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Seeking congruity for communal and agentic goals: a longitudinal examination of U.S. college women's persistence in STEM

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Abstract
An abundance of literature has examined barriers to women's equitable representation in science, technology, engineering, and math (STEM) fields, with many studies demonstrating that STEM fields are not perceived to afford communal goals, a key component of women's interest in future careers. Using Goal Congruity Theory as a framework, we tested the longitudinal impact of perceptions of STEM career goal affordances, personal communal and agentic goal endorsements, and their congruity on persistence in science from the second through fourth years of college among women in STEM majors in the United States. We found that women's intent to persist in science were highest in the fall of their second year, that persistence intentions exhibited a sharp decline, and eventually leveled off by their fourth year of college. This pattern was moderated by perceptions of agentic affordances in STEM, such that women who believe that STEM careers afford the opportunity for achievement and individualism experienced smaller declines. We found that higher perceptions of communal goal affordances in STEM consistently predicted higher persistence intentions indicating women may benefit from perceptions that STEM affords communal goals. Finally, we found women with higher agentic affordances in STEM also had greater intentions to persist, and this relationship was stronger for women with higher agentic goals. We conclude that because STEM fields are stereotyped as affording agentic goals, women who identify interest in a STEM major during their first years of college may be drawn to these fields for this reason and may benefit from perceptions that STEM affords agentic goals.

Keywords Gender · Women in STEM · Goal congruity theory · Communal goals · Agentic goals · Scientific persistence intentions

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1 Introduction

As a continued global push for an increase in diversity of the science, technology, engineering, and mathematics (STEM) workforce (National Science Board, 2018), researchers have focused on a need to create a STEM workforce in the United States that is more inclusive and comprised of members representative of the population at large (Nielsen et al., 2017; President's Council of Advisors on Science and Technology, 2012; Snyder et al., 2009). These efforts include examining the numerous barriers to women's recruitment and retention in these fields. In the U.S., individuals often decide on a major that will inform their career choice during their college years. Despite having an early collegiate interest in scientific careers, women in the United States are not remaining in STEM majors and careers at numbers comparable to men (Chen, 2013; Glass et al., 2013; National Science Foundation, 2019; Shauman, 2017). As with much of the extant literature on retention of women in STEM (e.g., Chen, 2013), we focus on intentions to pursue a scientific career, rather than a career in primary or secondary education as a teacher of science. Although there are many barriers persons from historically under-represented groups in STEM (e.g., Black, Indigenous, People of Color, and women) face in the U.S., one appears to be the perception that STEM disciplines do not afford the opportunity to fulfil personal career goals (Diekman et al., 2010). Specifically, STEM fields are largely perceived as affording agentic more than communal goals and given that women generally tend to value communal more than agentic goals in their academic and career pursuits, this perception may deter women's persistence in STEM (see Boucher et al., 2017 for a review). However, women still report interest in pursuing agentic goals, and little research has documented whether perceptions of agentic goal affordances influence women's persistence in STEM, especially during their college years. Women may enter college with interest in STEM fields but may lose interest and leave these fields if their experiences do not reinforce that STEM affords them the goals they seek. The purpose of the current study was to explore this possibility over the college tenure among college STEM women in the United States, and to specifically examine the relationship between their communal and agentic goals and their perceived goal affordances of STEM on persistence in STEM.

1.1 Goal congruity theory and persistence in STEM

Goal Congruity Theory (GCT; Diekman et al., 2011) provides a framework for examining how the goals that individuals personally strive to attain match with the goals certain careers and fields are perceived to afford, and individual interest in these fields resulting from a congruous or incongruous match. Although a variety of theories describe the content of careers, skills, and interests, such as person-focused versus object-focused (Yang & Barth, 2015), a common delineation in psychology is between communal and agentic foci. Communal pursuits are generally defined as other-focused, interest in helping or serving others, social, interactive, and cooperative (Abele et al., 2008). Agentic pursuits on the other hand are more self-focused, and include goals such as achievement, success, and recognition, and are more likely to be thing-oriented (Abele et al., 2008). At the core of GCT is that an individual's personal goals (as being communal and/or agentic) should be congruent with their perceptions that a chosen career affords those goals in order to maintain interest (Diekman et al., 2017). That is, there should be an interaction between goals and perceived affordances on career interest, with interest only being high when one's goals and the career's perceived affordances are both high (whether those goals are communal or agentic). In addition, perceptions that various careers afford communal or agentic goals can change over time and with differing experiences (Diekman et al., 2017), such as during the undergraduate years. Research related to GCT documents persistent patterns in U.S. college students' perceptions of careers as being likely to afford communal or agentic goals (Diekman et al., 2010, 2011; Evans & Diekman, 2009; Morgan et al., 2001). Specifically, STEM careers are more likely to be perceived as affording agentic goals, and even worse, can be perceived as obstructing communal goals (Diekman et al., 2011). However, this perception of obstruction is not consistent across cultures. In a recent study comparing American, Chinese, and Indian students, American students perceived STEM as affording less communal opportunities than Chinese and Indian students (Brown et al., 2018), indicating that the goals STEM is perceived to afford may depend on the way careers and disciplines are portrayed.

Most research pertaining to GCT and women's attrition in STEM has focused on communal goals (Boucher et al., 2017). Studies have shown that from an early age, gender stereotypes expressed in the academic environment and at home influence women such that they have a greater personal endorsement of communal goals than men (see Wang & Degol, 2017 for a review) and this influence leads to a perceived lack of belonging in male-dominated fields once in college (Cheryan & Plaut, 2010). Correspondingly, women are more likely than men to seek out roles and careers that they perceive afford communal goals that are other-oriented (Diekman et al., 2010; Lippa, 1998). Because STEM fields are perceived to afford more agentic and less communal goals, research has shown that the personal endorsement of communal goals negatively predicts women's interest in the pursuit of STEM careers (Diekman et al., 2010, 2011). This may be compounded for first-generation college women, as barriers arise for first-generation college students when their science education experiences fail to underscore communal affordances (Allen et al., 2015). Indeed, while communal goals are often important to college women, research also indicates that regardless of major and gender, undergraduate college students' perception of STEM careers as affording greater communion is associated with greater STEM career interest (Brown, Smith, et al., 2015; Brown, Thoman, et al., 2015). Across experimental and naturalistic settings, college student perceptions that STEM fields provide communal opportunities predicted positivity toward STEM (Steinberg & Diekman, 2017) and increased career interest (Fuesting et al., 2017). College STEM majors prefer interacting with advisors that exhibit communal behaviors and perceive them as affording more of both communal and agentic goals (Fuesting & Diekman, 2017). Further, both short-term and long-term exposure to experiences depicting STEM careers as communal increases undergraduate college students' communal affordance perceptions and positivity toward science (Steinberg

& Diekman, 2017), and exposure to communal opportunities in math and science classrooms increases interest in STEM careers via beliefs that STEM careers afford communal goals (Fuesting et al., 2017).

1.1.1 Limitations of the extant research

As discussed above, goal congruity theory research has, to date, provided more insight into the relationship between communal goals and intentions to persist in STEM than it has for the relationship between agentic goals and persistence. This focus perhaps resulted from early goal congruity research which found evidence that gender differences emerge primarily on communal goals (Diekman et al., 2011) and the impetus for studying women's underrepresentation in STEM compared to men's. The scant findings reported in the context of GCT research on agentic goal affordances in STEM has limited the depth of our understanding agency's role in influencing college women in STEM and research suggests that a dismissal of agentic goal affordances may be premature (Barth et al., 2015; Yang & Barth, 2015). College women in non-biology STEM majors have been shown to be equally interested in people-oriented and thing-oriented careers (Yang & Barth, 2015). American college women are more likely to express interest in occupations with higher salaries than those associated with helping others (Barth et al., 2015). Based on these findings, we argue that while communal goal congruity may be a larger driver of the discrepancy between women's and men's representation in STEM, agentic goal congruity may still be an important motivation for many women in STEM.

Finally, given the intense focus on college women's attrition from STEM, relatively few studies have documented the longitudinal co-development of college women's goals and persistence in STEM fields. The majority of studies that do examine women's trajectories in STEM over the course of their college careers document various structural and psychological barriers and examine how factors such as belonging, mentoring, motivation, self-efficacy, and a host of other psychological processes influence women's success in STEM (e.g., see Blackburn, 2017). Research documenting trends in persistence find that college women's interest and intentions to major in STEM are initially high and then quickly decline and level off over 4 years of college (Brainard & Carlin, 1998; Schultz et al., 2011). Importantly, however, there is scant research on how (or whether) the longitudinal influence of goals and affordances impacts STEM career aspirations in college women.

1.2 The current study

The current research examines undergraduate college women's communal and agentic goal endorsements and their perceived goal affordances by science across their four-year degree, with the ultimate goal of predicting college women's persistence in science. Data is drawn from the Analysis of Women's Advancement Retention and Education in Science (AWARES) Study, which tracked over 400 undergraduate women across 9 U.S. universities twice a year from 2015 to 2019 (Hernandez et al., 2017). In addition, half of the women in this study participated in the PROGRESS

(PROmoting Geoscience Research, Education, and SuccesS) intervention program, which, among other elements, actively promoted the idea that science is a communal pursuit and provided peer and mentor networking opportunities (see Fischer et al., 2018). Based on previous research described above, we hypothesize the following:

Hypothesis 1 Based on prior research (e.g., Schultz et al., 2011), we expected scientific career persistence intentions to decline over women's four-year college experience.

Hypothesis 2a College women's perceptions that science careers afford communal goals positively predict intentions to persist in science.

Hypothesis 2b The effect of perceptions of communal affordances on persistence intentions in science is moderated by communal goal endorsement, such that the relationship between perceived communal affordances and persistence intentions is stronger as college women's personal communal goal endorsement increases.

Hypothesis 3a College women's perceptions that science careers afford agentic goals positively predict intentions to persist in science.

Hypothesis 3b The effect of perceptions of agentic affordances on persistence intentions is moderated by agentic goal endorsement, such that the relationship between perceived agentic affordances and persistence intentions becomes stronger as college women's personal agentic goal endorsement increases.

In addition, we also explore whether time moderates the relationship between communal or agentic goal congruity affordances and personal endorsements and persistence intentions. Although we expect college women's science persistence intentions to decrease over time, it is unclear whether women's personal goal endorsements or perceptions of STEM affordances of communal and agentic goals change over time, and how this may ultimately impact the trajectory of their interest in pursuing science.

2 Method

2.1 Participants

Four-hundred seventy-four first- and second-year college women who expressed interest in a STEM major from multiple universities were recruited to participate in a longitudinal survey study of women's education and success. The analytic sample for this study consists of 421 college women who responded to one or more of the surveys after being recruited into the study. The study participants were recruited from five universities in the Colorado/Wyoming Front Range region and four universities in the Carolinas during the fall semesters of 2015 (Cohort 1) and 2016 (Cohort

Table 1 Summary descriptive statistics for sample characteristics at the time of recruitment into the study ($N=421$)

Source	%
1. First-generation college student	27.3
2. Race/Ethnicity	
Asian	5.7
African	7.1
LatinX	5.5
Native American/Pacific Islander	1.2
European	56.8
Multi-Ethnic	15.0
Other	0.50
No Response	7.1
3. Major	
Agricultural Science	3.6
Biological / Life Sciences	42.5
Health & Human Sciences	.2
Physical Sciences	29.2
Mathematics or Computer Science	5.2
Engineering	19.2
4. First cohort of participants	49.4
5. Participants in the PROGRESS mentoring program	62.9
6. Full-time students	98.6
7. College	
Colorado College	6.7
Colorado State University	17.8
Metropolitan State Univ. of Denver	5.2
North Carolina A&T University	5.2
North Carolina State University	12.1
University of Colorado-Boulder	16.6
Univ. of North Carolina-Charlotte	12.6
University of South Carolina	14.0
University of Wyoming	9.7

2). At the time of recruitment, approximately half of the students were in their first year of college, over 98% were full-time students, and 27.3% were first-generation students. Average household income was between $50,000–$75,000. We did not ask about participants' age, other than to ascertain that participants were 18 years old or older for the purposes of consenting to participation in a research study. Additionally, 63% of participants were involved in the PROGRESS program. Other key demographic characteristics are reported in Table 1.

A preliminary analysis was conducted to compare students in the total and analytic samples using logistic regression. The results showed no differences between students included in the total and analytic samples on academic background or demographic characteristics, with the only exception being that survey non-responders were more likely to be from cohort 2 (i.e., recruited in 2016; $n=45$ or 17% didn't complete follow-up surveys) than from cohort 1 (i.e., recruited in 2015; $n=8$ or 4% didn't complete follow-up surveys). Therefore, cohort status, as well as the other academic and demographic characteristics were included as auxiliary variables in the substantive analyses to control for any potential missing data bias (Enders, 2008, 2010).

2.2 Procedure

Students were recruited into this study in two cohorts, first in the fall of 2015 and second in the fall of 2016, through face-to-face announcements in introductory STEM courses, campus flyers, and emails obtained through registrars, departments, or faculty. The local Institutional Review Board (IRB) required an expedited review because participants were tracked longitudinally. To participate in the longitudinal study, all students completed an IRB-approved informed consent form (IRB# 14-4829H). This consent form covered the recruitment survey and all follow-up surveys. After completing the consent form, the students completed a brief online recruitment survey, for which they received a $5 gift card. The recruitment survey was used to identify students who met the inclusion criteria of identifying as a woman, majoring in (or intending to major) in a STEM discipline, and expressing interest in earth and environmental sciences to be invited to participate in the study.

Follow-up, twice-annual (fall and spring semesters), longitudinal surveys concerning educational experiences and achievements, psychosocial factors, and career aspirations were emailed to participants and completed online from the spring of 2016 to the spring of 2019. A tailored panel management (TPM) approach (Estrada et al., 2014) was employed to keep response rates high across time, which resulted in consistently high (80% or higher) average response rates per survey. Participants received a $10 electronic gift card for completing each longitudinal follow-up survey.

2.3 Measures

The survey measures reported here were collected from the second through the fourth years of college (i.e., Sophomore through Senior years of college). All survey measures included in the following analyses (i.e., persistence intentions, goal affordances, and goal endorsements) were administered starting in the fall of 2016 and every six months thereafter until the spring of 2019.

2.3.1 Goal endorsement

Individual differences in agentic and communal goal endorsement were measured by asking participants to report "how important each of the following kinds of goals is to you personally," on a scale from 1 (extremely unimportant) to 7 (extremely important; Diekman et al., 2010). Prior studies have asked about anywhere between one and fourteen agentic and between one and ten communal goal endorsements

Table 2 Summary of level-1 correlation and average ω reliability estimates ($N_i = 421$, $N_{ti} = 1743$)

Source	1	2	3	4	5
1. Persistence intentions	*.73*				
2. Agentic affordances	.29***	*.72*			
3. Communal affordances	.29***	.50***	*.81*		
4. Agentic endorsement	.05†	.45***	.15***	*.67*	
5. Communal endorsement	.05*	.16***	.41***	.11***	*.76*

Italics indicate reliability coefficients

Values on the diagonal represent the average McDonald's omega (ω) reliability estimates were ascertained from longitudinal confirmatory factor analyses (Hayes & Coutts, 2020; McDonald, 1999). Values on the off-diagonal are correlation coefficients. N_i = number of persons in the sample. N_{ti} = number of observations over time

†$p = .06$, *$p < .05$, ***$p < .001$

(Brown, Smith, et al., 2015; Brown, Thoman, et al., 2015; Diekman et al., 2010, 2011; Smith et al., 2015). Out of concern for participant fatigue due to completing multiple measures across multiple time points, the present study asked participants to respond to three agentic goals ("achievement," "individualism," and "competition") and three communal goals ("serving community," "working with people," and "helping others") at T1–T3. T4 and T6 included single-item agentic ("How important are goals such as power, achievement, and seeking new experiences or excitement to you personally?") and single-item communal ("How important are goals such as working with people, helping others, and serving the community to you personally?") endorsement measures (Smith et al., 2015), and T5 included two agentic endorsement items (i.e., "achievement" and the single-item agentic measure), as well as two communal endorsement items (i.e., "Helping others" and the single-item communal measure).

The original study validating longer form scale scores found adequate evidence of internal consistency reliability (Agentic endorsement $\alpha = 0.87$, Communal endorsement $\alpha = 0.84$; Diekman et al., 2010). The present study used longitudinal confirmatory factor analyses to estimate more robust McDonald's omega (ω) reliability estimates of scale scores. An advantage of the longitudinal CFA approach was that we were able to estimate reliability at each time point, even when only a single item was measured. The results indicated adequate reliability evidence for agentic and communal goal endorsement scales, Table 2.

2.3.2 Perceived goal affordances in STEM careers

Student perceptions of STEM careers as affording agentic and communal goals were measured by asking participants to report "how much a career in Science, Technology, Engineering, or Mathematics would fulfill the following goals," on a scale from 1 (not at all) to 7 (extremely; Diekman et al., 2010). Like the measures of goal endorsement, out of concern for participant fatigue, the present study asked participants to respond to three agentic goals ("achievement," "individualism," and "competition") and three communal goals ("serving community," "working with people," and "helping others") at T1–T3. T4 and T6 included single-item agentic ("Power, achievement, and seeking new experiences or excitement?") and single-item communal ("Working with people, helping others, and serving the community?") affordances measures (Smith et al., 2015), and T5 included two agentic affordances items (i.e., "achievement" and the single-item agentic measure), as well as two communal affordances items (i.e., "Helping others" and the single-item communal measure).

The original study validating a longer form of the scale found adequate evidence of internal consistency reliability in STEM disciplines (Agentic affordances $\alpha = 0.79$, Communal affordances $\alpha = 0.80$; Diekman et al., 2010). Longitudinal confirmatory factor analysis based McDonald's ω reliability estimates revealed adequate reliability evidence for perceptions of agentic and communal goal affordances scales, Table 2.

2.3.3 Intentions to persist in science

Student intentions to persist in their pursuit of a scientific career (Woodcock et al., 2015) served as the primary outcome for this study. Participants rated the strength of their future intentions to pursue a scientific career by responding to three statements: "To what extent do you plan to pursue a science-related research career?," "What is the likelihood of you obtaining a science-related degree?," and "To what extent do you plan to pursue a science-related graduate degree?" on a scale from "definitely will not" (1) to "definitely will" (7).[1] Prior research on scientific career persistence intention scale scores have shown acceptable internal consistency reliability (Cronbach's $\alpha = 0.74$; Woodcock et al., 2015). Longitudinal confirmatory factor analysis based McDonald's ω reliability estimates revealed adequate reliability evidence for scientific career persistence intention scale scores, Table 2.

2.3.4 Time

Given the longitudinal nature and focus of this study, the passage of time was tracked for each student. The linear time clock was coded as follows for growth curve models: T1 (fall Sophomore) = −1, T2 (spring Sophomore) = 0, T3 (fall Junior) = 1, T4 (spring Junior) = 2, T5 (fall Senior) = 3, T6 (spring Senior) = 4. The goal of this coding scheme was to model an intercept of linear and quadratic growth curve models on the first possible time point that included both cohort 1 and cohort 2 persistence intentions data.

[1] T1 included only the first two persistence intentions questions (i.e., at T1, the graduate school question did not specify "science-related" and is therefore not used for this time point).

Table 3 Summary of the level-1 descriptive statistics for the outcome and predictors ($N_i = 421$, $N_{ti} = 1743$)

Source	*M*	SD	Skew	Kurtosis
1. Persistence intentions	5.45	1.44	− 1.18	1.09
2. Agentic affordances	5.81	1.08	− 1.00	1.17
3. Communal affordances	5.88	1.15	− 1.06	0.90
4. Agentic endorsement	5.44	1.28	− 0.66	0.02
5. Communal endorsement	6.15	1.04	− 1.49	2.46

N_i = number of persons in the sample. N_{ti} = number of observations over time

2.3.5 Control variables

Control variables for this study include participant demographics reported above, as well as gender identity and parental educational achievement reported on the brief recruitment survey, to control for the well-documented association between parental educational achievement and children's educational achievement in college (Svoboda et al., 2016). Participants were asked academic questions, such as college enrollment status (e.g., enrolled, not a student), which university they attended, college rank (e.g., sophomore), and college major on both the brief recruitment survey and longitudinal follow-up surveys. In addition, study involvement factors, such as cohort of recruitment into the study and involvement in the PROGRESS program were administratively tracked by the study team. All control variables were effect-coded and entered as level-2 (between-persons) factors for the substantive analyses.

2.4 Analysis

2.4.1 Confirmatory factor analyses and longitudinal measurement invariance.

Consistent with best practices, confirmatory factor analysis based tests of longitudinal measurement invariance were examined prior to conducting substantive analyses of growth and change over time (Vandenberg & Lance, 2000) using M*plus* version 8.00 (Muthén & Muthén, 1998–2017). More specifically, we tested for scalar level measurement invariance in the outcome due to our interest in mean-level change in persistence intentions over time. Furthermore, we tested for metric level invariance in the predictors due to our interest in their structural relationships between the predictors and persistence intentions over time. Maximum likelihood estimation with robust standard errors were used in CFA models to account for non-normality in the item-level data, while ML estimation was used with scale scores in the multilevel models, which were more consistent with distributional assumptions, Table 3.

The adequacy of model-data fit in these analyses was assessed with a variety of global fit indices, such as the χ^2 test, root-mean-square error of approximation (*RMSEA*), comparative fit index (*CFI*), and standardized root-mean-square residual (*SRMR*) (Hu & Bentler, 1999; Kline, 2016; Little, 2013; Marsh et al., 2004). The observed fit index values compared to values representing good model fit, such as CFI ≥ 0.95, RMSEA ≤ 0.05 (or a 90% CI that included 0.05 but did not include

0.10), or SRMR ≤ 0.08. Furthermore, tests of longitudinal measurement invariance involved comparing a series of progressively more restricted nested models (i.e., configural [same factor structure at all time-points], metric [equal factor loadings at all time-points], and scalar for the dependent variable [equal indicator intercept values at all time-points]). A nested model comparison approach was used to evaluate the effect of model constraints on worsening model fit. When nested models were compared, the cutoff value of ΔCFI values ≥ 0.01 or $\Delta RMSEA$ values ≤ − 0.015 indicated worse model fit (Cheung & Rensvold, 2002; Little, 2013).

2.4.2 Multilevel growth curve models

Substantive analyses concerning longitudinal change in intentions to persist in science, as well as prediction of that change were conducted in a two-level (i.e., time within persons) multilevel growth curve modeling (GCM) framework (Raudenbush & Bryk, 2002) using M*plus* version 8.00 (Muthén & Muthén, 1998–2017). We employed a model building approach, wherein successively more complex models were tested and compared to prior simpler models (Raudenbush & Bryk, 2002). More specifically, a series of GCMs were conducted to (a) identify the best fitting model of change over time, (b) test hypotheses from goal congruity theory, and (c) explore the potential for goal congruity by time moderation effects. Improvements in model-data fit in these analyses were assessed with a variety of information criteria fit indices, Akaike information criterion (AIC), Bayesian Information Criterion (BIC), and the sample size adjusted BIC (SBIC), where lower values indicate better model fit (Raudenbush & Bryk, 2002). When nested models were compared, statistically significant $\Delta\chi^2$ tests, as well as, lower AIC, BIC, and SBIC values indicated improved model fit (Raudenbush & Bryk, 2002).

2.4.3 Preliminary analyses

Longitudinal measurement invariance Longitudinal confirmatory factor analyses were conducted to examine the scalar level measurement invariance of scientific persistence intentions, as well as the metric level measurement invariance of agentic goal affordances in STEM careers, agentic goal endorsement, communal goal affordances in STEM careers, and communal goal endorsement across time. As shown in Table 4, the longitudinal CFA configural model provided excellent fit to the scientific persistence intentions data. Furthermore, scientific persistence intentions metric invariance and partial scalar invariance did not worsen model fit, Table 4. A close examination of local fit statistics (i.e., the scientific persistence intentions indicator intercept standardized residuals) showed that intercept constraints for the items 1 "science-related research career" and 3 "science related graduate degree" needed to be freed for some of the later time points.

Next, we tested for metric level invariance for the predictors (i.e., agentic and communal goal affordances, as well as agentic and communal goal endorsement). As shown in Table 4, the longitudinal CFA configural models provided excellent fit to the data for each of the constructs. Furthermore, tests of metric invariance or partial metric invariance did not worsen model fit for any of the constructs. As above,

Table 4 Summary of model fit and model comparisons for the longitudinal confirmatory factor analyses

Invariance Model tested	χ^2	RMSEA	RMSEA 90% CI	CFI	Model Comparison	Pass?
Persistence intentions						
1.1 Configural	88.81 (64) *	.030	[.012, .045]	.990		n/a
1.2 Metric	119.43 (78) **	.036	[.022, .048]	.983	1.1 versus 1.2	Yes
1.3 Scalar	209.41 (92) ***	.055	[.045, .065]	.952	1.2 versus 1.3	No
1.4 Partial scalar	144.43 (89) ***	.038	[.027, .050]	.977	1.2 versus 1.4	Yes
Agentic affordances						
2.1 Configural	57.33 (40) *	.032	[.008, .050]	.976		n/a
2.2 Metric	80.68 (49) **	.039	[.023, .054]	.955	2.1 versus 2.2	No
2.3 Partial metric	69.80 (47) *	.034	[.015, .050]	.968	2.1 versus 2.3	Yes
Agentic endorsement						
3.1 Configural	61.78 (40) *	.036	[.016, .053]	.979		n/a
3.2 Metric	80.51 (49) **	.039	[.023, .054]	.970	3.1 versus 3.2	Yes
Communal affordances						
4.1 Configural	48.16 (40)	.022	[.000, .042]	.993		n/a
4.2 Metric	67.32 (49) *	.030	[.006, .046]	.985	4.1 versus 4.2	Yes
Communal endorsement						
5.1 Configural	51.79 (40)	.026	[.000, .045]	.992		n/a
5.2 Metric	61.08 (49)	.024	[.000, .042]	.991	5.1 versus 5.2	Yes

When nested models were compared, the cutoff value of ΔCFI values ≥ .01 or $\Delta RMSEA$ values ≤ -.015 indicated worse model fit. Pass? = "Yes" when the nested model change did not exceed the above misfit values and Pass? = "No" when they did exceed misfit values

*$p < .05$, **$p < .01$, ***$p < .001$

partial metric invariance was required for agentic affordances, as an inspection of local fit indices (i.e., standardized residual covariances), indicated that factor loading constraint on item 2 "Achievement" needed to be relaxed for later time points.

Having established evidence for measurement invariance, we next used the final measurement models to estimate McDonald's ω reliability coefficient for each construct at each time point (Hayes & Coutts, 2020; McDonald, 1999; McNeish, 2018).

Missing data, outliers, and statistical assumptions. Next, we examined the patterns of missing data, screened for outliers, and tested the statistical assumptions related to distributions of scale scores. Concerning missing data, the response rates to the survey were very high (~80%) over time. Overall, 14.7% of participants completed all six surveys, 34.9% completed five surveys, 31.1% completed four surveys, 9.7% completed three surveys, 5.2% completed two surveys, and only 4.3% completed one survey. We used Little's MCAR test (Little, 1988) to determine if the pattern of missing data in the scale scores were consistent with the restrictive assumption of missing completely at random. The test revealed that the data were consistent with the MCAR assumption $\chi^2(df = 1374) = 1357.82$, $p = 0.62$. This finding points to little to no threat of missing data bias; however, we still used maximum likelihood (ML) methods to ensure unbiased estimates under the more reasonable missing-at-random (MAR) assumption in this longitudinal research design (Enders, 2010; Jeličić et al., 2009).

Outlier analyses (using leverage values, Studentized deleted residuals, and Cook's distance values) and distributional assumptions (i.e., normality of residuals, homoscedasticity of residuals, linearity) were conducted (Judd, McClelland, & Ryan, 2009). The analyses revealed no extreme outliers and confirmed the tenability of distributional assumptions. Finally, we recognized that students were nested within multiple universities and examined the intra-class coefficient (ICC) due to nesting (i.e., the assumption of independence of errors due to nesting within universities). The ICCs for persistence intentions were extremely small at all time points (i.e., $ICC_{T1} = 0.023$, $ICC_{T2} = 0.018$, $ICC_{T3} = 0.008$, $ICC_{T1} = 0.009$, $ICC_{T1} = 0.007$, $ICC_{T1} = 0.013$), indicating that nesting within universities was largely an ignorable source of variability. However, as noted above, we still include university as a control variable in our statistical models as a "fixed effects" approach to account for between university variability in the outcome (Cohen et al., 2003).

3 Results

3.1 Intentions to persist in science decline and level-off over time

Our first goal was to identify the average growth trajectory and quantify variability in growth trajectories of intentions to persist over time using multilevel modeling-based growth curve analysis. Therefore, we first conducted a series of nested growth curve models to assess linear and curvilinear changes in intentions to persist over time. The series of nested models revealed that the curvilinear model provided the best fit of the data, Table 5 (i.e., the preponderance of fit indices [$\Delta\chi 2$ test, bolded AIC, and bolded SBIC] pointed to Model 4 providing the best fit).

The results of the growth curve model showed that students initially expressed relatively high intentions to persist in scientific careers (i.e., Intercept: $\gamma_{00} = 5.61$, $S.E. = 0.06$, $p < 0.001$); however, their intentions decline relatively rapidly (Instantaneous linear slope: $\gamma_{10} = 0.18$, $S.E. = 0.03$, $p < 0.001$) and eventually level off (Quadratic slope: $\gamma_{20} = 0.02$, $S.E. = 0.06$, $p < 0.001$). Moreover, the growth curve random coefficients indicated that 32.7% of the variability in intentions to persist was within-person over time, 64.5% of the variability was between-persons around the intercept, and 2.8% of the variability was between-persons around the linear growth slope, Table 6.

3.2 Goal congruity tests

Having established growth trajectories, we next tested the effects of time-varying agentic and communal goal affordances, goal endorsements, and goal congruity

Table 5 Summary of model fit and model comparisons for the longitudinal growth curve models

Model tested	Deviance	#*P*	AIC	BIC	SBIC	$\Delta\chi^2$(df)	Model Comparison	Pass?
Unconditional growth models								
1. Intercept only	−2676.455	3	5358.909	5375.299	5365.768			n/a
2. Linear growth (Random)	−2613.879	5	5237.758	**5265.075**	5249.191	125.152 (2)***	1 versus 2	Yes
3. Quadratic growth (Random)	−2611.358	7	5236.717	5274.960	5252.722	5.042 (2)	2 versus 3	No
4. Quadratic growth (Fixed)	−2611.172	6	**5234.344**	5267.124	**5248.063**	5.414 (1)*	2 versus 4	Yes
Conditional growth models								
5. Control variables	−2565.497	51	5232.995	5511.626	5349.604	91.35 (45)***	4 versus 5	Yes
6. Affordances & endorsements	−2514.506	55	5139.011	5439.496	5264.766	101.982 (4)***	5 versus 6	Yes
7. Agentic Affordances × endorsement interaction	−2512.553	56	5137.106	5443.055	5265.148	3.906 (1)*	6 versus 7	Yes
8. Communal Affordances × endorsement interaction	−2512.153	57	5138.307	5449.718	5268.635	0.800 (1)	7 versus 8	No
9. Linear growth × affordances & endorsements	−2506.527	61	5135.053	5468.318	5274.527	11.252 (4)*	8 versus 9	Yes
10. Linear growth × affordances × endorsements interactions	−2506.352	63	5138.703	5482.895	5282.750	0.350 (2)	9 versus 10	No
11. Quadratic growth × affordances & endorsements	−2503.827	67	5141.654	5507.700	5294.847	5.050 (4)	10 versus 11	No
12. Quadratic growth × affordances × endorsements interactions	−2503.427	69	5144.853	5521.825	5302.619	0.800 (2)	11 versus 12	No
13. Final Model	−2507.763	56	**5127.526**	**5433.474**	**5255.568**	n/a	n/a	n/a

Bolded values indicate the lowest information index values for the unconditional and the conditional growth curve models

$^*p<.05$, $^{**}p<.01$, $^{***}p<.001$

Table 6 Summary of random effects from key unconditional growth and conditional growth curve models (Models 4, 5, & 13)

Source	Variance	S.E	p	Pseudo-R^2	Pseudo-ΔR^2
Final unconditional growth model (Model 4)					
Residual (e_{ti})	0.609	.027	< .001		
Intercept (u_{0i})	1.199	.100	< .001		
Linear growth slope (u_{1i})	0.052	.009	< .001		
Conditional growth model (Controls—Model 5)					
Residual (e_{ti})	0.593	.026	< .001	.026	.026
Intercept (u_{0i})	1.069	.080	< .001	.108	.108
Linear growth slope (u_{1i})	0.047	.008	< .001	.096	.096
Final conditional growth model (Model 13)					
Residual (e_{ti})	0.583	.026	< .001	.043	.017
Intercept (u_{0i})	0.964	.082	< .001	.196	.088
Linear growth slope (u_{1i})	0.031	.007	< .001	.404	.308

The proportion of variance to be explained within-persons, around the intercept, and around the slope was determined by multiplying the ratio of each unconditional variance of component to the sum of variance components by 100 (e.g., % variance of persistence intentions within-persons: [0.609/(0.609 + 1.199 + 0.052) × 100 = 32.7%])

Table 7 Summary of Fixed Effects from Key Conditional Growth Curve Models (Model 7 & Model 13)

Source	Model 7			Model 13		
	b	S.E	p	b	S.E	p
Intercept (γ_{00})	5.637	0.078	< .001	5.642	0.078	< .001
Linear growth slope (γ_{10})	−0.184	0.051	< .001	−0.186	0.051	< .001
Quadratic growth slope (γ_{20})	0.028	0.013	.039	0.027	0.013	.047
Communal Affordances (γ_{30})	0.189	0.030	< .001	0.118	0.027	< .001
Communal Endorsement (γ_{40})	−0.021	0.025	.395	–	–	–
Agentic Affordances (γ_{50})	0.127	0.027	< .001	0.120	0.038	.002
Agentic Endorsement (γ_{60})	0.016	0.030	.590	−0.016	0.025	.513
Agentic Affordances x Endorsement Interaction (γ_{70})	0.032	0.016	.048	0.034	0.016	.035
Linear growth x Agentic Affordances Interaction (γ_{80})	–	–	–	0.046	0.015	.002

All predictors were grand mean-centered for the analysis. Values for γ_{80} are not shown in Model 7 because this predictor came in a later model. Values for γ_{40} are not shown in Model 13 because this non-significant predictor was constrained to zero in the model. b = unstandardized regression coefficients

interactions on the growth trajectories, over and above control variables. We first controlled for academic and demographic characteristics by regressing the intentions to persist intercept, linear, and quadratic growth slopes on the level-2 effect-coded time-invariant control variables (Model 5). Entering the control variables improved model fit (Table 5) and explained a small proportion of variability within-person, as well as a moderate proportion of variance in the intercept and linear growth slopes (Table 6).

Next, we directly tested the goal congruity hypotheses by conducting a series of increasingly complex models. That is, intentions to persist were regressed on the grand-mean centered time-varying agentic and communal goal affordances and endorsement predictors, which improved model fit (Table 5, Model 6). Next, intentions to persist were regressed on an agentic affordances × endorsement multiplicative term, which improved model fit (Table 5, Model 7). However, regressing intentions to persist on a communal affordances × endorsement multiplicative term did not improve model fit (Table 5, Model 8). As shown in Table 7—Model 7, communal goal affordances (γ_{30}), agentic goal affordances (γ_{50}), and the agentic affordances × endorsement interaction term (γ_{70}) were all significant positive predictors of intentions to persist over time.

3.3 Exploratory goal congruity by time moderation tests

As a final step, we conducted a series of exploratory analyses to test the degree to which linear and quadratic change over time were moderated by goal congruity. First, we examined if the linear growth slope was moderated by agentic goal affordances, communal goal affordances, agentic endorsement, or communal endorsement, which improved model fit (Table 5, Model 9). More specifically, the regression coefficients showed that the linear growth slope was moderated by agentic goal affordances.

Second, we examined if the linear growth slope was moderated by the affordances × endorsement interactions (e.g., three-way interaction of linear growth × agentic affordances × agentic endorsement); which did not improve model fit (Table 5, Model 10). Third, we examined if the quadratic growth slope was moderated by agentic goal affordances, communal goal affordances, agentic endorsement, or communal endorsement, which did not improve model fit (Table 5, Model 11). Fourth, we examined if the quadratic growth slope was moderated by the affordances × endorsement interactions (e.g., three-way interaction of quadratic growth × agentic affordances × agentic endorsement); which did not improve model fit (Table 5, Model 12).

3.4 Final growth curve model

As a final step, we estimated a parsimonious model that only included the set of predictors that had been shown to improve model fit over the prior series of models (Model 13). The final model provided the best fit to the data (Table 5, see bolded AIC, BIC, and SBIC indices) and explained a small proportion of variability within-persons, a moderate proportion of variance in the intercept, and a large proportion of variance in the linear growth slopes (Table 6, see *Pseudo-*ΔR^2).

An inspection of regression coefficients indicated positive effects of communal (γ_{30}) and agentic (γ_{40}) goal affordances on intentions to persist in science (Table 7,

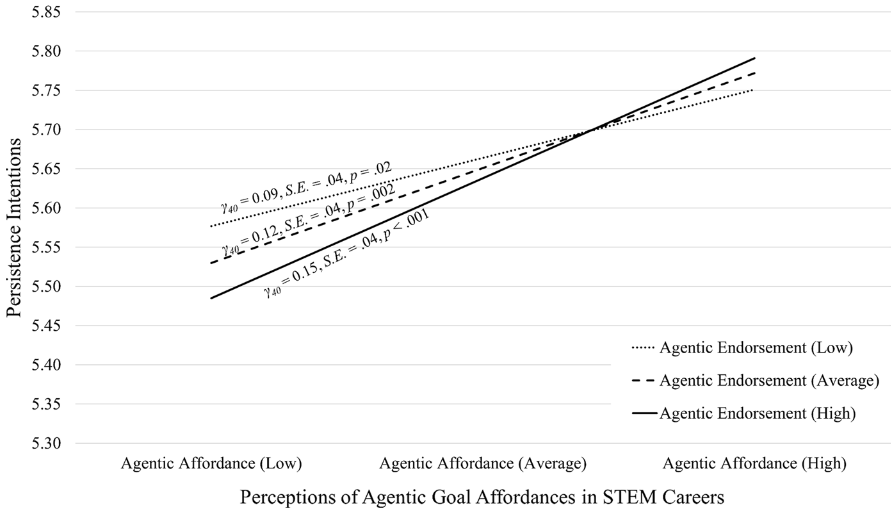

Fig. 1 The Effect of Perceptions of Agentic Affordances in STEM Careers on Intentions to Persistence in Science Moderated by Agentic Endorsement

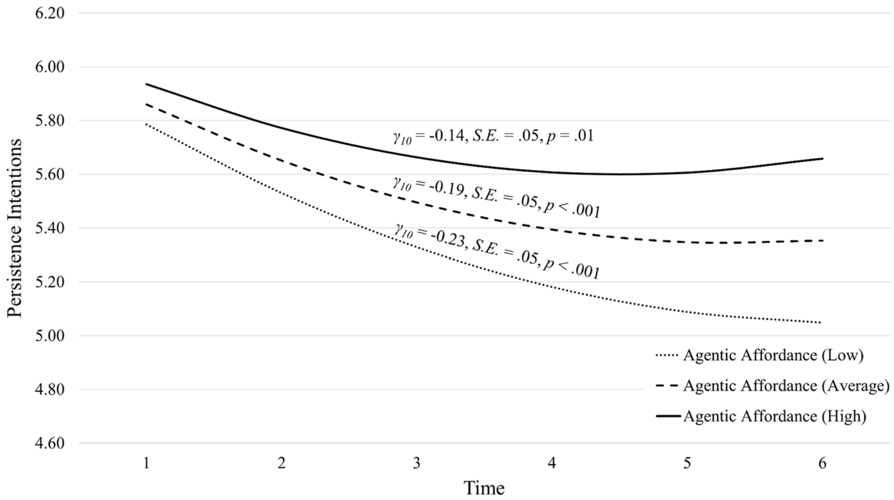

Fig. 2 Change Over Time in Intentions to Persist in Science Moderated by Perceptions of Agentic Affordances in STEM careers

Model 13). Furthermore, the regression coefficients indicated that the effect of agentic goal affordances was moderated by agentic goal endorsement (γ_{70}). As shown in the simple slopes graph (Fig. 1), the positive effect of agentic goal affordances on intentions to persist was stronger for women with higher endorsement of agentic goals and weaker for women with lower endorsement of agentic goals.

In addition, the regression coefficients indicated that the decline in intentions to persist over time (i.e., the linear growth slope) was moderated by agentic affordances (γ_{80}; Table 7, Model 13). As shown in the simple slopes graph (Fig. 2), declines in intentions to persist over time were less steep for women with higher perceptions of agentic affordances, but more steep for women with lower perceptions of agentic affordances.

4 Discussion

The results of the current study expand our understanding of American college women's persistence in science over the span of their undergraduate career and specifically elucidates how goal affordances impact STEM-identified women's intentions to persist in STEM. Study participants express relatively high initial intentions to persist in scientific careers, which is unsurprising given the entry criteria that participants should have plans to be a STEM major with an interest in earth and environmental science. In support of Hypothesis 1 and consistent with past research focused on populations of underrepresented groups in STEM (e.g., Schultz et al., 2011), the intent to persist for undergraduate women declines rapidly at first and leveled off over time. We also find that higher perceptions that STEM affords communal goals increased undergraduate women's intentions to persist in science, supporting Hypothesis 2a and an abundance of findings from the GCT literature (e.g., see Diekman et al., 2017 for a review). However, we do not find support for the predicted moderation of communal goal endorsement (Hypothesis 2b). This is relatively surprising, because perceived communal affordances in STEM should only impact interest among women who endorse personal communal goals, and we discuss this lack of interaction in more detail below. Finally, we find support for both Hypotheses 3a and 3b, which indicate that, at least among women who identify an early college interest in STEM, perceptions that STEM affords agentic goals increases women's intentions to persist in science, and that this is particularly true for women who endorse personal agentic goals. Finally, we find that perceived agentic, but not communal, goal affordances in STEM are an important factor in reducing the amount of "drop-off" in undergraduate women's intentions to persist in science—such that women who perceive STEM as affording more agentic goals are less likely to lose interest in science over the course of their college career.

4.1 Seeking congruity: interactions for women in STEM

Although CGT explicitly states that interest in careers should be the product of an interaction between one's personal goal endorsements and the perception that the career can afford those goals, no previous research has reported findings of an interaction between the two. Instead, studies demonstrate that women endorse more communal goals than men, women and men perceive STEM as affording fewer communal than agentic goals, and that higher communal goal endorsement predicts less interest in STEM (see Diekman et al., 2015 for a review). However, there has not been a direct test, to our knowledge, of the interaction between goal endorsement and perceived goal affordances of STEM. It is possible that previous studies have not found statistical support for an interaction, which may lead to a lack of reported findings, or that the interaction has not been previously tested.

The lack of an interaction between communal goal endorsement and affordances is important. For one, the lack of an interaction in our study could suggest important differences between personal goals and perceived affordances in STEM by college women compared to younger women (high school age and earlier). Women have been exposed to and often endorse strong gender stereotypes related to career pathways (e.g., Diekman et al., 2010; Nosek et al., 2002). Thus, by the time they enter college, women who seek agentic goals may have already identified interest in a STEM major because of the perceived agentic affordances (and likewise, women who seek communal goals may have already discounted an interest in STEM). Because our study looked at undergraduate women who planned to or were majoring in STEM, it is possible that while communal goal affordances could increase their interest, this interest does not necessarily depend on a strong personal endorsement of communal goals.

Second, if the lack of an interaction between personal communal goals and affordances extends to women who do not identify an interest in STEM at the college level, it could suggest a demand characteristic of women's responses to questions about their communal goals. Goal Congruity Theory originates from Social Role Theory (Eagly, 1987; Eagly & Wood, 1991), which proposes that people infer stereotypes about gendered interests and characteristics based on the observed social roles that women and men occupy. Correspondingly, women are more likely than men to endorse communal interests and skills and men are more likely than women to endorse agentic interests and skills (Spence & Buckner, 2000). Thus, social role demands and characteristics could influence the degree to which women feel they have to report endorsing communal goals, or even the degree to which they overemphasize their own interests. This is not to suggest that communal goals are not important to many people—indeed, as mentioned earlier, both women and men gain positive perceptions of fields and careers when they are framed as helping others and contributing to the greater good (Brown, Smith, et al., 2015; Brown, Thoman, et al., 2015; Fuesting et al., 2017; Steinberg & Diekman, 2017). Instead, it may be that while women are more likely than men to say they endorse communal goals, both groups may actually care highly about communal goals, and thus the perception that certain careers afford communal goals does not depend on one's level of expressed endorsement of communal goals. Therefore, the framing of STEM fields and careers as affording communal goals may better serve to increase gender equality among women who did not previously consider STEM to be in congruence with their goals.

On the other hand, the novel finding of an interaction between personal agentic goals and perceived affordances among undergraduate women who identify interest in STEM suggests that, at least during the college years, it may be important to maintain the perception that STEM also affords agentic goals. One possibility is that women who start off with an interest in STEM majors at the beginning of their college careers may have different goals than women who express an interest in other majors. Children are able to identify gender-stereotypic careers as early as age 3 (Mulvey & Irvin, 2018), and associate male-dominated careers, including most STEM careers, as affording agentic goals by the age of 5 (Weisgram et al., 2010). Therefore, women who choose STEM majors at the beginning of college may have already identified an interest in agentic goals compared to women in other majors. The research on GCT has primarily been conducted with college students from a variety of majors, with a possible emphasis on social science majors,[2] but we know very little about goal congruity among self-identified STEM majors, especially when it comes to agentic goals (Boucher et al., 2017). Given the strong backlash that both women and men receive for expressing counter-stereotypic interests and skills (Rudman & Glick, 2001), we also recommend that women's agentic goals should be supported and validated.

Additionally, we did not find that perceptions of communal goal affordances hindered these undergraduate women's intent to persist in science, indicating that the framing of STEM as communal-focused does not reduce interest among college women who endorse agentic goals, and is still a valid form of intervention for increasing the representation of women in STEM. Our findings continue to validate CGT, although in an unconventional way. Specifically, while gender differences in communal goal endorsement may drive the major discrepancy between women's and men's representation in STEM, there remains an important interaction in the congruity between women's agentic goals and affordances, at least during their college years.

The implication for universities, faculty, and other stakeholders is that college students should have the opportunity to see how their personally held goals and values are reflected in their field of choice. For undergraduate women pursuing STEM, providing contexts to witness STEM careers affording communal *and* agentic pursuits may lessen attrition from STEM careers.

4.2 Limitations

The present study is limited by a sample of mostly majority-status college women (i.e., White, middle-class, cisgender women). This limits the ability to look at confounding variables such as the additional layers of stereotypes, prejudice, and discrimination that impact the experiences and intentions of specific groups such as undergraduate women of color, LBTQ women, first-generation women, and so forth. For example, LBTQ women might have different career interest expectations placed on them due to stereotypes about their gendered identity or expression. Although we

[2] Most research does not report the major of participants. However, because the majority of studies conducted on GCT are by social scientists and based on the common practice of recruiting college participants from psychology subject-pools, we assume that social science majors are potentially over-represented in these samples.

are unable to examine the differential experiences of these underrepresented women, other research has documented that members of these minority groups are even more likely than their majority counterparts to leave STEM, such as through additional or different forms of discrimination, and even less ability to find identity-similar role models and mentors (Cech & Pham, 2017; Hernandez et al., 2013; McGee & Bentley, 2017; Shaw & Barbuti, 2010). Similarly, this study focused exclusively on the experiences, perceptions, and processes of college women in STEM, which limits our inferences about the longitudinal processes among college women not in STEM or differences in the processes between college men and women. Future longitudinal research may investigate the degree to which the trends and patterns modeled in this work hold over other populations. In addition, this study did not evaluate other barriers that have been shown to significantly impact college women's integration into science, such as discouragement from advisors, a chilly environment with limited role models, a lack of sense of belonging, feelings of isolation, and an environment that is in opposition to balancing work/family life (Bernstein & Russo, 2007; Cabay et al., 2018; Clancy et al., 2017; Fabert & Bernstein, 2009; Herrmann et al., 2016; Lippa, 1998). Therefore, future research may benefit from understanding how women's agentic goal congruity intersects with these other common collegiate experiences. Finally, we have limited our focus to women during their undergraduate college career. While the benefits of this include being able to reliably track women's persistence in science through their senior and graduation years, we are not able to document the effects of communal and agentic goal congruity onto graduate school or career status. Research has shown that women leave STEM careers at a rate 30% higher than other careers and are 165% more likely to leave STEM after earning an advanced degree than earning degrees in other fields (Glass et al., 2013). Thus, it also remains critical to understand whether the transition from college to graduate school and STEM careers is impacted by the perceived congruity between women's goals and the affordances of STEM.

5 Conclusion

We show that perceptions of STEM affording both communal and agentic goals have positive effects on intentions to persist in science for undergraduate women who initially identify interest in a STEM major. These findings echo results from earlier research showing that women in male dominated STEM fields are interested in both "People Jobs" and "Thing Jobs" (Yang & Barth, 2015). Furthermore, we provide insight into GCT and its longitudinal effect on undergraduate women's intentions to persist in science throughout the duration of their undergraduate career. Declines in intentions to persist over time are less steep for college women with higher perceptions that science affords agentic goals than for college women with lower perceptions that science affords agentic goals, implying that more research needs to focus on the longitudinal effects of GCT on undergraduate women's intentions to persist in STEM. These findings suggest that focusing on ways to increase college women's perceptions that science provides a path for women to attain their agentic goals could help to maintain the number of women with initial intentions to persist in science.

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Data availability All data files are available from the Colorado State University Data Repository (https://hdl.handle.net/10217/211545).

Code availability Not applicable.

Declarations

Conflict of interest No authors have a conflict of interest to declare.

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