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Gender Roles and Stereotypes about Science Careers Help Explain Women and Men's Science Pursuits

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Abstract Diverse perspectives in science promote innovation and creativity, and represent the needs of a diverse populace. However, many science fields lack gender diversity. Although fewer women than men pursue careers in physical science, technology, engineering, and mathematics (pSTEM), more women than men pursue careers in behavioral science. The current work measured the relationship between first-year college students' stereotypes about science professions and course completion in science fields over the next 3 years. pSTEM careers were more associated with self-direction and self-promotion (i.e., agency) than with working with and for the betterment of others (i.e., communion). On the flip side, behavioral science careers were associated with communion to a greater degree than with agency. Women completed a lower proportion of pSTEM courses than did men, but this gender disparity disappeared when women perceived high opportunity for communion in pSTEM. Men pursued behavioral science courses to a lesser degree than did women; this disparity did not exist when men perceived ample opportunity for agency in behavioral science. These results suggest highlighting the communal nature of pSTEM and the agentic nature of behavioral science in pre-college settings may promote greater gender diversity across science fields.

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Science fields in the United States are largely gendered. Although a much larger proportion of men than women pursue physical science, technology, engineering, and mathematics (pSTEM) careers, women outnumber men in behavioral science (e.g., psychology, sociology). For example, in 2012, 24 % of Bachelor's degrees and 25 % of Ph.D. s in pSTEM were awarded to women, compared to 63 % of Bachelor's degrees and 59 % of Ph.D.s awarded to women in behavioral science (National Science Foundation 2015a, b). This trend is also present in the workforce: a 2013 sample of employed scientists indicated 22 % of pSTEM scientists were women compared to 62 % in behavioral science (National Science Foundation 2015d). In biological science, however, women and men appear to be roughly at parity: 59 % of graduates with a B.S., 53 % of individuals with a Ph.D. in biological science fields, and 48 % of professionals in biological science are women (National Science Foundation 2015a, b, d).

Gender disparities across science fields are suboptimal for a number of reasons. First, diversity in the workplace is known to foster innovation; a diversity of experiences and perspective-taking yields greater opportunity for creativity (Hoever et al. 2012; Leung et al. 2008; Woolley et al. 2010). Second, a homogenous set of prerogatives at the decision table leaves non-represented voices unheard so that the needs of many are ignored. For example, early voice activated systems developed by computer scientists only worked for men because women's voices were literally unheard during the development (Camp 2012; Margolis and Fisher 2002). Finally, science professions systematically differ in their level of cultural status and financial reward. Whereas pSTEM offers some of the top paying jobs in U.S. culture, behavioral science positions typically pay significantly less, with biological science positions falling somewhere in the middle (Forbes 2016; U.S. News and World Report 2016). Unequal distributions of women and men across strata of the science career hierarchy, where women are most often found in the lowest tier, may perpetuate social inequality among women and men (Cejka and Eagly 1999; Sheffield 2004). In sum, greater gender diversity in the sciences may foster a host of benefits to society.

Over the past decade, social scientists have taken great interest in understanding women's underrepresentation in the sciences (Ceci and Williams 2011; Ceci et al. 2009; Dasgupta and Stout 2014), acknowledging that women's underrepresentation is specific to pSTEM (Cheryan et al. 2016). A great deal of research has focused on the role of cultural gender stereotypes about "who fits" in pSTEM to partially explain women's low pursuit of pSTEM. Computer scientists, engineers, and physical scientists are conventionally believed to be men (Cheryan et al. 2013; Finson 2002; Hoh 2009), a stereotype that is reinforced by the fact that most college professors and researchers in these fields are men (National Science Foundation 2015c, e), as are portrayals of these professionals in the media (Smith et al. 2014). Importantly, research indicates women tend to dis-identify with, avoid, or drop out of pSTEM fields they believe are predominately composed of men (Cheryan et al. 2009; Murphy et al. 2007; Stout et al. 2011).

Related to stereotypes about the type of people who pursue pSTEM are stereotypes about what one can achieve by way of a pSTEM career. There is the widespread belief that pSTEM careers involve working with inorganic materials in isolation and with being paid well to do so; by contrast, people tend to believe pSTEM careers afford little opportunity to work with, and to the benefit of others (Diekman et al. 2010, 2011; Morgan et al. 2001). The former set of pSTEM traits align with theoretical definitions of *agency*, or a focus on autonomy and self-promotion; the latter set aligns with agency's counterpart, *communion*, or maintaining relationships and working to the service of others (Abele and Wojciszke 2007; Judd et al. 2005). In contrast to perceptions about pSTEM, and of relevance to the current work, professions more closely aligned to behavioral science (e.g., registered nurse; social worker) tend to be perceived as affording ample opportunity for communion, as well as low opportunity for agency (Diekman et al. 2010, 2011; Morgan et al. 2001).

Theory and research suggest cultural beliefs about the types of things people can achieve in different science careers (i.e., communion versus agency) may determine who decides to pursue those careers, which may in turn explain differential gender representation in science fields. To start, social role theory posits stereotypes about social groups (e.g., women and men) are rooted in traits affiliated with the positions those groups hold in society (Eagly 1987; Eagly and Steffen 1984). Thus, because men have traditionally occupied positions of power and leadership, and women have traditionally served as caregivers, gender roles have formed that equate men with agency and women with communion. Next, role congruity theory indicates people are rewarded and feel more positive when they assume social roles consistent with cultural expectations (Diekman and Eagly 2008; Eagly and Karau 2002). Thus, role congruity theory may help to explain why men are more attracted to pSTEM than are women, given pSTEM's agentic association, and women generally gravitate more towards behavioral science than do men because of behavioral science's communal affiliation. In sum, role congruity theory suggests whereas women's engagement in science should be shaped by the degree to which women feel they can be communal, men's engagement in science should be shaped by the degree to which men feel they can be agentic.

Indeed, prior research indicates women tend to show more interest in careers affiliated with communion than do men, and men tend to show more interest in careers affiliated with agency than do women (Lippa 1998; Morgan et al. 2001). Importantly, women's interests in communion, coupled with perceptions about the degree to which different types of science careers afford communion, has explained women's relatively low interest in and negative attitudes towards science (see Diekman et al. 2010). As a case in point, Diekman et al. (2011) found the more women believed they would be able to meet communal goals in an entry-level science career, the more attracted women were to that science career. Thus, existing empirical evidence suggests women's low interest in some science fields may be partially explained by cultural stereotypes about those science fields' dissociation with communal work.

However, to our knowledge, no research has assessed whether men's agentic perceptions about behavioral science are related to their engagement in behavioral science (see Croft et al. 2015 for a discussion on the dearth of research on this topic). Also absent from this body of research is an assessment of the link between stereotypic beliefs about science fields, and actual behavioral pursuit of science fields. That is, although existing research examines the links between stereotypes about science with attitudes and interests in science fields, no known research links stereotypes with behavior. Finally, although researchers have used role congruity theory to explain gender disparities in pSTEM, this theory has not yet been used to explain women's and men's pursuit of other non-pSTEM fields, namely biological and behavioral science. The current work seeks to fill these gaps in the literature by (a) assessing perceptions of three science fields (pSTEM, biological science, behavioral science) among incoming, first-year students who have not yet declared a major at the beginning of their college career, (b) observing the degree to which those students engage in courses in those three science fields during their college career, and (c) measuring the link between initial perceptions and subsequent engagement in science fields for women versus men.

We surveyed undergraduate students who had not yet declared an academic major during the first semester of their first year in college on perceived communal and agentic affordances for three science subfields: pSTEM, biological science, and behavioral science. We focused on these three categories due to their well-documented, distinct patterns in gender representation (see earlier statistics). Three years later, we obtained students' academic transcripts in order to assess the relationship (if any) between students' perceived goal affordances for science fields and course-taking behavior.

Consistent with existing research, we expected students would affiliate pSTEM with stronger agentic goals than with communal goals, as well as affiliate behavioral science with stronger communal goals than with agentic goals (Diekman et al. 2010, 2011; Morgan et al. 2001). Although no known prior research has gauged communal versus agentic perceived affordances for biological science, we expected little if any difference in perceptions about communal and agentic affordances in biological science. This hypothesis derives from prior research indicating students strongly affiliate careers in biological science with both communality (i.e., working with and helping others) and agency (i.e., provides opportunity for high pay and status; Morgan et al. 2001).

We also expected to replicate national trends in the gender distribution of science field pursuits. Specifically, we expected women would engage in pSTEM courses to a lesser degree than would men, behavioral science to a greater degree than would men, and biological science to a degree equal to men. These expected gender distributions are consistent with role congruity theory, indicating women and men, as groups, will pursue science disciplines that are aligned with cultural expectations about fields that are most appropriate for women and men (Diekman and Eagly 2008; Eagly and Karau 2002).

So far, our predictions about the overall gender distribution of science course taking behavior primarily reflect the relationship between cultural beliefs about women's and men's social roles and cultural stereotypes associated with different science fields. However, we also utilized role congruity theory to explain individual instances where women and men might pursue science fields culturally believed to be incongruent with gender roles (e.g., women who engage in pSTEM). Here, we expected individuals' interest in culturally stereotype-incongruent fields to increase if personal beliefs suggest those fields are in fact more gender-role congruent. For instance, a woman's personal beliefs about the communal potential of pSTEM could align with her gender roles, if she perceives high communal potential in pSTEM. Thus, we expected individual women who viewed pSTEM as affording ample opportunity for communion would engage in pSTEM courses more than would women who perceived low opportunity for communion in pSTEM. Similarly, we expected individual men's pursuit of behavioral science to depend on the degree to which they perceived behavioral science to afford agency: the more a man viewed behavioral science to be agentic, the more behavioral science courses he should complete.

An important feature of our research design is that we assessed the impact of communal and agentic affordances, above and beyond prior quantitative ability (operationalized as ACT/SAT quantitative scores). Existing quantitative ability is a robust predictor of future achievement and self-efficacy in pSTEM in particular (Hazari et al. 2007; Kost-Smith et al. 2009; Stangor et al. 1998). Simultaneously evaluating the effects of women and men's affordances on science course taking behavior above and beyond prior ability provides a strong test of the unique effects of those perceptions on science engagement.

Method

Participants

Seventy-one undergraduate women and 65 undergraduate men participated in our study in exchange for $20 credited to their student account. All participants were first-year, undeclared majors. Their median age was 18, ranging from 18–20. Students' racial and ethnic identification included 2 Asian, 1 Black, 11 Latina/o; 1 Native American; 112 White; 6 Mixed; 1 Other; and 1 Unknown.

To be included in analyses, students needed to have completed the original survey (described below) and consented to the researchers obtaining their academic transcripts for the remainder of their college career. Of the 339 students who completed the survey, 145 (43 %) consented to the researchers obtaining their academic transcripts. Of those 145 students, five had incomplete survey data, and four left college immediately after their first semester, leaving 136 for analysis. Of note, the demographics and beliefs profiles of students included in data analysis ($N = 136$) did not differ from that of students not included in data analysis (the remaining 203 who completed the survey); the gender distribution, age, and perceived communal and agentic affordances for all three science fields did not differ between groups ($ps > .12$).

Procedure

Students completed a survey approximately one month into the first academic semester of their first year in college (i.e., fall semester). Within the survey, students were asked to consider a list of science majors offered at their institution and rate their perceived goal affordances for a career relating to each major. After completing the survey, students were thanked and their student accounts were credited. Three years later, we obtained student's academic transcripts from the Registrar's office and manually coded the courses students had taken using the following three categories: (a) pSTEM (Aerospace Engineering, Applied Math, Architectural Engineering, Astrophysical & Planetary Sciences, Atmospheric & Oceanic Sciences, Chemical Engineering, Chemistry, Civil Engineering, Computer Science, Electrical & Computer Engineering, Environmental Engineering, Environmental Studies, General Engineering, Geological Sciences, Mathematics, Mechanical Engineering, and Physics), (b) biological science (Bio: Ecology & Evolutionary Biology, Integrative Physiology, Molecular Cellular and Developmental Biology, and Neuroscience), and (c) behavioral science (Beh: Anthropology, Communication, Economics, Geography, International Affairs, Political Science, Psychology, and Sociology).

Given clear, distinct patterns of gender representation across pSTEM, Bio, and Beh that occur nationally (see earlier statistics reported in the first paragraph of this paper), we examined affordances for the three subfields of science separately. Courses within each category were coded by three independent coders ($\kappa = .83$; Fleiss 1971); disagreements about category coding were resolved by discussion until consensus was reached (e.g., reading descriptions of majors and required courses for those majors on the university website; consulting with the Classification of Institutional Programs [CIP] developed by the U.S. Department of Education's National Center for Education Statistics; Institute of Education Statistics, n.d.). A raw count of the number of courses completed across science fields indicated 814 pSTEM, 336 Bio, and 776 Beh courses were completed by students in our sample.

Materials

Goal Affordances

Students were presented with the following instructions: "Think about the type of career you would pursue for each major that you see, then rate how likely it would be for you to meet the following goals," using a 5-point scale from 1 (*very unlikely*) to 5 (*very likely*) (Diekman et al. 2011). Communal goal affordances included "helping others," "serving humanity," "connecting with others," and "working with people." Agentic goal affordances included "independence," "power," "recognition," "self-direction," and "self-promotion." Students provided ratings of goal affordance for two pSTEM majors (computer science; physics), two Bio majors (integrative physiology; molecular, cellular, and developmental biology), and two Beh majors (psychology; sociology). Only two majors per science field were selected in order to allay survey fatigue. Scores within each goal affordance were averaged for each science subfield, such that higher scores indicated higher levels of perceived communion and agency. Reliability for aggregate communal affordance measures ($\alpha_{pSTEM} = .89$, $\alpha_{Bio} = .86$, $\alpha_{Beh} = .87$) and agentic affordance measures ($\alpha_{pSTEM} = .88$, $\alpha_{Bio} = .86$, $\alpha_{Beh} = .91$) was high.

Science Engagement

To measure the degree to which students engaged in the three science fields during the three years following our survey, we calculated the proportion of credits taken in a given science category during those three years (e.g., pSTEM) relative to the total number of credits taken over those three years. The total number of credits taken included science courses and non-science courses (e.g., humanities; business). We included summer course credits in our calculations. We opted to calculate a proportion of science credits completed rather than a simple numeric count of courses completed because credits take into consideration course rigor and personal investment (i.e., taking a 4-credit course in pSTEM suggests greater dedication to the subject than taking a 1-credit course).

Incoming Ability

A measure of incoming quantitative ability at the beginning of college was calculated first by standardizing students' quantitative ACT and SAT scores (obtained from the Registrar), then using whichever of the two scores was available. In cases where scores for both tests were available, we created an average of the two scores.

Results

Goal Affordances

We first assessed whether students' perceived communal versus agentic affordances differed across the three science fields: pSTEM, Bio, and Beh. Consistent with prior analytic designs for this line of research (Diekman et al. 2010, 2011), we also looked at whether women's and men's perceived communal versus agentic affordances differed across fields. A 2 (Gender) x 3 (Field) x 2 (Goal Affordance) Repeated Measured Analysis of Variance (ANOVA), where gender was a between-subjects variable and the field and goal affordance variables were repeated measures, yielded no effect of gender, $F(1, 134) = .03$, $p = .87$, $\eta_p^2 = .00$. We did find a main effect of field, $F(2, 268) = 93.72$, $p < .001$, $\eta_p^2 = .41$, such that students' perceived affordances varied in a linear pattern, $F(1, 134) = 143.80$, $p < 001$, $\eta_p^2 = .52$: pSTEM had the lowest affordances ($M = 3.34$, $SD = .70$), Bio had higher affordances ($M = 3.72$, $SD = .70$), and Beh had the highest affordances

(M = 4.03, SD = .58). A Gender x Field interaction, F(2, 268) = 10.66, p < .001, η_p^2 = .07, indicated this linear trend was stronger among women, F(1, 70) = 161.87, p < .001, η_p^2 = .70 (pSTEM: M = 3.24, SD = .67; Bio: M = 3.71, SD = .67; Beh: M = 4.17, SD = .42), compared to men, F(1, 64) = 25.76, p < .001, η_p^2 = .29, (pSTEM: M = 3.43, SD = .70; Bio: M = 3.74, SD = .58; Beh: M = 3.90, SD = .58).

We also found an effect of goal affordances, such that students perceived higher communal affordances (M = 3.88, SD = .58) than agentic affordances (M = 3.52, SD = .58) across all fields, F(1134) = 89.37, p < .001, η_p^2 = .40. A Gender x Goal Affordance interaction, F(1, 134) = 5.20, p = .02, η_p^2 = .04, indicated, across all fields, women perceived a difference between communal affordances (M = 3.84, SD = .59) and agentic affordances (M = 3.57, SD = .59), F(1,70) = 25.90, p < .001, η_p^2 = .27, but this difference was larger for men, F(1,64) = 68.90, p < .001, η_p^2 = .52 (communal: M = 3.91, SD = .64; agentic: M = 3.47, SD = .56). Of particular interest was a significant Field x Goal Affordance interaction, F(2268) = 118.56, p < .001, η_p^2 = .47. Descriptive statistics are displayed in Table 1. As predicted, students perceived pSTEM to afford less opportunity to meet communal than agentic goals, F(1135) = 17.67 p < .001, η_p^2 = .12, but perceived more opportunity to meet communal than agentic goals in Bio, F(1135) = 96.76, p < .001, η_p^2 = .42, and in Beh, F(1135) = 232.83, p < .001, η_p^2 = .63. The three-way interaction was not significant, F(2, 268) = .13, p = .88, η_p^2 = .00.

Science Engagement

Next, we assessed whether women and men completed courses in the three science fields at different rates during the semesters following our survey. Here, the dependent measure was the proportion of credits completed for each science field from the total credits students completed. A 2 (Gender) x 3 (Field) Repeated Measures ANOVA yielded a main effect of gender, F(1134) = 14.88, p < .001, η_p^2 = .10 (women: M = .17, SD = .07; men: M = .21, SD = .06), such that men completed more science courses than did women. A main effect of Field, F(2268) = 32.62, p < .001, η_p^2 = .20, indicated students completed science courses in the following linear pattern, F(1, 134) = 1072.11, p < 001, η_p^2 = .89: the proportion of Bio courses completed was lowest (M = .08, SD = .12), higher for Beh courses (M = .20, SD = .23), and highest for pSTEM courses (M = .28, SD = .23).

These main effects were overshadowed by a significant Gender x Field interaction, F(2, 268) = 23.13, p < .001, η_p^2 = .15 (see Table 2 for descriptive statistics). As expected, women completed fewer pSTEM courses than did men, F(1134) = 39.45, p < .001, η_p^2 = .23, but women completed more Bio courses than did men, F(1134) = 4.02, p = .05, η_p^2 = .03, and more Beh courses than did men, F(1134) = 4.54, p = .04, η_p^2 = .03.

The Relationship between Science Engagement, Affordances, and Gender

In order to assess our prediction that individual variability in women's and men's perceived goal affordances would predict their own course taking, we computed a measure of course taking within each discipline, which was the proportion of pSTEM, Bio, and Beh courses students took during their college career to date. We ran three separate linear multiple regression analyses, one for each science field, where gender (women = −1, men = +1), communal and agentic goal affordances for that science field (continuous; mean centered), all two-way interaction terms, and the three-way interaction term were predictor variables. We also included a measure of existing ability (standardized ACT/SAT score) as a covariate in each regression analysis. Doing so allowed us to assess the effects of gender and perceived goal affordances on course taking behavior, while controlling for students' incoming quantitative aptitude. Table 3 displays our regression models and output using the coding described here for each science field. Of primary interest was the Gender x Affordance interaction term for each regression analysis, the results for which we present for each of the three dependent measures in turn.

pSTEM Course Completion

Men completed a higher proportion of pSTEM courses than did women, B = .08, SE = .02, t(135) = 3.52, p = .001,

Table 1 Perceived communal and agentic affordances for science careers

	pSTEM careers		Biology careers		Behavioral careers	
Affordance type	*M*	*SD*	*M*	*SD*	*M*	*SD*
Communal	3.20_a	.86	3.97_a	.74	4.44_a	.59
Agentic	3.47_b	.76	3.47_b	.72	3.64_b	.65

Numbers represent descriptive statistics for communal and agentic affordances for careers in each science field. pSTEM = physical sciences, technology, engineering, and mathematics; Biology = biological science; Behavioral = behavioral science. Different subscripts within each type of science career indicate significant differences in perceived affordances, $p \leq .05$

Table 2 Proportion science courses completed by women and men

	pSTEM courses		Biology courses		Behavioral courses	
Gender	*M*	*SD*	*M*	*SD*	*M*	*SD*
Women	$.16_a$	.25	$.10_a$	.08	$.23_a$	.17
Men	$.40_b$	.24	$.06_b$	.20	$.16_b$	.16

Numbers represent descriptive statistics for the proportion of courses completed for each science field from the total courses completed. pSTEM = physical sciences, technology, engineering, and mathematics; Biology = biological science; Behavorial = behavioral science. Different subscripts within each science field indicate significant gender differences in proportions, $p \leq .05$

consistent with the prior ANOVA for science engagement. Further, higher existing quantitative ability predicted completing a higher proportion of pSTEM courses, $B = .07$, $SE = .02$, $t(135) = 3.30$, $p = .001$. We also found a marginally significant Gender x Communal Affordances interaction for the proportion of pSTEM courses students completed, $B = -.05$, $SE = .03$, $t(135) = -1.91$, $p = .058$. Although this interaction did not reach a conventional level of statistical significant ($p \leq .05$), we chose to examine our a priori hypothesis that the effect of communal affordances on course completion rates would differ for women and men. To do so, we used conventional dummy coding protocol where our reference group was zero, and the non-reference group was 1 (e.g., to find the simple effect for women, we coded women =0, men =1; Aiken and West 1991). In doing so, we found, as expected, communal goal affordances predicted pSTEM course completion rate for women, $B = .07$, $SE = .04$, $t(135) = 1.96$, $p = .05$, but not for men, $B = -.03$, $SE = .04$, $t(135) = -.81$, $p = .42$.

We also examined this two-way interaction by looking at gender differences in pSTEM course completion rate by re-running our original regression model using two new iterations: one centering communal goal affordances at 1 SD below mean communal affordances, and a second centering communal goal affordances 1 SD above mean communal affordances (Aiken and West 1991). Here, we found whereas men completed pSTEM courses at a significantly higher rate than did women when communal affordances were low, $B = .12$, $SE = .03$, $t(135) = 3.95$, $p < .001$, there was no gender difference in course completion rates when communal affordances were high, $B = .03$, $SE = .03$, $t(135) = .95$, $p = .34$. That women engaged in pSTEM courses at a statistically equivalent rate as men when communal affordances perceptions were high is noteworthy; we discuss implications for this finding in the Discussion section. See Fig. 1a for a graphical depiction of this two-way interaction.

We also found a significant Gender x Agentic Affordances interaction for the proportion of pSTEM courses completed, $B = .07$, $SE = .03$, $t(135) = 2.27$, $p = .03$. We dissected this interaction using the methods described previously, and found agentic affordances for pSTEM careers predicted pSTEM course completion rate for men, $B = .13$, $SE = .05$, $t(135) = 2.77$, $p = .01$, but not for women, $B = -.02$, $SE = .05$, $t(135) = -.45$, $p = .67$. Further, we found men completed pSTEM courses at a significantly higher rate than did women when students' agentic affordances of pSTEM were high, $B = .12$, $SE = .03$, $t(135) = 3.96$, $p < .001$, but there was no gender difference in pSTEM course completion rate when agentic affordances were low, $B = .03$, $SE = .03$, $t(135) = .95$, $p = .34$. See Fig. 1b for a graph of this interaction.

Biology Course Completion

Women completed a higher proportion of Bio courses than did men, $B = -.03$, $SE = .01$, $t(135) = -2.39$, $p = .02$, consistent with the ANOVA on science engagement reported earlier. Further,

Table 3 Regression output predicting science engagement from goal affordances and gender

	pSTEM courses		Biology courses		Behavioral courses	
Predictor	*b*	B	*b*	B	*b*	B
Gender (W = −1, M = +1)	.08**	.30	−.03*	−.25	−.03	−.14
Communal Affordances	.02	.07	.00	.01	−.02	−.06
Agentic Affordances	.05	.16	.01	.08	.02	.05
Communal x Gender	−.05+	−.17	−.01	−.04	−.06	−.19
Agentic x Gender	.07*	.22	−.01	−.08	.07*	.23
Commual x Agentic	.03	.12	−.00	−.01	.02	.07
Gender x Communal x Agentic	.02	.09	−.00	−.04	.02	.06
Quantitative ACT/SAT	.07**	.27	.02*	.20	−.03	−.15

pSTEM = physical sciences, technology, engineering, and mathematics; Biology = biological science; Behavioral = behavioral science

$+p = .058$

$*p \leq .05$. $** p < .01$

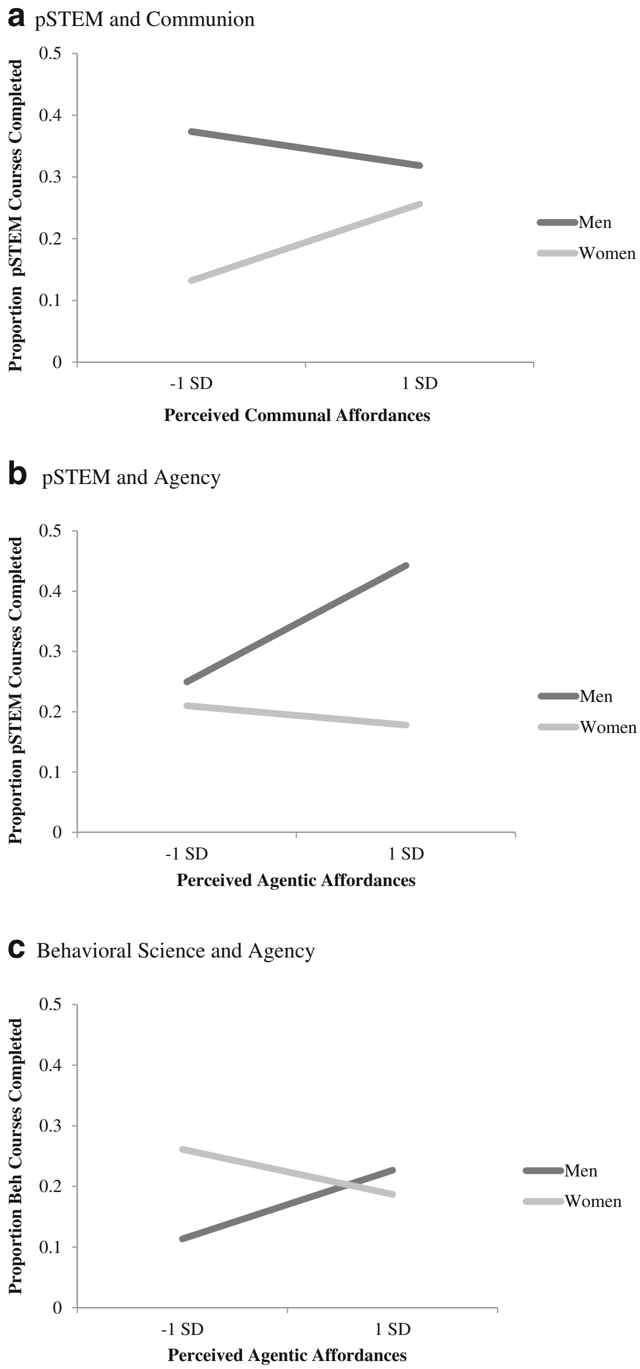

Fig. 1 Course completion by field, gender, and perceived agentic or communal affordance: **a** Proportion physical science, technology, engineering, and mathematics (pSTEM) course completion as a function of gender and perceived communal goal affordances; **b** Proportion physical science, technology, engineering, and mathematics (pSTEM) course completion as a function of gender and perceived agentic goal affordances; and **c** Proportion behavioral science course completion as a function of gender and perceived agentic goal affordances

higher existing quantitative ability predicted completing a higher proportion of Bio courses, $B = .02$, $SE = .01$, $t(135) = 2.11$, $p = .04$. Of interest, the Gender x Communal Affordances interaction term was not significant for students' Bio course completion rates, $B = -.01$, $SE = .02$, $t(135) = -.29$, $p = .77$. The Gender x Agentic Affordances interaction term was also not significant, $B = -.01$, $SE = .02$, $t(135) = -.64$, $p = .53$.

Behavioral Course Completion

The only significant effect that emerged for Beh courses was the Gender x Agentic Affordances interaction, $B = .07$, $SE = .03$, $t(135) = 2.45$, $p = .02$. The pattern of the interaction was as anticipated: stronger agentic affordances predicted more Beh course taking for men, $B = .09$, $SE = .04$, $t(135) = 2.16$, $p = .03$, but not for women, $B = -.06$, $SE = .04$, $t(135) = -1.33$, $p = .19$. When students perceived low opportunity for agentic affordances in Beh, men completed courses at a lower rate than did women, $B = -.07$, $SE = .03$, $t(135) = -2.70$, $p = .01$; when agentic affordances were high, there was no gender difference, $B = .02$, $SE = .03$, $t(135) = .76$, $p = .46$. See Fig. 1c for a graph of this interaction.

Discussion

In the current work, we found first year college students held preconceived notions about their ability to be communal versus agentic in various science fields. Whereas students perceived greater opportunity to be agentic than communal in pSTEM careers, biological and behavioral science were perceived to afford more communal than agentic opportunities. When we tracked the types of science courses students pursued over the next three years, we found gender disparities in women's and men's course-taking: more men than women completed pSTEM courses, but more women than men completed biological and behavioral science courses. Moreover, women and men's course taking was influenced by perceived goal affordances, particularly when those affordances suggested a field was gender-role congruent. That is, our results showed a marginally significant effect of gender and communal goal affordances on pSTEM course taking, with higher communal affordances leading to significantly more pSTEM course taking among women. Similarly, for behavioral science course taking, higher agentic affordances lead men to take significantly more behavioral science courses. Of note, the effects of women and men's affordances on course taking occurred controlling for their existing quantitative ability, providing strong evidence for the unique effects of affordance perceptions on science engagement.

Our results align with role congruity theory; whereas women pursued fields strongly associated with communion, men pursued fields more strongly associated with agency. Role congruity theory also explained the following: women who believed pSTEM afforded ample opportunity to be communal completed more pSTEM courses, and men who viewed behavioral science to readily afford agency pursued more behavioral science courses. Thus, our data suggest women and men do opt into gender-incongruent science fields, provided affordances align with gender roles; we discuss the implications of this findings in the following Practice Implications section.

Limitations and Future Directions

In the current study, a more definitive measure of students' career path would have been the type of academic major students elected (pSTEM, Bio, Beh, or Other) as opposed to the type of courses students completed. Unfortunately, low analytic power precluded this type of outcome measure. For instance, only 21 students (15 % of our sample) ended up declaring a pSTEM major, three of whom were women. Running our multiple regression models on an outcome measure with such low variability would have rendered our results unstable and unreliable. Instead, we focused on students' engagement in different types of science courses, which allowed for greater variability in our outcome measures and more reliable results. Although students' decision of academic major would have been an ideal outcome to assess, we believe students' science course-taking behavior nonetheless provides useful information. In fact, a benefit of measuring course-taking rather than major selection is the former allows for a more nuanced approach to measuring pSTEM engagement than the latter. That is, pSTEM majors and careers are increasingly interdisciplinary, and women pSTEM professionals tend to pursue interdisciplinary work to a greater degree than do men (see Lahey 2014). Studying students' major selection in isolation may have overlooked women who are indeed engaging in pSTEM but are using those pSTEM principles in their non-pSTEM major (e.g., bioinformatics; cognitive science; computational economics).

Our study design and need to sample a particular subject-population of students (i.e., undeclared first-year students) made it difficult to obtain a large sample size. This created limitations with statistical power, which may explain why our hypothesized Gender x Communal Affordances interaction on pSTEM course completion was only marginally significant. Indeed, a post hoc power analysis indicated this analysis was underpowered. However, the fact that the interaction approached significance at all, in conjunction with its alignment with our a priori hypothesis, suggests to us this was a valid relationship in the data and not a statistical artifact. At the very least, our results suggest an important issue for further study.

Low power may have also impaired role congruity theory's ability to explain men's biological science course-taking behavior. That is, students associated biological science and behavioral science more strongly with cultural gender roles for women (communion) than men (agency). However, although men who perceived behavioral science to foster agency completed more behavioral science courses (consistent with role congruity theory), we did not find this same pattern for biological science courses. This may have been due, in part, to the fact that relatively few students pursued biological science in our sample, compared to pSTEM and behavioral science, rendering lower power to explain men's biological course-taking behavior via perceived agentic affordances. Although we sought to obtain a larger sample size in the current work (recall we originally surveyed 339 students), over half of our original sample declined to have their academic record tracked by the researchers. Although we are currently unable to determine why more students did not allow us to track their academic records, we suspect this may be related to a general belief that academic transcripts are private. Knowing this tendency among students, researchers should strive for larger sample sizes in this type of longitudinal work than was the case in our work.

The current work contributes to a growing body of research supporting the claim that girls and young women are less interested in pSTEM fields than are boys and young men due to negative stereotypes about pSTEM's communal opportunities (Diekman et al. 2010, 2011). An important future direction for this research is to take an intersectional approach by assessing the role that multiple social identities might play on the relationship between perceived affordances and science pursuits. For instance, it may also be the case that gender roles concerning communality versus agency may not apply to all racial/ethnic groups. As a case in point, research indicates African American girls tend to be raised to be independent, self-assured, and communal (e.g., Hanson and Palmer-Johnson 2000), suggesting both types of affordances may play an important role in African American women's science pursuits. Unfortunately, insufficient racial/ethnic diversity in the current sample precluded our ability to take an intersectional approach in our research, limiting the generalizability of our findings across racial lines. Related to this shortcoming, future research should account for the degree to which women and men endorse traditional gender roles (i.e., communion for women; agency for men) because this may be an important moderator for the current pattern of results. By acknowledging the complexity of women's and men's gender identities, researchers may develop a more thorough understanding of the precursors to gender diversity in science.

Practice Implications

A particularly striking finding in the current research was women participated in pSTEM at an equal rate as men when women perceived communal opportunities in pSTEM. This finding extends existing research (Diekman et al. 2011) to demonstrate the impact of communal affordances on women's behavior, and it touts the importance of making pSTEM content socially relevant and collaborative for students before college. That is, our student sample had preconceived notions about science careers' affordances by the time we contacted them during their first semester of college. As such, content in K-12 pSTEM education should showcase the social relevance and collaborative nature of pSTEM so a greater proportion of women enter college with the belief that pSTEM careers can be communal than is currently the case. We recommend (diverse) members of research labs visit K-12 classrooms, emphasize the social impact of their research, and highlight the collaborative nature of their work. At an administrative level, this type of outreach should be rewarded so that researchers have incentive to share their work with young people. A good example of incentive for outreach lies in the National Science Foundation CAREER award for pre-tenure faculty, which requires grant awardees to weave "broad impact," such as K-12 outreach, into the fabric of their research program. For more guidelines on attracting young women to pSTEM, see Dasgupta and Stout (2014).

We also found men were less likely to pursue behavioral science courses than were women, but men's behavioral science pursuits increased when they believed they could be agentic in that field. Given that men are (vastly) overrepresented in pSTEM but underrepresented in behavioral science, our data suggest greater diversity in these fields is achievable if stereotypes shift to highlight agentic opportunities in behavioral science as well as tamp down emphasis on agency in pSTEM. One benefit to increasing the number of men in science fields traditionally occupied by women is that doing so may weaken outmoded gender roles that may be stymying the upward social mobility of women. As outlined by social role theory, stereotypes about professions tend to extend to the social groups that typically hold those professions. Thus, if an equal mix of women and men pursue behavioral science, communion may start to be associated with men to a greater degree than is currently the case, alleviating cultural constraints about who is best suited for caretaking roles. For instance, associating men and women equally with communion may result in a cultural shift towards gender-neutral expectations for parental leave in the workplace and greater egalitarian parenting practices at home. For a cogent discussion on the benefits of men moving into traditionally feminine fields, see Croft et al. 2015.

Conclusion

Diversity across science fields is important for a number of reasons: it improves innovation and creativity, it acknowledges the needs of a diverse populace, and it has the potential to promote social equity among social groups by tempering social roles. The current work draws on role congruity theory to explain current trends in women's and men's science pursuits and to understand how to correct for low diversity in particular science fields. Specifically, our work indicates widespread perceptions about communal versus agentic opportunities differ systematically across science fields, but these perceptions also vary within people. Educators, policymakers, and administrators should capitalize on the malleable nature of science stereotypes in order to change the gendered nature of science fields, which may ultimately promote gender parity at a larger, cultural level.

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