Contemporary Educational Psychology 79 (2024) 102324

Contents lists available at ScienceDirect

Contemporary Educational Psychology

journal homepage: www.elsevier.com/locate/cedpsych

To stay, switch, or leave: A four-year longitudinal study of the situated and stable social influences on women's STEM major choices

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ARTICLE INFO

Keywords:
Social influence
Motivation
Stereotype threat
Within-person differences
Between-person differences
STEM persistence

ABSTRACT

Research on situational antecedents for women's persistence is critical to advancing gender equity in science, technology, engineering, and mathematics (STEM) fields. To disentangle the influences of stable and situated aspects of motivational antecedents, we used survival analysis to predict if, when, and to where undergraduate women change majors (i.e., staying in, switching across, or out of STEM) from between-person average and within-person fluctuations in Tripartite Integration Model of Social Influence (TIMSI) motivational constructs (science self-efficacy, identity, and community values) and stereotype threat. Women ($N = 413$) STEM majors in their first or second year of college were recruited from nine U.S. universities and followed over four years. Women were most likely to leave STEM in the first year of college and were most likely to change STEM majors within the first two years. Major change was predicted by (a) between-person average and within-person fluctuations in science identity, (b) within-person fluctuations in stereotype threat, and (c) an interaction between average stereotype threat and fluctuations in science identity. These findings emphasize the importance of distinguishing between-person and within-person aspects of motivational antecedents of STEM choices and developing tailored motivational interventions for short- and longer-term periods.

1. Introduction

Creating an inclusive community in science, technology, engineering, and mathematics (STEM) fields is critical for achieving innovation and equity goals (Hofstra et al., 2020). Women's (vs. men's) higher attrition rates (Chang et al., 2014; Cimpian et al., 2020; Riegle-Crumb et al., 2012) highlight the need to understand better why women who initially choose a STEM major change their major in college. Extant work indicates high attrition rates during the early college years (Chen, 2013; Denice, 2021; NCES, 2017) and varying forms of changing majors in STEM (e.g., switching across or out of STEM; Denice, 2021; Robinson et al., 2019). This points to the need for additional research to develop a more complete understanding of women's choices and the timing of changing majors from a longitudinal perspective. Understanding the longitudinal patterns of women's major choice and the antecedents of major choice throughout college can help capture the situated nature of women's motivational processes in pursuing a STEM degree and career.

Theories (Eccles & Wigfield, 2020; Estrada et al., 2011) and ample empirical research have suggested the roles of key motivational processes (Fong et al., 2021; Hernandez et al., 2020; Robinson et al., 2018) and stereotype threat (Beasley & Fischer, 2012; Cimpian et al., 2020) that predict women's pursuit of and persistence in STEM fields. However, previous studies almost exclusively focused on between-person differences, reflecting the influences of students' average levels of motivational processes and stereotype threat on outcomes over time. Incorporating the fluctuations (i.e., spikes and dips) that occur within-

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https://doi.org/10.1016/j.cedpsych.2024.102324

Available online 10 November 2024
0361-476X/

person over time may provide a more nuanced understanding of the contributions of students' motivational processes and stereotype threat. To better understand the situated nature of motivational processes, we aimed to examine the differentiated effects of within-person (semester-to-semester fluctuations/spikes and dips from the personal average) and between-person differences (average across college years) in three key motivational constructs (science self-efficacy, identity, and community values) and stereotype threat on the patterns of undergraduate STEM women's major choice (i.e., staying in, switching across, or out of STEM) in this four-year longitudinal study.

In the following sections, we begin by introducing the theoretical framework guiding the current study, the Tripartite Integration Model of Social Influence (TIMSI; Estrada et al., 2011). Next, we discuss prior work on the patterns of STEM major choice and the benefits of exploring change over a longer time frame. We then describe prior work on stereotype threat and its interactive relations with science identity. Finally, we discuss the importance of considering between-person and within-person differences in TIMSI motivational constructs and stereotype threat.

1.1. Tripartite integration model of social influence (TIMSI)

The "situated" nature of an individual's educational choices in a given domain has long been a critical question in the literature (Eccles & Wigfield, 2020). In this line of work, TIMSI (Estrada et al., 2011) provides a social influence theoretical foundation to understand how situations and contextual cues influence the psychological processes that instigate and maintain a person's motivation to pursue and persist in a STEM degree path. While multiple definitions of "motivation" exist, from a social psychological perspective, motivation is the latent psychological force that enables action and explains a person's response (as well as the energy and frequency of a response) in a given situation (Bargh et al., 2010; Touré-Tillery & Fishbach, 2014). TIMSI's explanations of an individual's integration and persistence into a given field are grounded in a social-psychological perspective and connected to the conceptualizations of motivation in the achievement literature.

TIMSI describes three processes that instigate an individual's motivation to integrate into a STEM community: (a) integration by complying with social norms of the science community to be efficacious, (b) integration by developing the social identity within the science community, (c) integration by internalizing the values of the science community to maintain congruency between personal-professional values. Contextual and sociocultural cues in a STEM community can activate or inhibit one or more of the three integration processes, energizing or enervating the drive to pursue a STEM degree. For example, TIMSI posits that students from minoritized groups in STEM (e.g., women, underrepresented racial/ethnic minorities [URMs]) who encounter social barriers, such as stereotype threat (Totonchi et al., 2021), are likely challenged to develop a social identity for the science community. Thus, students from minoritized groups may not integrate into their STEM disciplines at the same rate as those from majority groups, which results in educational disparities in STEM (Estrada et al., 2018).

Processes mentioned above are operationalized as three psychological constructs that instigate and sustain a person's drive and behavioral choices toward a goal (e.g., college major) in empirical research: science self-efficacy, science identity, and internalized science community values (see Estrada et al., 2011 for discussion). *Science self-efficacy* refers to students' confidence that they can successfully execute scientific practices (Bandura, 1977). *Science identity* describes the degree to which students identify with the science community (Chemers et al., 2011). Internalizing *science community values* represents the degree to which students personally value the objectives of the science community (e.g., scientific discovery; Estrada et al., 2011). Three TIMSI processes represent motivational constructs that precipitate, instigate, and maintain the drive underlying goal-directed activities. We, therefore, use the term *TIMSI motivational constructs* to address social influence processes defined in TIMSI in this study.

1.2. TIMSI motivational constructs and longitudinal patterns of major Choice: The If, When, and where for STEM persistence

TIMSI depicts that social influence processes occur over time. This means undergraduates develop their science self-efficacy, identity, and community values over time, which may predict their pursuit of STEM throughout college. Evidence shows the TIMSI-related motivational constructs, as well as short-term and long-term developmental patterns of change in these constructs (e.g., increasing or decreasing science identity over semesters or college years), can predict college STEM persistence at a given time point (Ainscough et al., 2016; Cole & Beck, 2022; Estrada et al., 2018; Fong et al., 2021; Robinson et al., 2018; Widlund et al., 2024). Despite their important empirical contributions, prior studies included indicators of STEM persistence measured at one point in time, for example, self-reported intention (Fong et al., 2021), course completion (Totonchi et al., 2021) or major status (Robinson, Lee, et al., 2019; Robinson, Perez, et al., 2019). Therefore, the research mentioned above primarily explains that motivational constructs (or their developmental patterns) predict "*if*" students leave STEM fields at some specific time. However, questions about "*when*" (i.e., the timing of major change) or "*where*" (i.e., majors students switch into) remain largely unanswered. Examining the longitudinal patterns of if, when, and to where students shift their STEM majors as an ongoing process rather than a static snapshot can contribute to our understanding of the situated nature of motivational processes.

A small body of research supports the relations between TIMSI motivational constructs and varying patterns of STEM major choice (i.e., the "where" part of STEM persistence). For example, Robinson, Perez, et al. (2019) examined the relations between undergraduates' science identity trajectories and four categories of STEM major choice (never selecting, staying in, switching into, and out of STEM) in introductory chemistry. Results showed that students with a high and stable trajectory of science identity were the most likely to stay in STEM. In contrast, those with a moderate and declining trajectory of science identity were the most likely never to select a STEM major. Fong et al. (2021), adopting a similar four-category approach to STEM major choice, found that high school students with high math and science motivation (including attainment value reflective of science identity) were the most likely to select STEM majors three years post-high school graduation. In contrast, those with low math and science motivation were the most likely to change their intent and drop STEM majors in college. Rosenzweig et al. (2021) found multiple factors (disenchantment or attraction) related to undergraduate students' major changes within and out of biomedical fields throughout college. To extend current understandings of STEM persistence, we tracked first- and second-year college women in STEM majors over four years to capture "if" they changed majors, "when" major change occurred, and to "where" students changed majors, as well as the relations between TIMSI motivational constructs and major changes. Such examinations should provide useful information to design effective and well-timed practices that support women's persistence in STEM.

1.3. Stereotype threat in STEM

Stereotype threat can be evoked in situations where members of stigmatized social groups are primed with or reminded of negative stereotypes, which can produce worry that they may inadvertently confirm the negative stereotypes (Steele et al., 2002). STEM domains involve stereotypes that women or URM students may not possess sufficient competence or characteristics required for success (Cheryan et al., 2009; Shapiro & Williams, 2012). Cues or messages that highlight women's gender identity may make women concerned about being judged negatively or confirming the stereotype (Steele et al., 2002), which can undermine their performance and persistence in STEM (Beasley & Fischer, 2012; Cadaret et al., 2017; Cheryan et al., 2009). However, stereotype threat may not affect all women equally. Social identity theory (Tajfel and Turner, 2004) and empirical evidence (Baysu & Phalet, 2019) suggest that racial minority women may be more susceptible to stereotype threat (vs. racial majority women) in STEM due to the intersection of disadvantaged social group statuses (e.g., gender *and* race/ethnicity). Racial minority women may have fewer or no positive social identities that help them feel consistent with the norms in STEM (Greenwald et al., 2002), which may make them more likely to leave STEM than racial majority women. Thus, we adopted an intersectionality approach to understanding the relations between stereotype threat, TIMSI motivational constructs, and women's STEM persistence.

Steele (1997) postulated that students who highly identify with the stereotyped domains are particularly vulnerable to the harmful effects of stereotype threat (Steele, 1997). When women have a high science identity and thus view STEM success as a core aspect of the self, they may be more likely (vs. those with a low science identity) to be concerned that their underperformance could confirm the competence-deficit stereotypes about women. Accordingly, these students may choose to disidentify with the science domain and ultimately withdraw from the aversive science community to protect their self-esteem (for review, see Steele et al., 2002; Thoman et al., 2013). Despite accumulated evidence of the interactive effects of stereotype threat and science identity on women's performance (Keller, 2007; Nguyen & Ryan, 2008), women's STEM persistence has gone largely underexamined. One study among URM college students in biomedical or behavioral science fields found that highly domain-identified[1] first-year students with frequent negative stereotype experiences were considerably less likely to remain in their initial majors than their similarly domain-identified counterparts with fewer stereotyped experiences (Chang et al., 2011). Similarly, a study of URM secondary students found that those with high academic identification[2] were more likely to withdraw from high school than less-identified URM students (Osborne & Walker, 2006). Conversely, White students with high academic identification were less likely to withdraw from schools than less identified White peers. Consistent with Steele's suggestion, these findings indicate the particularly detrimental roles of stereotype threat in highly identified women's pursuits of STEM. Thus, we aimed to examine such interactive relations in this study.

1.4. Between-person and within-person differences of TIMSI motivational constructs and stereotype threat

To address the situated aspect of women's major choice in STEM, we considered their associations with TIMSI motivational constructs and stereotype threat in terms of both between-person and within-person differences. This study operationalizes between-person differences as students' average perceptions of stereotype threat and TIMSI motivational constructs over time until a major change occurs, which captures being relatively higher or lower than others. Prior work on the longitudinal relations from stereotype threat and TIMSI motivational constructs to STEM persistence has been primarily examined from the between-person differences approach (e.g., Cadaret et al., 2017; Hernandez et al., 2020).

What has been largely missing from this line of research is also examining the contribution of within-person differences. This study operationalizes within-person differences as changes from a student's personal average, which captures time-specific situated fluctuations or spikes and dips in stereotype threat and TIMSI motivational constructs (e.g., at a given time, being relatively higher or lower than usual for oneself). Previous research showed students' short-term fluctuations (e.g., daily or weekly intervals) in stereotype threat (Hall et al., 2019; Hall et al., 2015) and TIMSI motivational constructs (Ahlqvist et al., 2013; Beymer & Rosenzweig, 2023; Cervone et al., 2020) and their consequences for STEM outcomes (e.g., achievement). While not as granular as daily or weekly intervals, we suspect that semester-to-semester fluctuations in perceptions of stereotype threat and TIMSI motivational constructs will be uniquely sensitive to situational changes and, thus, may predict major choice independent of students' over-time average of these constructs.

1.5. Present study

Guided by TIMSI and stereotype threat theories, we pursued two overarching goals to examine (1) the predictive roles of TIMSI motivational constructs (i.e., science self-efficacy, identity, and community values) and stereotype threat and (2) the interactive role of stereotype threat and science identity on the patterns of major choice among undergraduate women pursuing STEM degrees across four years in college. We adopted a longitudinal and situative approach to address these goals in three ways.

First, we innovated beyond prior research on STEM persistence by utilizing a survival analysis in investigating the patterns of women's major choices to identify "if," "when," and "where" women shift their STEM majors in college. To do so, we longitudinally followed women who indicated majoring in STEM each semester from the Fall semester of their first year through the Spring semester of their fourth year of college. We classified their major changes each semester as (1) no change, (2) change to a non-STEM major, and (3) change to another STEM major. Our approach reconceptualizes selecting a particular major (e.g., Geoscience) in each semester as one choice among competing alternatives (e.g., Chemistry, Business). The advantage of this approach is that it allowed us to use discrete-time competing risks hazard/survival analysis to (*a*) estimate the odds of a major change in a given semester (addressing "if" and "when" an event of interest occurs), (*b*) testing hypotheses about the relations between the odds of major change at each time point and time-invariant between-person differences (e.g., average science identity) or time-varying within-person fluctuations (e.g., within-student spikes and dips from one's average science identity) in TIMSI motivations or stereotype threat, as well as (*c*) differentiating various kinds of events (e.g., change to another STEM or non-STEM major) – thus addressing the "where" women go "when" changing their STEM major. These outcomes are particularly important considering a dearth of findings on temporal patterns of major changes among undergraduate women in STEM.

Second, our study included undergraduate women in STEM only to focus on illuminating the underlying mechanisms of their STEM persistence. We also adopted an intersectionality approach to understanding these mechanisms further; therefore, we compared the patterns of major choice between women from URM (i.e., African American, Latina, Native American/Alaskan Native descent) and well-represented (Asian, European descent) racial/ethnic backgrounds in STEM (National Center for Science and Engineering Statistics [NCSES], 2022). Third, we took a novel approach by predicting women's STEM persistence from their average (until major change) perceptions of stereotype threat and TIMSI motivational constructs, which reflect between-person differences across college years, as well as within-person fluctuations in these constructs, which reflect semester-to-semester situationally bound spikes and dips. This approach contributes to a more nuanced understanding of the situated mechanisms of women's major choices that are above and beyond the influence of average levels of stereotype threat and TIMSI motivational constructs. Moreover, we tested the degree to which the between-person average and within-person fluctuations of stereotype threat moderated the relations between science identity and women's persistence in STEM over time. Our study's inquiry thus

[1] In this study, domain identification assessed the degree of personal importance of commitment to and high performance in BBS fields, which is similar to the conceptualization of science identity (Eccles & Wigfield, 2020).

[2] In this study, academic identification assessed the degree to which students value and consider academics central to the self.

advances the literature in which most research has focused on testing science identity as a mediator in the relationship between stereotype threat and STEM persistence (e.g., Woodcock et al., 2012). Doing so contributes to empirical evidence of Steele's original assumption. The following four research questions guided our study:

> *RQ1. When are women most likely to change from an original STEM major to another STEM or non-STEM major?*

Based on prior findings (Chen, 2013), we hypothesized that women would be mostly likely to change to another or non-STEM major during their early college years (e.g., first or second year).

RQ2. Do women from URM groups exhibit the same patterns of major change compared to those from well-represented racial/ethnic groups in STEM?

Drawing from social identity theory (Tajfel and Turner, 2004) and empirical evidence (Baysu & Phalet, 2019), we hypothesized that women from URM groups would be more likely to change to another or non-STEM major compared to those from well-presented groups in STEM.

RQ3. To what extent are TIMSI motivational constructs (i.e., science self-efficacy, identity, and community values) and stereotype threat related to if, when, and to where women change their STEM majors over four years in college?

Guided by theories (Eccles & Wigfield, 2020; Estrada et al., 2011) and empirical evidence (Hernandez et al., 2020), we hypothesized that average and within-person fluctuations in TIMSI constructs would be negatively associated, and stereotype threat would be positively associated, with their change (*if*) to another or non-STEM major (*where*) in the earlier years of college (*when*).

RQ4. To what extent does stereotype threat moderate the relationship between science identity and if, when, and to where women change their STEM major over four years in college?

Based on Steele's assumption (1997), we hypothesized that both high average stereotype threat and spikes (i.e., within-person fluctuations) in stereotype threat would weaken the negative relationship between women's science identity and their change (*if*) to another or non-STEM major (*where*) in earlier years of college (*when*).

2. Methods

2.1. Participants

Data for this study were drawn from a larger study designed to examine the impact of a co-curricular mentoring and role-modeling program on undergraduate women's persistence in STEM. Undergraduates in their first or second year of college were recruited from four universities in the Colorado/Wyoming Front Range and five universities in North and South Carolina in Fall 2015 (Cohort 1) or Fall 2016 (Cohort 2). The analytic sample[3] consisted of 413 undergraduate women in STEM majors, of whom 63 % self-identified as being from a well-represented racial group in STEM (European, Asian descent; NCSES, 2022) and 29 % were first-generation college students (Table 1).

2.2. Procedure

Participants were recruited from nine universities via email invitations to students' school email addresses, in-person announcements in introductory STEM courses (e.g., Physics 101), and study flyers posted across the campuses. Interested students completed a screening survey and received a $5 gift card for their effort. Students who met the inclusion criteria (i.e., 18 years of age or older, identified as a woman, 1st or 2nd year of college, and majoring or intending to major in a STEM field) were invited to participate in the study. Identical recruitment procedures were used for Cohorts 1 and 2, resulting in nearly equal numbers of students in their first or second year of college at baseline (Table 1 and Table S1). The recruitment approach resulted in "planned" missing first-year data for those who started the study in their second year of college, and thus, college rank at baseline was included as a covariate in our models to account for these missing data and alleviate the potential for missing data bias. A Tailored Panel Management approach (Estrada et al., 2014), such as pre-paying participants $10 for their survey participation, resulted in a high overall average response rate of 86 % (range 74 %-100 % across time). All procedures were approved by the local IRB (#14–4829H).

Table 1
Summary of participant's demographic and academic characteristics at intake (N = 413).

Variable	*n*	*(%)*
Racial/Ethnic Descent		
African	32	7.75
Asian*	24	5.81
European*	236	57.14
Hispanic	25	6.05
Native American	4	0.97
Multi-Racial/Ethnic	57	13.80
Other	2	0.48
Non-response	33	7.99
First Generation College (Yes = 1, No* = 0)	119	28.81
First Major		
Agricultural/Natural Resources	27	6.54
Biological/Life Sciences*	177	42.86
Physical Science	71	17.19
Tech/Computer Science	14	3.39
Engineering	82	19.85
Mathematics/Statistics	10	2.42
Environmental Science	32	7.75
College Rank at Baseline		
1st Year*	208	50.36
2nd Year	205	49.64
Cohort Status		
2015*	198	47.94
2016	215	52.06
Mentoring Program Status (Yes = 1, No* = 0)	153	37.05

Notes. At baseline (T1), the self-reported average GPA was 3.62 (SD = 0.38, n = 408), and the average overall SAT/ACT equivalent score was 1,270 (SD = 144.41, n = 333). *Reference group in statistical models where this variable is used to predict major change.

2.3. Measures

Online surveys were administered each semester from the Fall of 2015 through the Spring of 2019. For students who started the study in their first year of college, repeated measures were taken each semester from the first through fourth years of college. Similarly, for students who started the study in their second year, repeated measures span from the second through fourth years of college. Demographic and academic characteristics were measured in an intake survey administered in the Fall semester (Table S1). Repeated measures of academic characteristics (e.g., major), the TIMSI motivational constructs, and stereotype threat

[3] The overall sample consisted of 484 participants, but 71 were removed from the current analysis due to (a) being in their junior year or above at the start of the study (*n*=11), pursuing a non-STEM major (e.g., History) at the start of the study (*n*=21), or having missing data on one-or-more baseline predictor variables (e.g., year in college; *n*=39).

were administered every semester following the intake through the Spring of the fourth year in college (Table S1).[4]

As detailed in the Plan of Analysis section below, we used repeated measurements of the predictors in two ways: average (until event occurrence) and within-person fluctuations from their own average. Students' *average* score on each construct consisted of their mean across semesters until event occurrence or censoring (defined below). For example, for a student who changed majors in the Spring semester of their second year of college, their average science identity score would be the mean science identity from the Fall of the first year of college through the Spring of the second year. Within-person fluctuations were operationalized as differences between the student's average and their observed score in a semester until event occurrence or censoring. For example, for a student who changed majors in the Spring semester of their second year of college, their within-person fluctuations in science identity scores would include semester-to-semester differences from average in science identity from the Fall semester in the first year of college through the Spring semester in the second year of college.

2.4. Outcomes

Major. Participants were asked to select Yes or No to a question about if they had declared a major. Participants who selected "Yes" were asked a follow-up open-response question to specify their major. Participants who indicated "No" were asked to select a category they most wanted to major in. The response options included a list of 10 common STEM (e.g., Biological/Life science), STEM-related (e.g., Psychology), and non-STEM major (e.g., Business) categories, as well as an "Other (Please specify)" option.[5] Responses to the follow-up questions were recoded into one of several science and engineering major categories (Table S2) according to the NSF STEM majors (NCSES, 2022).

Major change. At each time point, the student's major was recoded into a multi-valued variable that indicated a change in major status (*0 = no change, 1 = change to non-STEM major, 2 = change to another STEM major*). Both traditional non-STEM majors (e.g., Business) and STEM-related majors (e.g., Psychology) were included in the non-STEM major category.

Censoring. In survival analysis, censoring refers to instances where the outcome of interest (i.e., major change) is not observed in a participant before the study ends. Censoring is a form of missing data that can occur for two reasons (Allison, 2010): some persons never experience the event (e.g., never change majors), and others will experience the event, but the occurrence isn't measured as part of the study (e.g., the event occurs after the study concludes or a participant stops responding to data collection, also known as "right" censoring). In the current study, participants were treated as censored when data collection stopped due to the study ending or the participant stopped responding to the survey.[6] Missing data, including censored data, has the potential to bias study findings if the mechanism causing missingness is systematic and related to the outcome (i.e., "missing not at random" or "informative censoring"). Therefore, we carefully examined the patterns of censoring, conducted missing data tests, and concluded that in the present study, censoring was "non-informative" or independent from the likelihood of changing major (see Supplemental Materials).

2.5. Predictors

Time. Semester in school was recorded in a variable with nine ordered discrete categories, including: Fall semester in the first year of college (0), Spring semester in the first year of college (1), Fall semester in the second year (2), through Spring in the fourth year (8). For analyses, the time variables were recoded into a set of six dummy-coded discrete-time variables with second year-Fall semester set to the reference time-point: first year-Spring semester, second year-Spring semester, third year-Fall semester, third year-Spring semester, fourth year-Fall semester, and fourth year-Spring semester.

Stereotype threat. The four-item version of the Stereotype Vulnerability Scale (Woodcock et al., 2012) was used to assess student perceptions of gender-based stereotype threat at college (e.g., "How often do you feel that because you are a woman some people believe that you have less ability"). The measure used a seven-point Likert scale from 1 (*never*) to 7 (*almost always*).

Science self-efficacy. The three-item version of the Science Self-Efficacy scale (Chemers et al., 2011; Estrada et al., 2011) was used to measure participants' confidence in their ability to complete a variety of scientific tasks (e.g., "Use technical science skills [use of tools, instruments, and/or techniques]"). The measure used a seven-point Likert scale from 1 (*not at all confident*) to 7 (*absolutely confident*).

Science identity. The three-item version of the Science Identity scale (Chemers et al., 2011; Estrada et al., 2011) measured the degree to which participants regard themselves as scientists (e.g., "In general, being a scientist is an important part of my self-image"). The measure used a seven-point Likert scale from 1 (*strongly disagree*) to 7 (*strongly agree*).

Science community values. The four-item Science Community Values scale (Estrada et al., 2011) was used to assess science values (e.g., "A person who thinks discussing new theories and ideas between scientists is important"). The measure used a seven-point Likert scale from 1 (*not at all like me*) to 7 (*very much like me*).

Demographic and academic characteristics. Participants' race/ethnicity was recoded into a URM status dummy-coded variable that was used to identify participants from historically underrepresented minority racial/ethnic groups in STEM, which included those of African American/Black, Hispanic/Latinx, Pacific Islander, or Native American descent (*1 = URM, 0 = not URM*). A "prefer not to report race/ethnicity" dummy-coded variable was used to identify participants who opted not to report their race/ethnicity (*1 = yes, 0 = no*). Similarly, the following variables were dummy-coded and included as control variables in the models to account for the potential confounding influence of parameter estimates or standard errors: college rank at the time of recruitment (*0 = 1th Year, 1 = 2nd Year*), involvement in the mentoring program (*1 = yes, 0 = no*), and a set of indicators of initial college major.[7]

[4] At baseline survey, TIMSI motivational constructs and stereotype threat were measured using one item out of the original scale on a five-point Likert scale, respectively, out of concern for participant fatigue. For consistency across time points, we converted each scale's scores to the percent of maximum possible score (POMP) metric (Cohen et al., 1999). Consistent with prior evidence of internal structure measurement validity and reliability of scores (Woodcock et al, 2012), we used confirmatory factor analysis to assess longitudinal measurement invariance of each scale over time (Supplemental Materials). Further, McDonald's omega (ω) was used to estimate reliability, which is estimable even at time-points where only one-item was administered (Supplemental Materials).

[5] The major categories included: 1) Agricultural/Natural Resource Science, 2) Biological/Life Science, 3) Physical Science, 4) Tech/Computer Science, 5) Engineering, 6) Mathematics/Statistics, 7) Environmental Science, 8) STEM-related major (e.g., Psychology), or 9) non-STEM (e.g., History). Each response was coded by two research assistants and the inter-rater reliability was calculated using the Kappa statistic ranged from 0.84 to 0.97 across all survey and all time points. Disagreements were resolved through consensus with a third coder (i.e., principal investigator).

[6] In the small number of cases (n = 30) with interval censoring (i.e., participant skipped a survey and reported changing their major follow-up survey), major change was coded as having occurred on the follow-up survey.

[7] Agricultural/Natural Resources, Physical Science, Tech/Computer Science, Engineering, Mathematics/Statistics, and Environmental Science, with Biological/Life sciences as the comparison major.

2.6. Plan of analysis

To address RQ1 (*testing if, when, and to where women in STEM are most likely to change their major over time*), we conducted a discrete-time competing risks survival or hazard analysis (Allison, 2010) using multinomial logistic regression (Long & Freese, 2001) in Stata 17 (StataCorp, 2021). Data were restructured into a person-period or multilevel format, with event status (no change, change to non-STEM, change to other STEM, censored), discrete-time, and repeated observations on time-varying predictors (e.g., within-person fluctuations in science identity) coded within-person (i.e., level 1; Allison, 2010). In this model, a set of six dummy-coded time variables predicted the relative risk or odds of a major change to a non-STEM or other STEM major (relative to no change). To test RQ2 (*testing group differences in the hazards of major change as a function of URM status*), we added the between-person (i.e., level 2) URM status variable into the model to predict the odds of each type of major change. To address RQ3 (*testing TIMSI motivational constructs and stereotype threat*), we added average and within-person fluctuations in science self-efficacy, science identity, science community values, and stereotype threat into the model to predict the odds of each type of major change. Consistent with best practices (Wang & Maxwell, 2015; Yaremych et al., 2021), (*a*) the time-varying within-person predictors were group-mean centered within-person (reflecting fluctuations from their average until censoring), as well as (*b*) being aggregated to the between-person level (i.e., average across all time-points until censoring) and grand mean centered for analysis. Finally, to address RQ4 (*testing stereotype threat as a moderator of the relationship between science identity and major change*), we added two multiplicative terms into the model: a within-person level interaction of stereotype threat and science identity (both level 1) and a cross-level interaction of aggregated stereotype threat (level 2) and time-varying fluctuations in science identity (level 1).

2.7. Preliminary analyses

We examined the descriptive statistics and tested the tenability of statistical assumptions for survival analysis and longitudinal models in Stata 17. The tests confirmed the tenability of all statistical and longitudinal assumptions (see Supplemental Materials for descriptive statistics [Table S3-S7] and detailed discussion of assumption tests [Table S8]).

3. 3.Results

3.1. RQ 1: If, when, and to where women in STEM change majors

The discrete-time competing risks hazard analysis using multinomial logistic regression revealed that the relative risk or odds of change to a non-STEM major (relative to no change) were highest in the Spring semester of the first year of college before steadily declining (Figure S1 and Table S9). Interestingly, women's odds of change to another STEM major (relative to no change) had a double peak, being highest in the Spring semester of the first year, dropping in the Fall of the second year, and spiking again in the Spring of the second year before steadily declining (H1 supported). Furthermore, supplemental comparisons indicated that the odds for change to a non-STEM major relative to a change to Other STEM majors were not different at any time point (Supplemental materials).

3.2. RQs 2–4: How URM status, TIMSI motivational constructs, and stereotype threat predict the patterns of women's STEM major changes

Regarding RQ2, the odds of change to non-STEM or another STEM major (relative to no change) were *not* different for those from White/Asian vs. URM groups ($RRR = 1.31$ & 0.58, respectively; H2 not supported; Table 2 and S9[8]). Regarding RQ3, the results were more nuanced. First, we found that average science identity and within-person fluctuations in science identity predicted change to a non-STEM major (H3 partially supported). That is, semesters in which individuals saw themselves as more of a scientist (compared to their own average self-perception) were associated with lower odds of changing to a non-STEM major ($RRR = 0.96$ indicates every one-unit increase above their personal average was associated with 1.04 decline in the odds; see Fig. 1 [Left Panel]). Similarly, individuals with higher average perceptions of themselves as scientists (compared to the average self-perceptions of peers) had lower odds of changing to a non-STEM major ($RRR = 0.94$ indicates every one-unit increase above the sample average was associated with a 1.06 decline in the odds; Fig. 1 [Right Panel]). Second, we found that within-person fluctuations in stereotype threat predicted changing majors (H3 partially supported). That is, semesters in which individuals perceived higher levels of stereotype threat (compared to their average perception) were associated with higher odds of changing to a non-STEM or other STEM major ($RRR = 1.03$; Fig. 2, [Left Panel] Non-STEM & [Right Panel] Other STEM).

Regarding RQ4, we found that students' average stereotype threat moderated, and thereby weakened, the beneficial relationship between within-person fluctuations in science identity and change to a non-STEM major ($RRR = 1.001$, H4 partially supported). That is, among women with low average stereotype threat, semesters in which individuals saw themselves as more of a scientist (compared to their own average self-perception) were associated with lower odds of changing to a non-STEM major (Fig. 3 [Left Panel]). By contrast, among those with high average stereotype threat, semesters in which individuals saw themselves as more of a scientist (compared to their own average self-perception) did not substantially lower the odds of changing to a non-STEM major (Fig. 3 [Right Panel]).

4. Discussion

This 4-year longitudinal study investigated the predictive roles of TIMSI motivational constructs (science self-efficacy, identity, and community values) and stereotype threat in the patterns of major choice (staying in, switching within, or out of STEM) among undergraduate women who initially majored in STEM. We further examined the interactive effects of stereotype threat and science identity associated with these women's longitudinal persistence in STEM. We adopted two novel approaches to address the situated nature of motivational processes by (1) tracking women's major choices over four years (informing if, when, and where for women's STEM persistence) and (2) simultaneously testing associations with between-person average (across time) and within-person fluctuations (semester to semester spikes and dips from one's average) in TIMSI motivational constructs and stereotype threat as predictors of women's major choices. The present study's findings advance current understanding in four ways, as discussed in the following section.

4.1. The If, when, and where of women's persistence in STEM

First, the current study contributes to the literature by providing a more nuanced pattern of *when* and to *where* women changed their original STEM majors *if* they decided to do so. Specifically, we found

[8] Table 2 is a trimmed version of the results and omits control variables. Table S9 contains all results from the analyses conducted for RQs 2–4.

Table 2
Summary of discrete-time survival model for types of major changes ($N_i = 413$; $N_{ti} = 1{,}730$).

Predictors	Change to Non-STEM Majors				Change to Other STEM Majors			
	b	*S.E.*	*z*	*RRR*	*b*	*S.E.*	*z*	*RRR*
Within-Person Time-Varying (level 1)								
Science Self-Efficacy $_{TVC}$	0.021	0.014	1.54	1.02	0.004	0.013	0.33	1.00
Science Identity $_{TVC}$ (SI $_{TVC}$)	**−0.040******	**0.013**	**−3.17**	**0.96**	−0.018	0.013	−1.46	0.98
Science Community Values $_{TVC}$	0.008	0.015	0.53	1.01	−0.005	0.017	−0.27	1.00
Stereotype Threat $_{TVC}$ (ST $_{TVC}$)	**0.030******	**0.012**	**2.60**	**1.03**	**0.028******	**0.010**	**2.86**	**1.03**
Between-Person Time-Invariant (level 2)								
URM Status (1 = URM)[c]	0.269	0.344	0.78	1.31	−0.543	0.370	−1.46	0.58
Avg. Science Self-Efficacy $_{TIC}$	−0.001	0.012	−0.06	1.00	−0.011	0.012	−0.96	0.99
Avg. Science Identity $_{TIC}$	**−0.059*******	**0.011**	**−5.40**	**0.94**	0.000	0.011	−0.01	1.00
Avg. Science Community Values $_{TIC}$	−0.019	0.011	−1.70	0.98	0.001	0.015	0.06	1.00
Avg. Stereotype Threat $_{TIC}$ (ST $_{TIC}$)	0.002	0.008	0.27	1.00	−0.003	0.008	−0.39	1.00
SI $_{TVC}$ × ST $_{TVC}$	−0.001	0.001	−0.79	1.00	0.000	0.001	−0.28	1.00
SI $_{TVC}$ × ST $_{TIC}$	**0.001*****	**0.0005**	**2.09**	**1.001**	0.001	0.001	0.90	1.00

Notes. Significant coefficients are in bold. Avg. = Average. TVC = Time-varying covariate. TIC = Time-invariant covariate. RRR = Relative risk ratios are odds ratios indicating the change in the odds of changing major (relative to no change) for a one-unit change in the predictor. TVCs were group-mean centered, and continuous TICs were grand-mean centered for the models. Control variables are not shown in this table for the sake of parsimony (see Supplemental Materials Table S9 for complete details).
*$p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

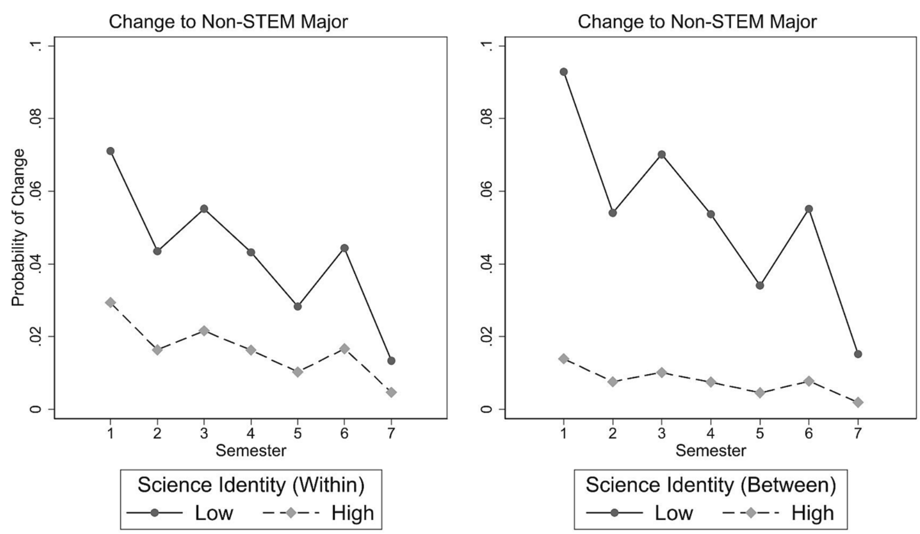

Fig. 1. Relations between within-person fluctuations (left) and between-person average (right) science identity and the probability of changing to non-STEM majors. *Notes.* Semester values are as follows: 1 = Spring first year of college, 2 = Fall second year, …, 7 = Spring fourth year. Science Identity (within) Low/High = −/+ 1SD personal mean. Science Identity (between) Low/High = −/+ 1SD sample grand mean.

that women were most likely to switch out of STEM majors by the end of the spring semester in the first year. This aligns with prior evidence that poor grades or challenges (e.g., lecture-based practices, large course size, difficult coursework) experienced by students (particularly women and URM students) in introductory courses are related to their STEM attrition (Hatfield et al., 2022). After a peak of women's attrition out of STEM during the first year, attrition steadily declined through the fourth year spring semester. Similarly, women's changes to another STEM major were most likely to occur in the first year Spring semester in college. Interestingly, this trend of major choice rebounded in the Spring semester of the second year, which points to women's continued changes in their majors – even within STEM fields – throughout the first two years of college.

Unexpectedly, we did not find differences in major changes between women from URM and well-represented racial/ethnic groups. Although much prior research points to the salience of intersectional differences in motivational experiences, our results indicate that the first year may be the most volatile time of college for women's choice of major, regardless of URM status (Ost, 2010). Moreover, it may be the case that Asian and White female students have differential motivational and stereotypical experiences (Hsieh et al., 2021) despite their well-represented status in STEM, which may attenuate group differences that might have existed. Future research is necessary to replicate and extend these findings by conducting even more detailed analyses of group differences. Overall, our findings provide a clearer picture of *if, when, and to where* women who entered college with an interest in pursuing STEM fields change their choice of major in college. Results reinforce the importance of the first two years of college as the key period for educational practices or interventions that can effectively retain women in STEM.

4.2. *Importance of average and within-person fluctuations in science identity*

Second, our findings demonstrated the importance of both between-person average and within-person fluctuations in science identity in women's choice of major, even after controlling for various covariates. To our knowledge, these two aspects of science identity have not been examined together in predicting women's STEM persistence until the current study. Consistent with well-established evidence on the influence of between-person differences in science identity (Fong et al., 2021;

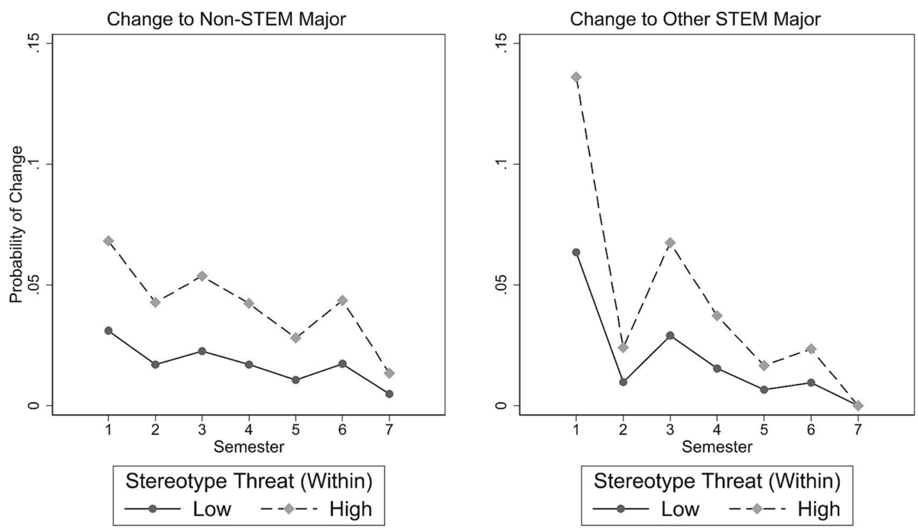

Fig. 2. Relations of within-person fluctuations in stereotype threat with the probability of changing to non-STEM majors (left) and other STEM majors (right). *Notes.* Semesters values are as follows: 1 = Spring first year of college, 2 = Fall second year, …, 7 = Spring fourth year. Stereotype Threat (within) Low/High = −/+ 1SD personal mean.

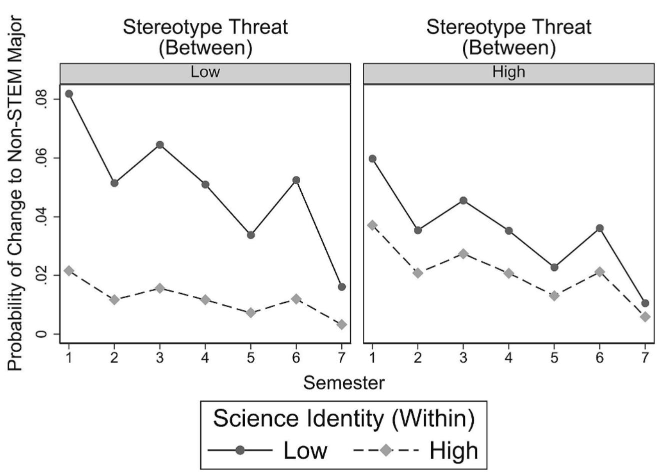

Fig. 3. Relations of within-person fluctuations in science identity with the probability of changing to non-STEM majors when between-person average stereotype threat is low (left) and high (right). *Notes.* Semesters values are as follows: 1 = Spring first year of college, 2 = Fall second year, …, 7 = Spring fourth year. Science Identity (within) Low/High = −/+ 1SD personal mean. Stereotype Threat (between) Low/High = −/+ 1SD sample grand mean.

Hernandez et al., 2020; Robinson et al., 2019), our results showed that women with high average science identity were significantly less likely to change to non-STEM majors (probability near zero) compared to those with low average science identity through the college years.

More notably, our results provide novel evidence for the predictive validity of within-person fluctuations in science identity for women's STEM persistence. Though prior research demonstrated the developmental change (e.g., growth) in science identity as a precursor of STEM persistence (Robinson et al., 2018), our study extends this work by corroborating the roles of semester-to-semester within-person fluctuations (e.g., relatively higher, lower-than-usual) in science identity in women's choice of major over four years. Specifically, semesters in which women's science identity spiked (above their average) were associated with a near-zero probability of changing to non-STEM majors. However, semesters in which women's science identity dipped (below their average, especially during the spring semester of their first year in college) were associated with their highest probability of attrition from STEM. Our findings thus indicate that women may view themselves as more or less like a scientist in a given semester, presumably in response to varying degrees of environmental influences (e.g., course difficulty, course climate, or discriminatory experiences; Ahlqvist et al., 2013; Lee et al., 2024), and these fluctuations may relate to their STEM major plans from semester to semester. Our study demonstrates the additional importance of considering within-person fluctuations in science identity, over and above the average science identity, as an important predictor of women's STEM pursuits throughout the years of college–especially in the first year.

Our findings support a recent re-focus on situated or contextually aware theory (Eccles & Wigfield, 2020), suggesting that individuals' behavioral choices are tied to their current "situation" and change over time. Along this line, our findings suggest that an integrated view considering both average and time-specific fluctuations in science identity is more informative to the current understanding of the situated nature of processes that instigate motivation and persistence choices in STEM fields. Unexpectedly, we did not find significant predictive validity of average and within-person fluctuations in the other TIMSI motivational constructs. However, this aligns with the theoretical premise and empirical findings that one's identity is more influential for behavioral choices, whereas self-efficacy is more predictive of performance (Eccles et al., 1983). Future research is encouraged to investigate the effects of average and within-person fluctuations in TIMSI motivational constructs on other relevant student outcomes.

4.3. Women's within-person fluctuations in stereotype threat and STEM persistence

Third, our results provide a more nuanced and critical understanding of complex reasons spurring women to change STEM majors by demonstrating the significant roles of within-person fluctuations in stereotype threat. We found that within-person fluctuations in stereotype threat were significantly associated with women's changes to other or non-STEM majors, but average stereotype threat was not. This finding indicates that semesters in which women experienced spikes in stereotype threat (higher than their average perceived stereotype threat) were the times in which they were the most likely to change to other STEM or non-STEM majors, particularly in the early years of college. This may indicate that, although women recognize stereotype threat from an early age (Zhao et al., 2022), stereotype threat can temporarily soar due to the cues about lack of fit in male-dominated STEM cultures (Hall et al., 2019; Hall et al., 2015). Such cues may cause a surge in stereotype threat that critically informs women's decision on their majors during early college years, which offers additional insights into how stereotype threat is associated with women's STEM pursuits.

This trend of major changes can be understood in light of the disproportionately lower representation of women across some STEM fields (Cheryan et al., 2017; Leslie et al., 2015). Although STEM fields contain stereotypes favoring men's ability in general, it may be more difficult for women to see themselves fitting into some fields (e.g., Physics) that are believed to require brilliance to succeed (e.g., the field-specific ability beliefs; Bian et al., 2018; Leslie et al., 2015), which leads some fields to be more gender-balanced than others (Cheryan et al., 2017; Hannak et al., 2023). Supporting this argument, our supplementary findings (Table S2 & Figure S2) showed that women who initially chose to major in Tech/Computer Science ($n = 14$) and Physical Science ($n = 71$) in the first year reported changing their major at a relatively higher rate across four years of college (93 % & 47 %, respectively). By contrast, women who initially chose less math-intensive STEM majors reported changing their major at a relatively smaller rate (e.g., Biological/Life Sciences, 22 %). Although our study does not indicate that students shifted from a less to a more gender-balanced STEM major, prior evidence indicates that women may change to STEM majors that focus more on effort than brilliance (Hannak et al., 2023) or are welcoming to women (Ramsey et al., 2013) at the time of spikes of stereotype threat in their current majors. Future research should investigate this possible explanation.

4.4. Interactive effects of science identity and stereotype threat on women's persistence in STEM

Despite Steele's (1997) assumption of stronger effects of stereotype threat on highly identified individuals, this hypothesis has been underexplored in the literature – especially in longitudinal and field settings. Thus, testing the interactive effects of science identity and stereotype threat associated with women's STEM persistence helps contribute to the literature in this area. Results showed that for women with low average stereotype threat, within-person fluctuations in science identity exhibited the expected beneficial associations with STEM major change (Fig. 3). That is, for women who reported experiencing low levels of stereotype threat in college, semesters in which their science identity spiked were associated with an exceptionally small probability of change to non-STEM majors. In contrast, dips in science identity were associated with a higher probability of change. By contrast, for women who reported experiencing high levels of stereotype threat in college, semesters in which their science identity spiked did not appreciably lower their probability of change to non-STEM majors compared to semesters in which their science identity dipped. Though our results partly support Steele's assertion, these findings suggest a more nuanced understanding of stereotype threat – that chronic stereotype threat may negate the positive effects of women's *temporarily* high science identity on their STEM pursuits.

Our findings suggest that considering average and within-person fluctuations in stereotype threat and TIMSI motivational constructs is necessary to draw more fine-grained conclusions concerning women's choice of STEM majors. Specifically, our findings shed light on the underexplored mechanism that chronic stereotype threat (high average stereotype threat) can even counteract the potential benefits of spikes in science identity in a given semester. Therefore, we suggest parents and educators provide women with counter-stereotypical experiences in childhood and beyond by introducing successful and relevant female role models, creating gender-neutral physical environments, and communicating that women and men equally belong and can achieve success in STEM (Cheryan et al., 2017; Lee et al., 2023), which may minimize women's chronic exposure to stereotype threat and maximize the effectiveness of interventions for women's science identity.

4.5. Limitations and directions for future research

Despite the valuable contributions of the current study's findings, it is also important to acknowledge some of its limitations, which point to multiple fruitful directions for future research. First, several aspects of the study sample and sampling limit generalizations. Although we contribute to a more nuanced understanding of women's TIMSI motivational processes in STEM, the results may not generalize to other populations. Moreover, although nearly 30 % of our participants were from underrepresented racial/ethnic minority groups in STEM, the current study was not sufficiently powered to detect differences in the experience of women from differing racial/ethnic groups (e.g., Black vs. Hispanic/Latinx). Future research should extend these findings by accounting for different student populations (e.g., gender, age) or addressing the intersectionality with more sophisticated analyses (e.g., multiple group analysis). Furthermore, findings on racialized motivational and stereotypical experiences (e.g., Hsieh et al., 2021) suggest the need for additional investigations on racial/ethnic differences – that complement the current study's focus on the representation status (well-represented vs. URM) in STEM – in the initial trends noted in the current study. Finally, our recruitment procedures focused on first- and second-year college women, resulting in "planned" missing data for study participants recruited in their second year of college (i.e., we could not collect their 1st-year data). Although we accounted for this missing data through statistical controls, our approach could have been underpowered to detect some aspects of survival events in the first year of college or their associations with the relevant TIMSI and stereotype threat predictors. Future research should extend our approach by focusing more heavily on the high school through college transitions for all study participants.

Second, out of a concern for participant fatigue and maintaining a high commitment to the longitudinal study, this study used shortened scales to assess TIMSI motivational constructs. Our approach may have resulted in more narrowly capturing the facets of some constructs. Although longitudinal measurement invariance tests provide validation evidence of our approach, future research should replicate the current findings by administering the same scales across multiple measurement time points to enhance the longitudinal measurement validity. Another limitation of measurement concerns our approach to censoring. We focused on time to the first event (i.e., major change) and did not incorporate multiple events. It is possible that some individuals changed out of STEM majors and then returned to a STEM major later in their college tenure. Future research should consider multiple event survival models to capture these dynamics better.

Third, our study provides evidence of associations rather than causal pathways. Based on theory and prior evidence, we situate motivational beliefs as predictors of major change, but this is a reciprocal process where beliefs can impact behavior and vice versa. The causal pathways could not be disentangled in our study, but future studies should examine the potential for reciprocal causal effects from beliefs to behavior and vice versa. Further, the results confirm that considering within-person fluctuations in motivational constructs is important to achieve a more comprehensive understanding of the situated aspects of motivations to persist in STEM. Thus, we encourage future work to further examine within-person fluctuations in TIMSI constructs and stereotype threat by using different intervals of time (e.g., weekly) along with the methods capturing ongoing experiences and perceptions (e.g., experience sampling, daily diary methods; Beymer & Rosenzweig, 2023). Future studies could also examine other motivational constructs (e.g., interest, utility value, cost; Part et al., 2023) that have been linked to STEM persistence in prior studies (e.g., Robinson et al., 2018), given that separating their associations with average and within-person fluctuations may alter or strengthen previously drawn conclusions.

Fourth, given the current study's evidence on science identity, future research is warranted to investigate the determinants and consequences of average science identity, within-person fluctuations in science identity, and relevant motivational constructs. Fifth, although the current study's four-year-longitudinal design provides novel insights, we recommend future work to build stronger causal inferences by adopting longitudinal experimental designs. Moreover, future research is encouraged to adopt the latent variable approach (e.g., latent moderated structural equations) to replicate the current study's interaction effects. Although we utilized observed variables due to the complexity of the current study's design, the latent variable approach may increase the reliability of findings by accounting for measurement error (Little et al., 2006). Finally, it should be noted that, due to missing data on SAT/ACT scores (see note in Table 1), we did not account for the baseline achievement to maximize the sample size and, thus, statistical power in this study. Future research should build upon the current study's findings by examining the degree to which motivational constructs predict major change patterns over and above prior achievement. The theoretical premise (Eccles & Wigfield, 2020) and empirical evidence (Cimpian et al., 2020) support this approach in strengthening current findings.

5. Conclusion

The current study contributes to theory and practice by demonstrating that the interplay of between-person average differences (across college years) and within-person fluctuations (from semester to semester) in TIMSI motivational constructs and stereotype threat predict *if* women persist in STEM majors, *when* changes occur, and *to where* undergraduate women go when departing their original STEM major. Women's STEM attrition peaked during the first year, and their odds of switching to another STEM major were highest in the first two years of college. These patterns were predicted by (a) average science identity and semester-to-semester within-person fluctuations in science identity and (b) within-person fluctuations in stereotype threat. Moreover, average stereotype moderated the relationship between science identity and STEM persistence, such that a high average stereotype threat thwarted the benefits of semester-to-semester spikes in science identity on persistence in a STEM major. Findings emphasize the importance of considering both average (over time) and fluctuations (semester-to-semester) in motivational constructs and stereotype threat for a more complete understanding of the situated nature of women's choices in STEM.

CRediT authorship contribution statement

Hyewon Lee: Writing – review & editing, Writing – original draft, Conceptualization. **Wenyi Du:** Writing – review & editing, Writing – original draft, Visualization, Formal analysis, Data curation. **Rachelle M. Pedersen:** Writing – review & editing, Writing – original draft, Formal analysis. **Mica Estrada:** Writing – review & editing. **Amanda S. Adams:** Writing – review & editing, Funding acquisition. **Rebecca T. Barnes:** Writing – review & editing, Funding acquisition. **Brittany Bloodhart:** Writing – review & editing. **Melissa Burt:** Writing – review & editing, Funding acquisition. **Sandra M. Clinton:** Writing – review & editing, Funding acquisition. **Ilana Pollack:** Writing – review & editing, Project administration. **Emily V. Fischer:** Writing – review & editing, Funding acquisition. **Paul R. Hernandez:** Writing – review & editing, Writing – original draft, Visualization, Supervision, Project administration, Methodology, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Funding

This work was supported by the National Science Foundation under Grant #DUE − 1431795, DUE − 1431823, and DUE − 1460229.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cedpsych.2024.102324.

Data Statement and Data Link

The data and code are publicly available in the Texas Data Repository at https://doi.org/10.18738/T8/CIZNP0.

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