix](#)).

Results

Analyses were conducted using both Multivariate Analysis of Variance (MANOVA) and Univariate Analyses of Variance (ANOVA) with SPSS statistical software. The participant’s role on the project team (PI and EL) was included as a control variable in all ANOVA analyses to account for differences between the groups. In all analyses, gender and racial/ethnic identity were independent variables. In the MANOVA analysis, all dependent variables were included in the analysis simultaneously. To replicate this analysis while maintaining a larger sample size, each dependent variable was then examined separately using Univariate ANOVA.

Multivariate analysis

To account for covariance among the four dependent variables, we first conducted a Three-Way Multivariate ANOVA (MANOVA), including all variables after standardization. The independent variables were gender, racial/ethnic identity, and their interaction (for sample description, see [Tables 1–4](#); for detailed results, [Tables 5 and 6](#)). The control variable was the project team role (either EL or PI). Drawing on the capital framework and prior literature suggesting that women and minoritized racial/ethnic groups experience social and structural barriers affecting their access to resources, we expected that women and minoritized racial/ethnic group members would report lower levels of these resources across each dependent variable. Further, by adopting an intersectional approach, we hypothesized significant interaction effects between gender and racial/ethnic identity, although prior literature does not provide clear expectations regarding the direction of these effects.

Table 2.MANOVA sample
bivariate correlations

		Entrepreneurial intention	Team interactions	Instructional climate
Prior experience	Pearson Correlation	0.178**	0.141**	-0.157**
	Sig. (2-tailed)	<0.001	0.004	0.002
	N	403	403	403
Entrepreneurial intention	Pearson Correlation		0.130**	-0.097
	Sig. (2-tailed)		0.009	0.053
	N		403	403
Team interactions	Pearson Correlation			-0.116*
	Sig. (2-tailed)			0.02
	N			403

Note(s): **Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed)

Table 3.MANOVA sample
racial/ethnic
identification detail

Team role	Racial/ethnic identification	Frequency	Percent
PI	White	109	53.9
	Asian	61	30.2
	Black/African American	10	5
	Hispanic	17	8.4
	Other	5	2.5
	Total	202	100
EL	White	92	45.8
	Asian	80	39.8
	Black/African American	4	2
	Hispanic	15	7.4
	other	10	5
	Total	201	100

For Prior Experience, we found that the effects of racial/ethnic identity and its interaction with gender were not significant (racial/ethnic identity: $F(1, 395) = 2.146, p = 0.144$; interaction: $F(1, 395) = 0.021, p = 0.886$). However, the significant effect of gender found using a similar dataset in a previous study (Epstein *et al.*, 2022) was replicated ($F(1, 395) = 5.932, p = 0.015$). The effect of the control variable, team role, was also significant ($F(1, 395) = 10.649, p = 0.001$).

For Instructional Climate, neither the main effects nor the interaction were significant (racial/ethnic identity: $F(1, 395) = 0.013, p = 0.91$; gender: $F(1, 395) = 0.396, p = 0.529$; interaction: $F(1, 395) = 0.366, p = 0.546$). The only significant effect was from the control variable team role ($F(1, 395) = 7.963, p = 0.005$).

For Team Interaction, none of the independent variables nor the control variable were significant (racial/ethnic identity: $F(1, 395) = 0.719, p = 0.397$; gender: $F(1, 395) = 2.028, p = 0.155$; interaction: $F(1, 395) = 0.761, p = 0.383$; team role: $F(1, 395) = 2.214, p = 0.138$).

For Entrepreneurial Intention, racial/ethnic identity showed a marginally significant effect ($F(1, 395) = 4.047, p = 0.045$), with no significant effects for gender or interaction (gender: $F(1, 395) = 0.019, p = 0.889$; interaction: $F(1, 395) = 2.659, p = 0.104$). Team role as the control variable also showed no significant effect ($F(1, 395) = 0.76, p = 0.384$).

Table 4.
MANOVA descriptive
statistics

	Racial/ethnic identification	Team role	Gender identity	Mean	Std. Deviation	N
Prior experience	Majority	PI	Female	−0.2	0.88	34
			Male	0.19	0.87	136
			Total	0.11	0.88	170
		EL	Female	−0.99	0.64	40
			Male	−0.67	0.88	132
			Total	−0.74	0.84	172
		Total	Female	−0.63	0.85	74
			Male	−0.23	0.97	268
			Total	−0.32	0.96	342
	Minoritized	PI	Female	−0.58	0.6	6
			Male	0.4	1.12	26
			Total	0.21	1.11	32
		EL	Female	−0.2	0.37	5
			Male	−0.37	0.83	24
			Total	−0.34	0.76	29
		Total	Female	−0.41	0.52	11
			Male	0.03	1.06	50
			Total	−0.05	0.99	61
Total		PI	Female	−0.26	0.85	40
			Male	0.22	0.91	162
			Total	0.13	0.92	202
		EL	Female	−0.9	0.67	45
			Male	−0.62	0.88	156
			Total	−0.68	0.84	201
		Total	Female	−0.6	0.82	85
			Male	−0.19	0.99	318
			Total	−0.28	0.97	403
						(continued)

	Racial/ethnic identification	Team role	Gender identity	Mean	Std. Deviation	N
Instructional climate	Majority	PI	Female	-0.1	1.09	34
			Male	-0.16	0.95	136
		EL	Total	-0.15	0.98	170
			Female	0.24	0.81	40
		Total	Male	0.31	0.93	132
			Total	0.3	0.9	172
	Minoritized	Total	Female	0.08	0.96	74
			Male	0.07	0.97	268
		PI	Total	0.07	0.96	342
			Female	-0.23	0.57	6
		EL	Male	-0.2	1.05	26
			Total	-0.21	0.97	32
		Total	Female	0.13	1.13	5
			Male	0.52	0.79	24
		Total	Total	0.45	0.84	29
			Female	-0.07	0.84	11
		PI	Male	0.14	0.99	50
			Total	0.1	0.96	61
	Total	PI	Female	-0.12	1.03	40
			Male	-0.17	0.96	162
		EL	Total	-0.16	0.97	202
			Female	0.23	0.83	45
		Total	Male	0.34	0.91	156
			Total	0.32	0.89	201
		Total	Female	0.06	0.94	85
			Male	0.08	0.97	318
		Total	Total	0.08	0.96	403

(continued)

Table 4.

Table 4.

Team interactions		Racial/ethnic identification	Team role	Gender identity	Mean	Std. Deviation	N
	Majority		PI	Female	0.13	0.95	34
				Male	0.23	0.85	136
				Total	0.21	0.87	170
			EL	Female	-0.28	0.92	40
				Male	-0.2	0.99	132
				Total	-0.22	0.97	172
			Total	Female	-0.09	0.95	74
				Male	0.02	0.95	268
				Total	0	0.95	342
	Minoritized		PI	Female	-0.6	0.42	6
				Male	0.33	0.9	26
				Total	0.16	0.9	32
			EL	Female	-0.13	0.66	5
				Male	-0.29	1.25	24
				Total	-0.27	1.16	29
			Total	Female	-0.39	0.57	11
				Male	0.03	1.12	50
				Total	-0.04	1.05	61
	Total		PI	Female	0.02	0.93	40
				Male	0.25	0.86	162
				Total	0.2	0.87	202
			EL	Female	-0.27	0.89	45
				Male	-0.21	1.03	156
				Total	-0.23	1	201
			Total	Female	-0.13	0.92	85
				Male	0.02	0.97	318
				Total	-0.01	0.96	403

(continued)

Table 4.

Entrepreneurial intention	Racial/ethnic identification	Team role	Gender identity	Mean	Std. Deviation	N
	Majority	PI	Female	−0.59	1.24	34
			Male	−0.05	0.89	136
		EL	Total	−0.16	0.99	170
			Female	0.05	0.8	40
		Total	Male	0.03	0.99	132
			Total	0.04	0.95	172
			Female	−0.24	1.07	74
			Male	−0.01	0.94	268
			Total	−0.06	0.97	342
			Female	0.26	1	6
	Minoritized	PI	Male	0.22	0.96	26
			Total	0.23	0.95	32
		EL	Female	0.48	0.76	5
			Male	−0.11	1.16	24
		Total	Total	−0.01	1.11	29
			Female	0.36	0.87	11
			Male	0.06	1.06	50
			Total	0.12	1.03	61
		PI	Female	−0.46	1.23	40
			Male	−0.01	0.9	162
	Total		Total	−0.1	0.99	202
			Female	0.1	0.8	45
		EL	Male	0.01	1.02	156
			Total	0.03	0.97	201
		Total	Female	−0.17	1.06	85
			Male	0	0.96	318
			Total	−0.03	0.98	403

Therefore, the only effect consistent with our hypotheses was related to gender differences in prior experience. Although we expected each dependent variable to be negatively impacted by the social contextual constraints, we found no such effects in most of our analyses. Furthermore, we did not find interaction effects that would imply an intersectional influence between these two identities. Unexpectedly, there was a marginally significant effect of racial/ethnic identity on entrepreneurial intention, suggesting that minoritized racial/ethnic group members reported higher levels of intent than majority group members. It is possible that these results, which are inconsistent with prior research and theory in this area of study, could be impacted by the small sample sizes reflecting the underrepresentation of minoritized racial/ethnic groups in the available data. Therefore, we conducted further univariate analyses with a larger participant group to examine these effects more thoroughly.

Univariate analysis 1: prior experience

We conducted a three-way univariate ANOVA to assess differences in prior entrepreneurial experience by gender, racial/ethnic identity, and their interaction while controlling for project team roles (EL or PI) (refer to [Tables 7–10](#)). Results showed no significant effects for racial/ethnic identity ($F(1, 673) = 0.043, p = 0.835$) or the interaction between racial/ethnic identity and gender ($F(1, 673) = 0.211, p = 0.647$). However, the significant effect of gender found using a similar dataset in a previous study ([Epstein et al., 2022](#)) was replicated ($F(1, 673) = 14.332, p < 0.001$), indicating that women reported less prior experience than men across racial/ethnic groups. The control variable team role also had a significant effect on prior experience ($F(1, 673) = 44.31, p < 0.001$).

Univariate analysis 2: instructional climate

Our analysis of the perceived instructional climate also used a three-way univariate ANOVA, controlling for project team role (see [Tables 11 and 12](#)). Neither the main effects of racial/ethnic identity ($F(1, 551) = 0.201, p = 0.654$) nor their interaction ($F(1, 551) = 1.575, p = 0.21$) were significant. This finding replicates previous studies in which gender showed no significant impact ($F(1, 551) = 0.944, p = 0.332$), suggesting similar perceptions of instructional climate across gender and racial/ethnic groups. Team role also had a significant effect on climate ($F(1, 551) = 18.21, p < 0.001$).

Univariate analysis 3: team interaction

This analysis examined differences in the quality of team interactions, controlling for project team role (see [Tables 13 and 14](#)). Results indicated no significant effects for racial/ethnic identity ($F(1, 547) = 1.663, p = 0.198$) or the interaction ($F(1, 547) = 0.798, p = 0.372$). Surprisingly, the significant effect of gender on this variable found in a previous analysis did not replicate ($F(1, 547) = 2.569, p = 0.11$), which may be due to a smaller subset of participants

Table 5.
MANOVA
multivariate test
results

Effect	<i>F</i>	Hypothesis df	Error df	Sig
Intercept	4.660	4	392	0.001
Minoritized racial/ethnic identification	1.619	4	392	0.169
Team role (EL)	5.770	4	392	<0.001
Gender (male)	2.265	4	392	0.062
Minoritized R/E by EL role	2.082	4	392	0.082
Minoritized R/E by male gender	1.101	4	392	0.356
EL role by male gender	1.848	4	392	0.119
Three-way interaction	1.426	4	392	0.225

Source	Dependent variable	Type III sum of squares	df	Mean square	<i>F</i>	Sig
Corrected model	Prior Experience	82.090 ^a	7	11.727	15.658	<0.001
	Instructional Climate	24.805 ^d	7	3.544	4.031	<0.001
	Team Interactions	23.584 ^c	7	3.369	3.821	<0.001
	Entrepreneurial Intention	15.060 ^b	7	2.151	2.283	0.027
Intercept	Prior Experience	11.378	1	11.378	15.191	<0.001
	Instructional Climate	0.488	1	0.488	0.555	0.457
	Team Interactions	1.275	1	1.275	1.447	0.23
	Entrepreneurial Intention	0.168	1	0.168	0.178	0.673
Minoritized racial/ ethnic identification	Prior Experience	1.607	1	1.607	2.146	0.144
	Instructional Climate	0.011	1	0.011	0.013	0.91
	Team Interactions	0.634	1	0.634	0.719	0.397
	Entrepreneurial Intention	3.813	1	3.813	4.047	0.045
Team role (EL)	Prior Experience	7.976	1	7.976	10.649	0.001
	Instructional Climate	7	1	7	7.963	0.005
	Team Interactions	1.952	1	1.952	2.214	0.138
	Entrepreneurial Intention	0.716	1	0.716	0.76	0.384
Gender (male)	Prior Experience	4.443	1	4.443	5.932	0.015
	Instructional Climate	0.348	1	0.348	0.396	0.529
	Team Interactions	1.788	1	1.788	2.028	0.155
	Entrepreneurial Intention	0.018	1	0.018	0.019	0.889
Minoritized R/E by EL role	Prior Experience	2.973	1	2.973	3.97	0.047
	Instructional Climate	0.129	1	0.129	0.146	0.702
	Team Interactions	0.918	1	0.918	1.041	0.308
	Entrepreneurial Intention	1.366	1	1.366	1.45	0.229
Minoritized R/E by male gender	Prior Experience	0.015	1	0.015	0.021	0.886
	Instructional Climate	0.322	1	0.322	0.366	0.546
	Team Interactions	0.671	1	0.671	0.761	0.383
	Entrepreneurial Intention	2.505	1	2.505	2.659	0.104
EL Role by male gender	Prior Experience	2.856	1	2.856	3.814	0.052
	Instructional Climate	0.487	1	0.487	0.554	0.457
	Team Interactions	2.413	1	2.413	2.737	0.099
	Entrepreneurial Intention	2.373	1	2.373	2.519	0.113
Three-way interaction	Prior Experience	2.213	1	2.213	2.955	0.086
	Instructional Climate	0.104	1	0.104	0.119	0.731
	Team Interactions	2.265	1	2.265	2.569	0.11
	Entrepreneurial Intention	7.36E-05	1	7.36E-05	0	0.993
Error	Prior Experience	295.848	395	0.749		
	Instructional Climate	347.252	395	0.879		
	Team Interactions	348.284	395	0.882		
	Entrepreneurial Intention	372.176	395	0.942		

Note(s): a. $R^2 = 0.217$ (Adjusted $R^2 = 0.203$) b. $R^2 = 0.067$ (Adjusted $R^2 = 0.050$) c. $R^2 = 0.063$ (Adjusted $R^2 = 0.047$) d. $R^2 = 0.039$ (Adjusted $R^2 = 0.022$)

Table 6.
MANOVA tests of
between-subjects
effects results

with complete data on both gender and racial/ethnic identity. Team role was also significant ($F(1, 547) = 6.62, p = 0.010$).

Univariate analysis 4: entrepreneurial intention

Our final analysis focused on entrepreneurial intention at the end of the course, using a Three-Way Univariate ANOVA (Tables 15 and 16). No significant effects were found for racial/ethnic identity ($F(1, 652) = 1.52, p = 0.219$), the interaction between racial/ethnic identity and gender ($F(1, 652) = 0.75, p = 0.385$), or gender alone ($F(1, 652) = 2.54, p = 0.112$). In summary,

Table 7.
Univariate ANOVA
sample racial/ethnic
identification detail

Team role	Racial/ethnic identification	Frequency	Percent
PI	White	242	55.8
	Asian	130	29.9
	Black/African American	19	4.4
	Hispanic	30	6.9
	Other	13	3
	Total	434	100
EL	White	202	49.8
	Asian	134	33
	Black/African American	10	2.5
	Hispanic	40	9.9
	other	20	4.9
	Total	406	100

Table 8.
Univariate ANOVA
sample correlations

		Entrepreneurial intention	Team interactions	Instructional climate
Prior experience	Pearson	0.181**	0.141**	−0.159**
	Correlation			
	Sig. (2-tailed)	<0.001	0.004	0.001
Entrepreneurial intention	N	503	403	406
	Pearson		0.142**	−0.113**
	Correlation			
Team interactions	Sig. (2-tailed)		<0.001	0.008
	N		555	556
	Pearson			−0.134**
	Correlation			
	Sig. (2-tailed)			0.002
	N			553

Note(s): **Correlation is significant at the 0.01 level (2-tailed). *Correlation is significant at the 0.05 level (2-tailed)

entrepreneurial intention was similar across gender and racial/ethnic groups at the end of the course. Similarly, team role was not significant ($F(1, 652) = 1.44, p = 0.231$).

Discussion

This study tested for gender and racial/ethnic identity differences within the context of the NSF’s I-Corps program, a large-scale academic entrepreneurship training initiative involving faculty and graduate student scientists and engineers from across the United States. Our goal was to use an “intersectional” approach to examine the non-additive combined effects of racial/ethnic identity and gender identity, or the statistical “interaction” of these two variables. We focused on four dependent variables drawn from forms of *internal* and *external “capital”* considered necessary for participation and success in technology entrepreneurship. In this study, *human capital* was represented by a composite variable of a participant’s prior entrepreneurial experience; *social capital* was represented by the quality of project team interactions and the quality of the course instructional climate; and *cognitive capital* was represented by entrepreneurial intention. Each form of capital impacts one’s ability to access *financial capital*, which is a well-known driver of success in technology entrepreneurship, but not examined directly in these analyses.

Table 9.
Prior experience
univariate ANOVA
descriptive statistics

Racial/ethnic identification	Team role	Gender identity	Mean	Std. Deviation	N
Majority	PI	Female	6.14	2.92	64
		Male	7.45	3.14	235
		Total	7.17	3.13	299
	EL	Female	3.29	2.42	56
		Male	4.49	2.96	222
		Total	4.24	2.89	278
	Total	Female	4.81	3.04	120
		Male	6.01	3.39	457
		Total	5.76	3.35	577
Minoritized	PI	Female	5.15	2.67	13
		Male	7.80	3.50	40
		Total	7.15	3.48	53
	EL	Female	4.08	2.84	12
		Male	4.64	2.89	39
		Total	4.51	2.86	51
	Total	Female	4.64	2.75	25
		Male	6.24	3.56	79
		Total	5.86	3.44	104
Total	PI	Female	5.97	2.88	77
		Male	7.50	3.19	275
		Total	7.17	3.18	352
	EL	Female	3.43	2.50	68
		Male	4.51	2.94	261
		Total	4.29	2.89	329
	Total	Female	4.78	2.99	145
		Male	6.04	3.41	536
		Total	5.78	3.36	681

Table 10.
Prior experience
univariate ANOVA
results

Source	Type III sum of squares	df	Mean square	F	Sig.
Corrected model	1637.83	7	233.98	25.99	<0.001
Intercept	7318.58	1	7318.58	812.94	<0.001
Gender	129.03	1	129.03	14.33	<0.001
Team role	398.92	1	398.92	44.31	<0.001
Minoritized race/ethnicity	0.39	1	0.39	0.04	0.835
Gender by team role	19.09	1	19.09	2.12	0.146
Gender by minoritized race/ethnicity	1.90	1	1.90	0.21	0.647
Team role by minoritized race/ethnicity	9.99	1	9.99	1.11	0.293
Three-way interaction	15.47	1	15.47	1.72	0.190
Error	6058.79	673	9.00		
Total	30411.00	681			
Corrected total	7696.63	680			

A surprising discovery across all four analyses was that we found few differences between minority and majority racial/ethnic groups, contradicting prior research in both the entrepreneurship and STEM education literature. Given the well-documented structural barriers and biases facing women and members of minority racial/ethnic communities in STEM and entrepreneurship settings (Conley and Bilimoria, 2021; Lee *et al.*, 2020), we expected that identification with these groups would be negatively associated with the outcome variables. We found only one significant gender difference for the variable of prior

Table 11.
Instructional climate
univariate ANOVA
descriptive statistics

Racial/ethnic identification	Team role	Gender identity	Mean	Std. Deviation	N
Majority	PI	Female	3.31	0.98	50
		Male	3.27	0.80	192
		Total	3.28	0.84	242
	EL	Female	3.67	0.64	51
		Male	3.65	0.80	179
		Total	3.66	0.77	230
	Total	Female	3.50	0.84	101
		Male	3.45	0.83	371
		Total	3.46	0.83	472
Minoritized	PI	Female	2.96	0.73	9
		Male	3.27	0.89	31
		Total	3.20	0.86	40
	EL	Female	3.63	0.87	9
		Male	3.83	0.66	38
		Total	3.79	0.70	47
	Total	Female	3.30	0.85	18
		Male	3.58	0.81	69
		Total	3.52	0.83	87
Total	PI	Female	3.26	0.95	59
		Male	3.27	0.81	223
		Total	3.27	0.84	282
	EL	Female	3.67	0.68	60
		Male	3.69	0.78	217
		Total	3.68	0.76	277
	Total	Female	3.47	0.84	119
		Male	3.47	0.82	440
		Total	3.47	0.83	559

Table 12.
Instructional climate
ANOVA results

Source	Type III sum of squares	df	Mean square	F	Sig
Corrected model	26.13	7	3.73	5.78	<0.001
Intercept	2301.29	1	2301.29	3563.06	<0.001
Gender	0.61	1	0.61	0.94	0.332
Team role	11.76	1	11.76	18.21	<0.001
Minoritized race/ethnicity	0.13	1	0.13	0.20	0.654
Gender by team role	0.02	1	0.02	0.03	0.864
Gender by minoritized race/ethnicity	1.02	1	1.02	1.57	0.210
Team role by minoritized race/ethnicity	0.69	1	0.69	1.07	0.302
Three-way interaction	0.06	1	0.06	0.09	0.769
Error	355.88	551	0.65		
Total	7120.53	559			
Corrected total	382.01	558			

entrepreneurial experience, corroborating the findings of a previous analysis of a similar dataset in which women reported significantly lower levels of prior entrepreneurial experience, team interaction quality, and entrepreneurial intention than men (Epstein *et al*, 2022). This gender disparity may be of particular importance because this pattern has been found to partially explain lower levels of resources critical to entrepreneurial behavior, self-efficacy, and the success of new ventures (Chowdhury *et al*, 2019). This supports calls to integrate relevant entrepreneurial and professional experiences into doctoral or other

Racial/ethnic identification	Team role	Gender identity	Mean	Std. Deviation	N
Majority	PI	Female	4.01	0.78	50
		Male	4.08	0.61	191
		Total	4.07	0.65	241
	EL	Female	3.73	0.64	51
		Male	3.80	0.73	179
		Total	3.78	0.71	230
	Total	Female	3.87	0.72	101
		Male	3.95	0.69	370
		Total	3.93	0.70	471
Minoritized	PI	Female	3.69	0.63	9
		Male	4.10	0.65	31
		Total	4.01	0.66	40
	EL	Female	3.60	0.83	8
		Male	3.70	0.90	36
		Total	3.68	0.88	44
	Total	Female	3.65	0.71	17
		Male	3.89	0.82	67
		Total	3.84	0.80	84
Total	PI	Female	3.96	0.77	59
		Male	4.09	0.62	222
		Total	4.06	0.65	281
	EL	Female	3.71	0.66	59
		Male	3.78	0.76	215
		Total	3.77	0.74	274
	Total	Female	3.84	0.72	118
		Male	3.94	0.71	437
		Total	3.92	0.71	555
			4.01	0.78	
			4.08	0.61	
			4.07	0.65	

Table 13.
Team interactions
univariate ANOVA
descriptive statistics

Source	Type III sum of squares	df	Mean square	F	Sig
Corrected model	14.11	7	2.02	4.14	<0.001
Intercept	2721.43	1	2721.43	5585.27	<0.001
Gender	1.25	1	1.25	2.57	0.110
Team role	3.23	1	3.23	6.62	0.010
Minoritized race/ethnicity	0.81	1	0.81	1.66	0.198
Gender by team role	0.30	1	0.30	0.62	0.433
Gender by minoritized race/ethnicity	0.39	1	0.39	0.80	0.372
Team role by minoritized race/ethnicity	0.01	1	0.01	0.03	0.864
Three-way interaction	0.28	1	0.28	0.57	0.453
Error	266.53	547	0.49		
Total	8789.01	555			
Corrected total	280.64	554			

Table 14.
Team interactions
ANOVA results

training, if the goal is to broaden women's participation in entrepreneurial activities in academic settings.

The unexpected absence of differences between minoritized and non-minoritized racial/ethnic group members in most analyses yields theoretically and practically significant results. Theoretically, these findings imply that the well-documented challenges faced by

Table 15.
Entrepreneurial
intention univariate
ANOVA descriptive
statistics

Racial/ethnic identification	Team role	Gender identity	Mean	Std. Deviation	N
Majority	PI	Female	3.71	1.00	62
		Male	4.14	0.72	236
		Total	4.05	0.80	298
	EL	Female	4.17	0.60	56
		Male	4.22	0.77	205
		Total	4.21	0.73	261
	Total	Female	3.93	0.86	118
		Male	4.18	0.75	441
		Total	4.13	0.78	559
Minoritized	PI	Female	4.12	0.84	12
		Male	4.28	0.73	37
		Total	4.24	0.76	49
	EL	Female	4.17	0.82	12
		Male	4.16	0.78	40
		Total	4.16	0.78	52
	Total	Female	4.15	0.81	24
		Male	4.21	0.75	77
		Total	4.20	0.77	101
Total	PI	Female	3.78	0.98	74
		Male	4.16	0.73	273
		Total	4.08	0.80	347
	EL	Female	4.17	0.63	68
		Male	4.21	0.77	245
		Total	4.20	0.74	313
	Total	Female	3.97	0.85	142
		Male	4.18	0.75	518
		Total	4.14	0.77	660

Table 16.
Entrepreneurial
intention ANOVA
results

Source	Type III sum of squares	df	Mean square	F	Sig
Corrected model	13.44	7	1.92	3.28	0.002
Intercept	4151.62	1	4151.62	7089.76	<0.001
Gender	1.48	1	1.48	2.54	0.112
Team role	0.84	1	0.84	1.44	0.231
Minoritized race/ethnicity	0.89	1	0.89	1.52	0.219
Gender by team role	1.17	1	1.17	1.99	0.158
Gender by minoritized race/ethnicity	0.44	1	0.44	0.75	0.385
Team role by minoritized race/ethnicity	1.38	1	1.38	2.35	0.126
Three-way interaction	0.15	1	0.15	0.26	0.609
Error	381.80	652	0.59		
Total	11689.58	660			
Corrected total	395.24	659			

minoritized racial/ethnic group members in the domains of entrepreneurship, STEM education, and technology entrepreneurship do not manifest quantitatively in the population and methodology used in this study. Practically, this pattern could simply indicate that the I-Corps program successfully creates an inclusive and collaborative training environment, where these forms of capital are equitably available to participants. However, prior research in both entrepreneurship and STEM has led us to consider and propose several possible methodological reasons for the absence of differences or our inability to detect them. These

relate to the uniqueness of academic entrepreneurship as an activity; the distinctive characteristics of faculty and graduate students who participate in technology commercialization and entrepreneurship training; how contextual factors associated with academia may influence experiences; how aspects of the I-Corps curriculum and training may mitigate group differences; and subsequent methodological issues. These are described in more detail below and are important to consider in the design of accurate and theoretically meaningful studies related to broadening participation in academic entrepreneurship.

Selection bias: Only a very small proportion of STEM faculty in the U.S. participate in technology commercialization and entrepreneurship activity (Åstebro *et al.*, 2019). Therefore, it is likely that this population shares attributes or prior experiences that lead them to this activity, such as holding patents, industry experience, or previous participation in entrepreneurship education (Eesley, 2016). For example, prior research has established that many entrepreneurship students come from entrepreneurial families or share other experiences that contribute to their interest in entrepreneurship (Nowiński and Haddoud, 2019). Therefore, in studies evaluating the impact of entrepreneurship education, it is often difficult to tease out the effect of the education itself, given students' prior exposure or predisposition. Research designs that involve matched control groups are necessary to avoid selection bias and draw causal inferences, but they remain rare in the field and difficult to undertake (Yi and Duval-Couetil, 2021).

Overqualification: This refers to a phenomenon where members of minoritized groups must reach higher levels of preparation to achieve professional outcomes equivalent to those of non-minoritized groups. The need to persevere through additional academic and professional challenges, often without the benefit of in-group favoritism and the social networks afforded to majority social identity groups, implies the need to develop coping skills that have a confounding influence on perceptions of academic settings and programs such as I-Corps. Even before applying to I-Corps, the academic entrepreneurs in our sample were required to accomplish several difficult professional milestones to achieve their professional status. These include passing preliminary examinations, publishing in refereed journals, presenting research, and competing at a high level with others for positions (Van Miegroet *et al.*, 2019). It is possible that by ascending through higher education ranks, academic entrepreneurs developed resilience as a result of overcoming barriers, thus increasing their sense of belonging through a "proving" process. It is also possible that this attenuates racial/ethnic and gender differences in outcomes that might occur in entrepreneurial settings.

Socio-economic status: Similarly, the significant human, social, cognitive, and financial capital that is considered important for success in technology entrepreneurship suggests that socioeconomic status or personal financial resources may play a moderating role. Patterns found among high-SES members of highly educated, minoritized racial/ethnic groups might differ dramatically from the general population of non-academic entrepreneurs, which is the case in STEM education (Mau and Li, 2018). Therefore, individuals more likely to perceive undesirable outcomes in relation to the variables included in this study may have been "selected out" at the recruitment stage.

Ethnic and cultural diversity present in academia: Given the cultural diversity of graduate students and faculty in STEM fields, the perception of being "other" could be less salient in academic entrepreneurship and training programs such as I-Corps. The National Science Board estimates that over 50% of engineers and computer scientists in the U.S. with PhDs are foreign-born (Deitz and Freyman, 2024). The cultural and ethnic diversity that is somewhat unique to research universities may mitigate differences typically reported by minoritized groups in non-academic entrepreneurship settings. In other words, the bias typical in "standard" educational or entrepreneurial settings may be different from that in academia, where instructors may be more apt to proactively individualize instruction and avoid stereotyping based on social identities.

Professional identity: While a career shift can be a motivation to pursue entrepreneurship in the general population, faculty members are less likely to demonstrate this, given the personal investment in research and scholarship required for full-time positions (Hayter *et al.*, 2021; Murnieks *et al.*, 2020). It is possible that a high level of career commitment decreases the importance of self-efficacy as an entrepreneur and entrepreneurial intention. Prior research has shown that few faculty members have any intention of leaving their faculty roles to become entrepreneurs (Boh *et al.*, 2016; Hayter *et al.*, 2017). Instead, they view the experience of participating in I-Corps as contributing to their research and teaching through a better understanding of market needs (Duval-Couetil *et al.*, 2021). Therefore, this unique combination of professional values and motivation may represent another confounding influence on the outcome variables examined in this study.

Survey measures: It is also possible that the survey instruments used to evaluate I-Corps are not able to detect differences in the experiences or intentions of underrepresented groups. Social desirability response bias may exist among this highly selective population, especially given that the surveys are linked to personally identifying information and are administered by the NSF, an influential grant funding institution. In addition, commonly used survey questions may be adequate to capture differential experiences based on gender but not racial/ethnic identity. Consistent use of qualitative and mixed-methods investigations is critical to accurately refine the survey measures used to assess these biases.

Survey sample: Finally, given the low representation of women and minoritized racial/ethnic group members in entrepreneurial activities, the sample sizes available for analyses of these groups are inherently constrained. For example, although the dataset used in this study is the largest available source of standardized nationwide survey information among academic entrepreneurs in the U.S., the low number of women of color diminished the potential of our analysis to identify interacting group effects. This methodological limitation must be addressed in future research through continued investment in developing larger quantitative datasets.

Our findings have implications for research and practice that scholars, instructors, program administrators, and other stakeholders must consider. First, the absence of quantitative differences identified in this study may mistakenly suggest that disparities do not exist or imply that there is no need for intervention. However, prior research has extensively documented the significant barriers faced by minoritized groups in technology entrepreneurship, both within and outside academia. These barriers manifest as lower participation rates, reduced engagement in critical activities, such as patenting, and challenges in attracting financial capital. Notably, we were not able to explore how our lack of group differences manifested in terms of raising capital for academic ventures. However, this presents an important avenue for future research.

Second, program administrators and instructors should strongly consider the effects of selection bias on program recruitment. It is possible that academics who might report bias are being deterred at the recruitment or enrollment stages. Structural barriers and biases can exert a stronger effect on participants' decision to enroll in a program than differences in instruction or instructor behavior during training. This consideration is particularly important given the mixed support for the effectiveness of offering diversity or inclusivity training as a means to address such disparities (Devine and Ash, 2022). Instead, targeted initiatives focused on recruiting and bolstering the self-efficacy of potential student and faculty participants from a variety of social identity groups may be more essential in addressing inclusivity improvements.

Third, a further implication of selection bias is that negative experiences may grow as program size and diversity increases. If a broader audience is effectively recruited into programs, particularly if expanded enrollment efforts succeed in reaching individuals with lower self-efficacy, these additional participants may require different supports than the

participants at the previous baseline level. Therefore, as program administrators make the case for supporting the expansion of entrepreneurship education programs, the use of evaluation data must be carefully considered in the appropriate broader context. Again, triangulation of analyses using various data collection methods, including both quantitative and qualitative data, will be critical to the success of these efforts.

Fourth, stakeholders must recognize that large-scale quantitative assessments may not effectively capture barriers experienced by minority and marginalized groups. Overall, the mixed findings found in research on group differences highlight the importance of comprehensive program evaluation and data “triangulation” which offer systematic methods for collecting, analyzing, and using data to determine program effectiveness and impact. Our results also highlight the importance of examining within-group differences and other social identity variables, such as prior professional experience and tenure status, which relate to the internal and external capital required for technology entrepreneurship and may be more salient for this population of academic entrepreneurs.

In fact, while not the primary focus of our research, we did find significant differences in the experiences of PIs (typically faculty) and ELs (typically graduate students), who serve in different roles on I-Corps teams and commercialization activity, more generally (Boh *et al.*, 2016; Hayter *et al.*, 2017). ELs reported less favorable team interactions and perceptions of instructional climate, which is not surprising given that they assume primary responsibility for the extensive market research interviews that is fundamental to I-Corps experiential training. PIs, who contribute their more extensive experience primarily through strategic oversight, are likely not exposed to the same pressure. Future research should explore how role-based experiences impact team outcomes and individual development. This can yield valuable insights into support mechanisms that may enhance participation and performance for all participants.

Conclusion

Mixed findings (positive, negative, and null effects) are common in entrepreneurship education research. Future research should examine these discrepancies in more depth by paying careful attention to the development and validation of measures that can detect potential bias and account for issues of self-selection when making conclusions from quantitative data about academic entrepreneurs. It also requires a more detailed understanding of the heterogeneity within and across groups, differences in curricula and pedagogical approaches, and contextual factors, including incentives and value placed on entrepreneurship activities by universities and academic departments. Overall, efforts to ensure that social identity groups are served equally by pathways into entrepreneurship must carefully navigate the conflicting qualitative and quantitative findings in the research literature, constraints on feasible data collection activities, and a broad range of stakeholder priorities and needs.

Limitations

Our findings must be interpreted in consideration of several methodological limitations, many of which are fundamental to our discussion. First, graduate students and faculty involved in technology commercialization and entrepreneurship training represent a very small proportion of STEM researchers in the United States. Therefore, we studied a unique, highly self-selected population of individuals who voluntarily choose to participate in a time-intensive activity in addition to traditional academic work. Given the cultural diversity of graduate students and faculty in STEM fields, it is possible that the perception of being “other” is lower in academia than in other settings. Finally, it is possible that the methods and surveys used to evaluate I-Corps are not able to detect differences in the experiences or intentions of underrepresented groups.

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Scale	Items
Prior experience	Indicate how many times you have participated in the following experiences prior to your involvement in the I-Corps program 1) Presented a business idea to investors 2) Served on a corporate advisory board 3) Founded or co-founded a venture . . . based on your research 4) Disclosed an invention to the university 5) Applied for a patent as an inventor or co-inventor 6) Issued a patent 7) Conducted market research 8) Interviewed potential customers about a product, service, or technology 9) Generated trade secrets 10) Licensed your research/technology 11) Participated in the technology transfer process at your university 12) Contributed ideas utilized by a company to improve a product, service, or process 13) Received royalties for your work 14) Participated in industry-funded research Response: Open-ended
Negative climate	Overall, how would you describe the learning environment created during the course 1) Stressful 2) Harsh 3) Exhausting Response choices: 1 “Not at all”, 2 “A little”, 3 “Somewhat”, 4 “Very”, 5 “Extremely”
Team Relationship	Describe the extent to which your team did the following 1) Collaborated effectively 2) Had a clear leadership structure 3) Distributed the workload equitably 4) Shared decision making 5) Made good decisions Response choices: 1 “Never”, 2 “Seldom”, 3 “Sometimes”, 4 “Most of the time”, 5 “Always”
Entrepreneurial intent	Indicate your level of agreement with the following statements about the current status of your technology and future plans 1) I will apply for SBIR funding for my technology in the next 12 months 2) I will seek other funding or investment for my technology within the next 12 months 3) I am interested in starting my own company 4) I am interested in working in a technology-based start up Response choices: 1 Totally disagree; 2 Disagree; 3 Unsure; 4 Agree; 5 Totally agree

Table A1.
Survey measures

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