


To Pursue or Not to Pursue STEM? Faculty Behavior Enhances Student Involvement in STEM Roles by Signaling Role-Specific Support

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Abstract

Four studies examine the faculty–student relationship as a mechanism through which students ascertain their place in science, technology, engineering, and mathematics (STEM) fields. Studies 1 and 2 use experimental methods to demonstrate STEM faculty who behave communally, relative to independently, increase undergraduates’ belonging and interest in STEM roles through anticipation of greater *role-specific support* (i.e., support that emphasizes guiding students through structures and activities of field-specific roles). Study 3 then examined the consequences of role-specific support for undergraduates’ belonging and interest in STEM. Students anticipated more belonging and interest in STEM roles when faculty provided high levels of role-specific support. Finally, STEM doctoral students’ perception of role-specific support from faculty related to their belonging and future identification in STEM fields (Study 4). Taken together, these studies demonstrate the importance of students’ construals of role-specific support from faculty, and how faculty behavior signals role-specific support, with benefits for student involvement in STEM.

Keywords

STEM education, support, faculty behavior, communion

“I was not always the best student with the highest grades, but my teachers saw something in me and tried to encourage me It made a difference.”

—May-Britt Moser (2014 Nobel Laureate)

In higher education, students make a series of decisions with lasting implications for their roles in society. Yet, many times students make these decisions without clear information about potential career paths or where they might fit within those pathways. In unpacking the “hidden curriculum” of higher education (Calarco, 2020; Margolis, 2002), the messages and behaviors of teachers and faculty are a powerful force. Echoing the words of May-Britt Moser, faculty are important figures who can confer a myriad of benefits for students’ educational paths (Paglis et al., 2006; Stout et al., 2011; for a review, see Crisp & Cruz, 2009). Faculty might be especially important for science, technology, engineering, and mathematics (STEM) fields by reducing barriers to recruitment and retention (National Academies of Sciences, Engineering, and Medicine, 2017) and increasing students’ likelihood of engaging in STEM (Canning et al., 2019; Cheryan et al., 2011).

When students observe faculty in professional roles, they make inferences that have implications for understanding their

own place in academic fields (Diekman et al., 2017). The current research seeks to understand the specific ways faculty motivate or demotivate students in STEM roles. We propose students’ observations of faculty behavior operate as cues to whether they will be supported by faculty and belong in academic roles. Specifically, we examine whether communal and independent faculty behaviors signal differential opportunities for role-specific support—support that emphasizes guiding students through structures and activities of field-specific roles. We further propose students’ perceptions of role-specific

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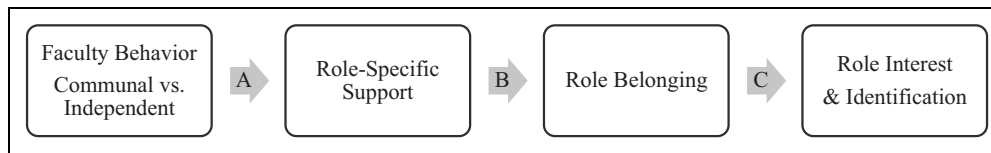


Figure 1. Conceptual model tested in the current research.

support from faculty can be consequential in communicating whether they belong and should (or should not) pursue STEM.

Faculty Behavior as Cues

As students navigate higher education, they seek cues signaling whether they will belong and succeed in different roles (Walton & Brady, 2017). Environmental cues—such as who is in the environment—can motivate, or demotivate, students in STEM fields (Dasgupta et al., 2015; Herrmann et al., 2016; Murphy et al., 2007; Shin et al., 2016). Another potent cue is faculty behavior.

Faculty behavior varies widely: Some behaviors are highly communal (e.g., collaborating with others, meeting with students to explain procedures), whereas others are more independent¹ (e.g., adopting a hands-off mentoring style, communicating with students through intermediaries such as lab managers). Because STEM fields are often perceived as incongruent with communal goals (e.g., working with or helping others; Diekman et al., 2010; Morgan et al., 2001), students feel greater belonging and interest when observing communal faculty (vs. independent or agentic faculty), in part through heightened expectations that STEM affords opportunities to fulfill communal goals (Belanger et al., 2020; Fuesting & Diekman, 2017). We propose faculty behavior can be beneficial in another way: Faculty behavior may inform students' expectations of whether faculty will support them in a role, positively impacting their belonging and involvement in STEM roles.

A Model of Role-Specific Support and Belonging

Perceptions of support availability are consistent and strong predictors of health and well-being (e.g., Haber et al., 2007); social support from faculty facilitates students' self-efficacy and persistence in academic roles (Rigg et al., 2013; Tenenbaum et al., 2001). Despite the importance of support, we know little about how students *infer* they will be supported. The current research identifies whether faculty who behave more communally or independently cue students' anticipated support, with consequences for belonging and involvement (i.e., interest and identification) in STEM.

We focus our investigation on an underrecognized form of support: *role-specific support*. Like other routes of social support, faculty support has been traditionally differentiated as either more emotion-focused, centered on helping students through social and emotional challenges, or problem-focused, centered on helping students overcome obstacles (Robnett et al., 2018). We define role-specific support as centered on guiding students through structures and activities of STEM

roles by providing material or psychological resources to aid student development. Within this definition, role-specific support from faculty could be emotion-focused (e.g., celebrating a student's poster acceptance) or problem-focused (e.g., working through data collection obstacles), but its defining feature is that it facilitates students' ability to fulfill academic roles. Other forms of emotion-focused support (e.g., helping students cope with stressful family situations) or problem-focused support (e.g., giving students financial advice) would not constitute role-specific support, as they do not center on students' role-specific experiences. We predicted that faculty behavior signals whether students will be supported in field-specific roles, and perceived role-specific support from faculty increases students' likelihood of entering and identifying with STEM roles. We outline our conceptual model in Figure 1.

Path A: Faculty behavior signals role-specific support. We argue the relative communality or independence of faculty behaviors is a foundational cue for students' perceptions of whether faculty will provide role-specific support. Because communality involves relationship building—including being oriented to others and supporting their goals (Allen et al., 2018)—we expected students would anticipate faculty who behave in communal ways to provide role-specific support. In contrast, we expected independent faculty behaviors would decrease students' expectations of role-specific support because those behaviors signal faculty are not oriented to others' needs and goals. At first, this prediction may appear counterintuitive: As long as faculty have competence in their discipline, the communality versus independence of behavior should not matter for students' educational development. However, there is a distinction between possessing field-specific skill sets and being attuned to needs and goals in ways that ensure the skill set facilitates students' educational development. Possessing disciplinary knowledge and expertise may be necessary, but not sufficient, for students' anticipated role-specific support from the faculty. The current research tests the novel prediction that communal faculty behavior, relative to independent behavior, suggests that faculty will support students in ways specific to their academic role.

Paths B and C: Consequences of role-specific support. It is not surprising that support from faculty, such as advice and assistance regarding academic tasks, increases students' self-efficacy (Syed et al., 2019). Support not only communicates information to students about what must be done in a role but may also enhance students' perceived ability to excel or signal that faculty see students' educational development as worthy of

investment (e.g., S. L. Clark, Dyer, et al., 2016). We argue this might be especially true in the case of role-specific support, in which faculty provide support focused on guiding, celebrating, and positioning students for success within roles. Thus, we considered it possible that role-specific support enhances students' belonging, which is important for student interest and identification in STEM (Thoman et al., 2014). In the current work, we directly test whether students' anticipations of role-specific support from faculty increase belonging and involvement in STEM roles.

In sum, we posit that the effects of faculty behavior extend beyond changing beliefs about cultures of STEM fields; these behaviors also signal whether students will receive role-specific support from faculty. We expected that, when students anticipate faculty will provide role-specific support, they will feel more belonging, interest, and identification with STEM. We further expected students' perceived role-specific support from faculty would convey benefits across the educational pipeline. We examine the consequences of role-specific support from faculty experimentally among students who have limited experience in STEM and longitudinally among highly invested students in current STEM roles. The current research extends understanding of faculty–student relationships in two main ways. First, we investigate how brief samples of typical faculty behaviors impact students' perceived support, or lack of support, in STEM roles. We test the novel prediction that communally behaving faculty signal more role-specific support than independently behaving faculty. Second, we demonstrate the causal role of perceived role-specific support for students' belonging and involvement in STEM.

Gender Differences

We tested whether the aforementioned processes differed across faculty gender and student gender. With respect to faculty gender, past research suggests both men and women scientists can enhance interest by highlighting communality (E. K. Clark, Fuesting, & Diekmann, 2016). Nonetheless, considering stereotypes about women behaving communally (Eagly et al., 2020), we test whether faculty gender moderates the effects of faculty behavior. With respect to student gender, we considered it possible that the proposed processes would be stronger for women relative to men, given women generally experience lower belonging in STEM (Good et al., 2012) and tend to more strongly endorse communal goals (Diekmann et al., 2010). Yet, prior literature also includes reasons to expect gender similarities across students: Perceiving STEM cultures as communal can benefit men and women students (Allen et al., 2018), and support benefits men and women equally (Holt-Lunstad et al., 2010).

Overview

Four studies investigate whether faculty behaviors serve as cues to the level of role-specific support students will receive from faculty and how perceived role-specific support relates

to student belonging, interest, and identification in STEM roles. First, we use experimental vignettes (Studies 1 and 2) to examine whether communal (vs. independent) faculty behavior signals role-specific support (Figure 1, Path A) and whether students' expectations of role-specific support from faculty relate to anticipated belonging and interest. In Study 1, we further test whether faculty gender moderates these processes and conduct exploratory analyses across student gender. Because Study 1 was not sufficiently powered for testing differences across student gender, we designed Study 2 to formally test moderation by student gender. We then turn to consequences of role-specific support (Figure 1, Path B), experimentally testing whether role-specific support impacts student belonging and interest in STEM roles (Study 3) and how STEM doctoral students' perceived role-specific support from faculty relate to their belonging and identification 6 months later (Study 4).

We report all analyses and exclusions in the main text or Supplemental Materials (SOM). Materials, syntax, data for all studies, and preregistrations for Studies 2 and 3 are publicly available on the Open Science Framework (OSF; <https://osf.io/6my54/>).

Study 1 Method

Participants and Design

This study used a 2(faculty behavior: *communal, independent*) × 2(faculty gender: *woman, man*) between-subjects design. We planned to recruit 50 participants per condition. The final sample included 206 U.S. college students (98 women, 106 men, and 2 not reporting; $M_{\text{age}} = 27.74$ and $SD_{\text{age}} = 6.78$) recruited via CloudResearch. Additional respondents ($n = 76$) were excluded for failing to correctly report faculty gender. Monte Carlo simulations conducted post-data collection suggested our final sample size corresponded to .98 power for primary mediation analyses (see SOM).

Procedures

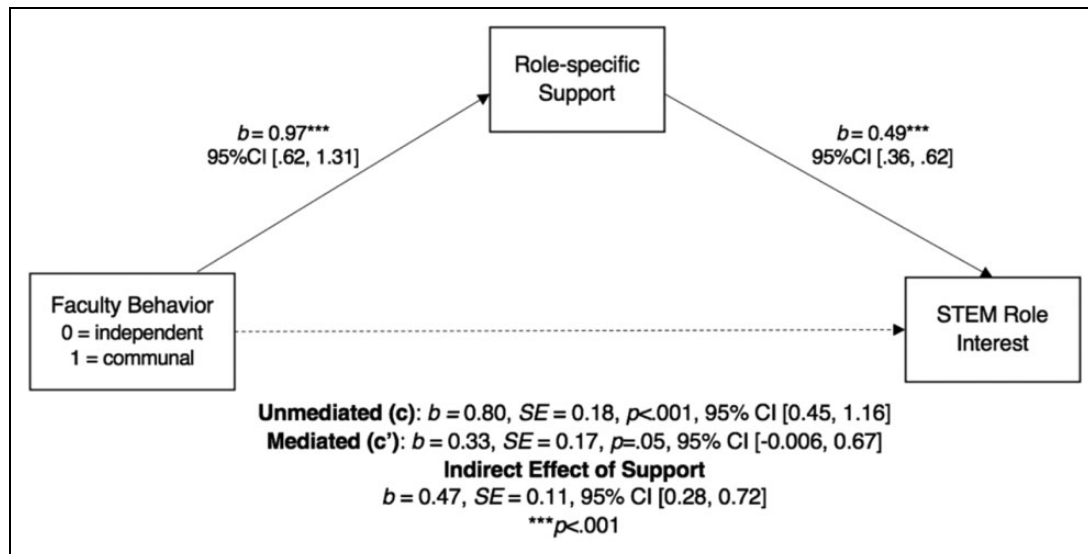
Participants read a description of a chemical engineering lab and imagined working as a research assistant (RA) in this lab (adapted from E. K. Clark, Fuesting, & Diekmann, 2016). The professor was described as well-known and respected. In the communal condition, the professor worked closely with other people (e.g., actively collaborated with other researchers) and displayed prosocial behaviors (e.g., presented findings at local schools and provided feedback to other researchers). In the independent condition, the professor displayed independent behaviors (e.g., contacted RAs via intermediaries and passively listened to others' presentations without providing feedback). We manipulated professor gender by varying gender pronouns and name (Lisa or Gary; equated on perceived competence and attractiveness; Kasof, 1993).

Participants rated the degree to which working with the professor would provide *opportunities to fulfill communal goals* (e.g., "allow me to form connections with others"; three items;

Table 1. Cell Means, Standard Deviations (SDs), and Correlations for Studies 1 and 2.

Variable	Communally Behaving Faculty	Independently Behaving Faculty	1	2	3	4
Study 1	(<i>n</i> = 107)	(<i>n</i> = 99)				
1. Communal affordances	5.68 (1.15)	4.75 (1.25)	—	.65***	.57***	
2. Role-specific support	5.33 (1.16)	4.36 (1.33)	—	—	.53***	
3. Role interest	5.58 (1.22)	4.77 (1.37)	—	—	—	
Study 2	(<i>n</i> = 208)	(<i>n</i> = 208)	1	2	3	4
1. Communal affordances	6.13 (0.90)	5.35 (1.15)	—	.55***	.60***	.60***
2. Role-specific support	6.01 (0.87)	4.61 (1.43)	—	—	.64***	.65***
3. Role belonging	5.61 (0.94)	4.72 (1.13)	—	—	—	.65***
4. Role interest	6.16 (1.00)	5.03 (1.41)	—	—	—	—

p* < .05. *p* < .01. ****p* < .001.

**Figure 2.** Faculty behavior cued science, technology, engineering, and mathematics (STEM) role interest through perceptions of anticipated role-specific support in the faculty–student relationship.

$\alpha = .83$; Fuesting & Diekman, 2017), *role-specific support* (e.g., “I could count on Dr. Smith when things go wrong”; four items; $\alpha = .86$), and their *interest in the RA position* (e.g., “if I were looking for a job I would be likely to apply to this lab”; three items; $\alpha = .90$). All ratings were on scales from 1 (*not at all*) to 7 (*extremely*). After participants responded to measures, they were debriefed and compensated (US\$0.50).

Results and Discussion

We conducted a 2(faculty behavior: *communal or independent*) \times 2(faculty gender: *man or woman*) analysis of variance (ANOVA) for each primary outcome. There was a significant main effect of faculty behavior on each of our outcomes. Communally behaving faculty were expected to provide more communal affordances than independently behaving faculty, $F(1, 202) = 30.95$, $p < .001$, $\eta_p^2 = .13$ (see Table 1). Participants anticipated receiving more role-specific support from faculty, $F(1, 202) = 30.38$, $p < .001$, $\eta_p^2 = .13$, and were more interested in working with faculty, $F(1, 202) = 19.92$, $p < .001$, $\eta_p^2 = .09$, who behaved communally (vs. independently). There

were no significant main effects of faculty gender on communal affordances, $F(1, 202) = 0.05$, $p = .83$, $\eta_p^2 < .001$; anticipated role-specific support, $F(1, 202) = 3.16$, $p = .08$, $\eta_p^2 = .01$; or role interest, $F(1, 202) = 0.003$, $p = .95$, $\eta_p^2 < .001$. There was also no moderation by faculty gender on the relationship between faculty behavior and communal affordances, $F(1, 202) = 0.02$, $p = .90$, $\eta_p^2 < .001$; anticipated role-specific support, $F(1, 202) < 0.001$, $p = .99$, $\eta_p^2 < .001$; or role interest, $F(1, 202) = 0.31$, $p = .57$, $\eta_p^2 = .002$. Results by participant gender are presented in SOM.

Next, we tested whether role-specific support statistically mediated the relationship between faculty behavior and interest, collapsing across faculty gender. Mediation analyses were run using PROCESS (Version 3.5; Hayes, 2018) with 5,000 bootstrapped samples. Role-specific support statistically mediated the relationship between faculty behavior and interest (see Figure 2). Students anticipated more role-specific support when faculty behaved communally and were subsequently more interested in the role.

Study 1 demonstrates how faculty behavior, regardless of faculty gender, cues students’ anticipated role-specific support.

In Study 2, we sought to replicate and extend these findings by including a measure of belonging and increasing our sample size to conduct a sufficiently powered test of whether participant gender moderated these effects. To test the unique benefits of role-specific support, Study 2 also examined whether role-specific support benefits students beyond merely perceiving faculty as interpersonally warm. We expected that, controlling for students' general perceptions of faculty warmth, role-specific support still communicates to students they belong and should be involved in STEM roles.

Study 2 Method

Participants and Design

Participants were randomly assigned to one of two faculty behavior conditions (communal, independent). A priori power analyses using Monte Carlo simulation indicated a sample size of 400 participants would achieve .80 power to detect moderation of the hypothesized mediation by participant gender (see SOM).

We preregistered we would recruit 420 U.S. college students on Prolific Academic (compensation rate of US\$11.79/hour) and exclude participants who responded with no variance across all primary measures and/or incorrectly answered a task check ($n = 4$). Our final sample included 416 participants ($M_{age} = 22.17$ and $SD_{age} = 5.22$; 233 women, 168 men, and 12 nonbinary).

Procedures

All procedures were identical to Study 1 with two exceptions. We held faculty gender constant as a man, consistent with existing STEM demographics (National Science Foundation, 2019), because it did not moderate Study 1 results. We also adjusted the manipulation to make job duties more parallel across conditions (see OSF).

Measures were assessed from 1 (*not at all*) to 7 (*extremely*). Three items ($\alpha = .74$) were used as a *manipulation check* (e.g., "If you worked as a research assistant in Dr. Johnson's lab, how likely would it be that he would . . . Form connections with others in the lab and field"). Adapted from Study 1, participants responded to a *communal affordances* measure (three items; $\alpha = .81$), reported how much *role-specific support* they anticipated receiving (four items; $\alpha = .93$; e.g., "Dr. Johnson would really try to help me with my lab work if I needed it"), and their *interest in the RA role* (four items; $\alpha = .95$). Unique to Study 2, seven items ($\alpha = .83$) adapted from Good et al. (2012) assessed anticipated *role belonging* (e.g., "If you worked as a research assistant in Dr. Johnson's lab, to what extent would you feel like you fit in"). To rule out alternative explanations, we also included a measure of perceived *faculty warmth* (three items; $\alpha = .93$; "Dr. Johnson seems friendly/nice/warm").

Results of Preregistered Analyses and Discussion

The manipulation was effective: Participants anticipated faculty would exhibit more communal behavior in the communal condition ($M = 6.42$ and $SD = 0.72$) than the independent condition ($M = 4.99$ and $SD = 1.16$), $t(412) = -15.01$, $p < .001$, $d = .97$.

We conducted a 2(faculty behavior: *communal or independent*) \times 2(participant gender: *man or woman*) ANOVA for each outcome.² Consistent with Study 1 (see Table 1), there was a main effect of faculty behavior: Faculty who behaved communally were anticipated to provide more communal affordances, $F(1, 397) = 50.63$, $p < .001$, $\eta^2 = .11$, and role-specific support, $F(1, 397) = 127.87$, $p < .001$, $\eta^2 = .24$, and participants were more interested in working with communal, than independent, faculty, $F(1, 397) = 74.51$, $p < .001$, $\eta^2 = .16$. As predicted, participants anticipated more belonging when faculty behaved communally than independently, $F(1, 397) = 67.39$, $p < .001$, $\eta^2 = .14$.

There was no main effect of participant gender on anticipated role-specific support, $F(1, 397) = 0.03$, $p = .87$, $\eta_p^2 < .001$, belonging; $F(1, 397) = 1.24$, $p = .27$, $\eta_p^2 = .003$; or interest, $F(1, 397) = 1.05$, $p = .31$, $\eta_p^2 = .002$. There was a main effect of participant gender on communal affordances, $F(1, 397) = 8.01$, $p = .005$, $\eta_p^2 = .02$, such that women on average reported higher anticipated communal affordances ($M = 5.87$ and $SD = 1.08$) than men ($M = 5.56$ and $SD = 1.09$).

Consistent with Study 1 exploratory analyses (see SOM), participant gender moderated the relationship between faculty behavior and role-specific support, $F(1, 397) = 5.57$, $p = .02$, $\eta_p^2 = .01$. The difference in anticipated role-specific support was greater for women, mean difference = 1.64, 95% CI of mean difference [1.33, 1.94], $p < .001$, $d = 1.32$, compared to men, mean difference = 1.07, 95% CI [0.71, 1.43], $p < .001$, $d = 0.97$. Inconsistent with Study 1, participant gender did not moderate the relationship between faculty behavior and communal affordances, $F(1, 397) = 0.47$, $p = .49$, $\eta_p^2 = .001$, but did moderate the relationship between faculty behavior and role interest, $F(1, 397) = 4.43$, $p = .04$, $\eta_p^2 = .01$. The difference between interest in working with communal faculty versus independent faculty was greater for women, mean difference = 1.33, 95% CI [1.02, 1.65], $p < .001$, $d = 1.04$, than men, mean difference = 0.19, 95% CI [0.44, 1.18], $p < .001$, $d = 0.70$. Participant gender did not moderate the relationship between faculty behavior and belonging, $F(1, 397) = 0.66$, $p = .42$, $\eta_p^2 = .002$.

We next tested a serial mediation model such that faculty behavior related to role interest through role-specific support followed by belonging (serial mediation selected due to past evidence that student belonging precedes interest; Thoman et al., 2014). Participants were more interested in working with communal faculty, and this was mediated by communal faculty signaling more role-specific support and belonging than independent faculty (see Figure 3). The indirect effect through support remained significant when including faculty warmth as a

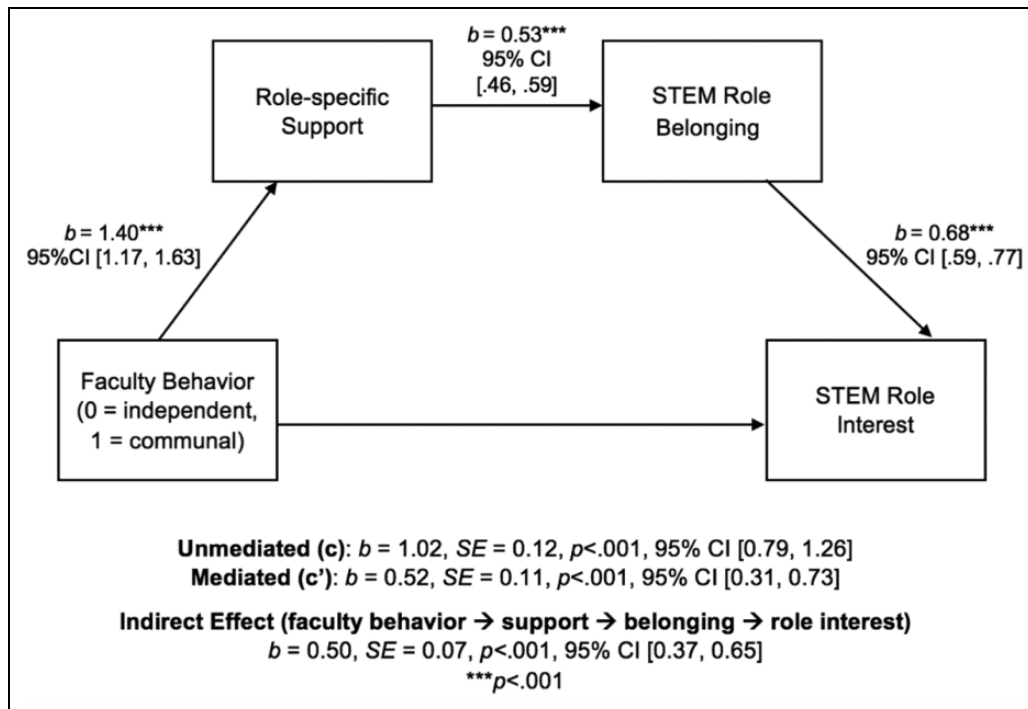


Figure 3. Faculty behavior cued science, technology, engineering, and mathematics (STEM) role interest through anticipated role-specific support and belonging within the role.

parallel mediator, $b_{\text{support}} = .29$, 95% CI [0.17, 0.42]. Participant gender did not moderate the indirect effect (faculty behavior → role-specific support → belonging → interest; moderated mediation index = .19, 95% CI [-0.10, 0.47]).

Study 2 provided support for our hypothesized causal relationship from faculty behavior to role-specific support, with downstream consequences for belonging and interest. Study 3 builds on these results to investigate the latter portion of the conceptual model: that role-specific support impacts student belonging and interest and belonging mediates the relationship between support and interest. Because we did not find consistent evidence across Studies 1 and 2 that processes differed for students who were women, compared to men, participant gender effects for remaining studies are presented in SOM.

Study 3 Method

Participants and Design

Participants were randomly assigned to one of two conditions (low or high role-specific support). We aimed to recruit 506 participants based on power analyses to detect small between-condition effects at .80 power using independent samples t tests (see SOM). We recruited 575 undergraduates and preregistered we would exclude participants who were not current college students ($n = 18$), completed the survey in less than half the median completion time ($n = 50$), responded with no variance to primary measures ($n = 3$), and failed to correctly remember faculty gender ($n = 307$).

The last exclusion criterion was very stringent; a number of participants declined to answer ($n = 140$) or indicated gender was not specified ($n = 124$). Because this criterion substantially reduced statistical power, we deviated from the preregistration and only excluded those who incorrectly identified the faculty as a woman ($n = 26$). Analyses conducted with preregistered exclusions are in SOM; results were unchanged. The final sample included 482 participants ($M_{\text{age}} = 22.26$ and $SD = 6.52$; 284 women, 188 men, and 10 participants not reporting or other identified).

Procedure

Participants were recruited by CloudResearch panel service and presented with a STEM lab description in which the professor (Dr. Robert Johnson) was described as providing either low or high levels of role-specific support. Role-specific support was manipulated by providing a brief transcript of a lab meeting and anonymized evaluations from previous RAs. During the lab meeting, students expressed issues with using lab equipment and writing up a scientific report. In the *low role-specific support* condition, Dr. Johnson referred students to manuals available in the lab, indicating he was unlikely to be able to meet with them. In the *high role-specific support* condition, Dr. Johnson offered to meet with students and discuss how to troubleshoot issues with equipment. Anonymized evaluations indicated Dr. Johnson was a clear communicator, RAs enjoyed working in his lab, and RAs “developed skills in the lab because they were often left to figure out problems on their

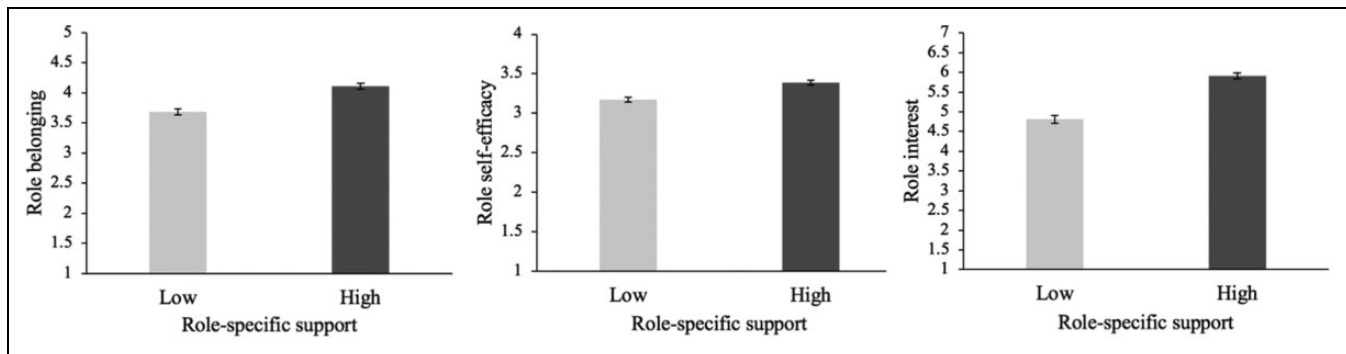


Figure 4. Role belonging, self-efficacy, and interest across low and high role-specific support conditions (error bars represent standard error).

own” (low role-specific support) or Dr. Johnson was “challenged students to gain research skills in a supportive and guided context” (high role-specific support). Next, participants responded to measures, were debriefed, and were compensated (US\$1.00).

We used four items as a *manipulation check* ($\alpha = .90$; adapted from Zimet et al., 1988; e.g., “Dr. Johnson would really try to help me if I needed it”) on a 5-point response scale. Participants also completed measures of anticipated *role belonging* (seven items; $\alpha = .88$; 5-point response scale) and *role interest* (four items; $\alpha = .78$; 7-point response scale), adapted from Study 2. To rule out alternative explanations, we included a measure of *self-efficacy* (five items; $\alpha = .78$; Schwarzer & Jerusalem, 1995). Participants responded to items (e.g., “If I joined this lab, I would usually be able to handle whatever came my way”) on a scale of 1 (*not at all true*) to 4 (*exactly true*).

Results of Preregistered Analyses and Discussion

We conducted independent samples *t* tests to test the effect of role-specific support condition. The manipulation was successful: Participants anticipated receiving lower role-specific support in the low-support condition ($M = 3.37$ and $SD = .98$) than the high-support condition ($M = 4.30$ and $SD = 0.77$), $t(478) = -11.50$, $p < .001$, $d = 1.06$.

As shown in Figure 4, participants in the high-support condition anticipated higher self-efficacy, $t(477) = -5.04$, 95% CI $[-.30, -.13]$, $p < .001$, $d = 0.46$; belonging, $t(474) = -5.82$, 95% CI $[-0.58, -0.29]$, $p < .001$, $d = 0.53$; and interest, $t(478) = -9.08$, 95% CI $[-1.34, -0.86]$, $p < .001$, $d = 0.83$, compared to participants in the low-support condition.

Next, we conducted a parallel mediation model to examine the simultaneous indirect effects through self-efficacy and belonging (see Figure 5). As predicted, the indirect effect through belonging was significant even with self-efficacy in the model. Role-specific support enhanced STEM role interest through increased belonging as well as self-efficacy, consistent with previous correlational research (Syed et al., 2019).

In sum, the results supported our hypothesized model. Role-specific support did not merely signal students’ anticipated

ability to succeed (i.e., self-efficacy) but also their belonging in STEM roles. The paradigms of Studies 1 and 3 showed consistent support for the hypothesized model and enabled strong experimental control, but a clear limitation was their hypothetical nature. Also, many participants were non-STEM majors. Understanding perceptions of non-STEM students helps identify barriers to recruitment into STEM but is less informative for understanding retention. To demonstrate the importance of perceived role-specific support from faculty in actual STEM contexts, Study 4 examined STEM doctoral students’ perceptions of role-specific support from faculty and associations with STEM belonging and identification over the course of an academic year. Study 4 focused on identification rather than interest because past work has shown identification with STEM is particularly important for retention (Perez et al., 2014).

Study 4 Method

Participants and Procedure

We recruited precandidacy STEM doctoral students at two public universities. The final sample included 151 students ($M_{age} = 25.05$ and $SD_{age} = 3.34$; 69 women and 78 men). Measures were administered through an online link emailed once in the first 3 months of the academic year and again in the last 3 months of the academic year (fall 2015–spring 2016). At Time 1 (T1), students reported perceived role-specific support from faculty followed by belonging and identification in their STEM field. At Time 2 (T2), participants reported belonging and identification, completed debriefing, and were compensated (US\$45 e-gift cards). See SOM for further details regarding sample determination and procedures.

All ratings were from 1 (*strongly disagree*) to 7 (*strongly agree*). We assessed perceived *role-specific support from faculty* with three items ($\alpha = .75$): “When I need [advice/motivation], I can seek support from my advisor and other professors” and “When I want to celebrate an academic achievement, I can count on my advisor and other professors.” *Belonging* ($\alpha_{T1} = .94$; $\alpha_{T2} = .88$) was measured using 22 items adapted from Good et al. (2012). Participants listed their research field and answered each item for that field (e.g., “I feel like I am a part of ____ community”). Students’ *identification with their field* was measured with two items, “Being

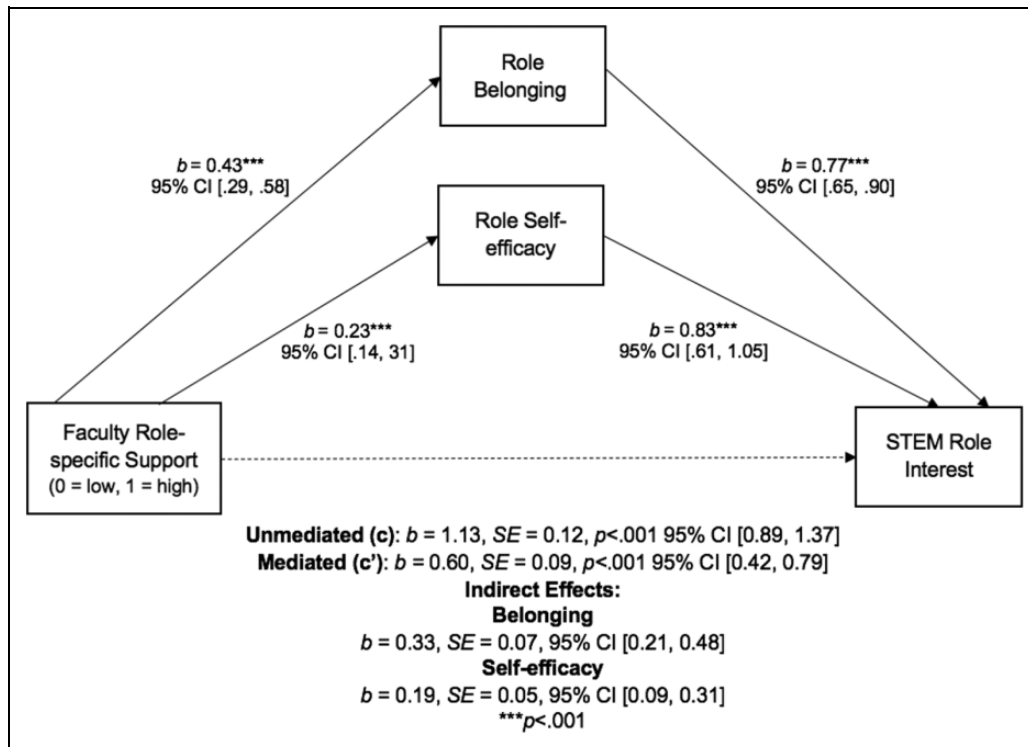


Figure 5. Role belonging and self-efficacy significantly mediated the relationship between role-specific support and science, technology, engineering, and mathematics (STEM) role interest.

Table 2. Means, Standard Deviations, and Correlations in Study 4.

Variable	Mean (SD)	1	2	3	4	5
1. Role-specific support	5.15 (1.16)	—	.37***	.25**	.11	.26**
2. T1 Belonging	4.80 (0.89)	—	—	.65***	.19*	.16*
3. T2 Belonging	4.75 (0.90)	—	—	—	-.09	.25**
4. T1 Identification	5.10 (1.36)	—	—	—	—	.46***
5. T2 Identification	5.20 (1.23)	—	—	—	—	—

Note. T1 = Time 1; T2 = Time 2.

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

in my field is an important part of who I am” and “Being in my field is a part of my self-concept,” $r_{T1}(147) = .85, p < .001$, $r_{T2}(148) = .87, p < .001$.

Results and Discussion

Correlations and means for primary variables are in Table 2. To test our conceptual model, we examined whether role-specific support from faculty predicted subsequent STEM identification through belonging. As shown in Figure 6, students who perceived more role-specific support from faculty at T1 reported higher T2 belonging and identification, controlling for T1 identification.³

Study 4 established temporal precedence for the impact of role-specific support on students’ identification with STEM roles and provided real-world support for hypotheses in a

sample with high external validity: More role-specific support from faculty was related to belonging and identification among students already involved in STEM.

General Discussion

Given the growth of STEM fields on a national and global scale (Burke, 2019), STEM educators, researchers, and policy makers wonder how to encourage students to enter and persist in STEM. Our research provides novel evidence that students’ construal of faculty behaviors as signaling role-specific support represents a critical mechanism by which students ascertain their place in STEM. We tested these processes across four studies using experimental and prospective methods. Students perceived a greater likelihood of role-specific support when faculty behaved communally, relative to independently, and role-specific support heightened students’ belonging and involvement in STEM.

Our findings extend current literature in two key ways. Adding to existing literature documenting interpersonal cues to belonging (Master et al., 2017; Murphy et al., 2007), our research expands knowledge about specific ways faculty effectively signal belonging to students. Goal congruity theory posits students’ connections to social roles, and structures, are enhanced when they perceive greater congruity between their goals and the affordances of a role (Diekmann et al., 2017). Because communality is a foundational human motivation (Bakan, 1966), increasing perceptions of communal affordances is one way to enhance belonging and involvement in

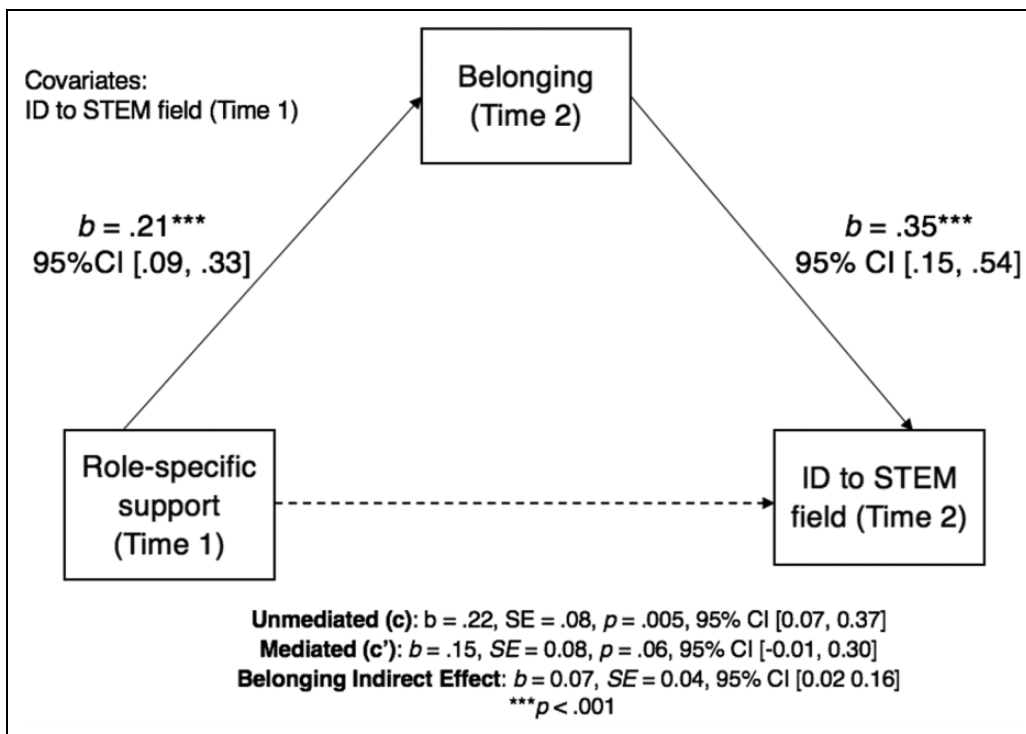


Figure 6. Students who perceived greater role-specific support from faculty at the beginning of the academic year had higher belonging and identification to their field at the end of the academic year.

a field-specific role. Yet, students’ ability to fulfill their goals also depends on the extent to which faculty will support them within STEM roles. Our research is the first to establish communal versus independent faculty behavior as cueing perceptions of support within the role. Role-specific support can enhance students’ belonging, and subsequently their involvement, in STEM roles.

Our findings also go beyond reinforcing the importance of support in educational contexts (e.g., London et al., 2011) by demonstrating that support that is specific and tailored to academic roles plays a vital role in belonging and involvement. We found that role-specific support from faculty (e.g., celebrating in academic accomplishments or providing advice about lab challenges) predicted student belonging and involvement in STEM above and beyond perceiving faculty as warm and controlling for students’ self-efficacy. Evidence for these effects emerged at different points in STEM pathways, suggesting these processes may be integral for both recruitment and retention in STEM.

Notably, we found more evidence for gender similarity than gender difference, suggesting these cues function regardless of who is signaling or receiving the cues. These data join other evidence (e.g., Cheryan et al., 2011) to suggest, in some contexts, faculty gender might be less important than the behaviors in which faculty engage. Regarding student gender, results were largely similar for both men and women participants, with some evidence of stronger effects for women, consistent with past research (Belanger et al., 2020; Steinberg & Diekmann, 2018). The overall similarity in our findings is consistent with

support being equally beneficial for men and women (Holt-Lunstad et al., 2010).

There are several limitations to the current research. First, although Studies 1 and 2 used previously validated experimental materials to manipulate communal and independent behaviors, the behaviors were not equated on other factors (e.g., valence), nor were they spontaneously generated by students. It will be important for future research to determine the frequency and external validity of these behaviors. Second, although our findings suggest belonging is one mechanism by which role-specific support fosters greater interest and identification, it is by no means the only mechanism. For example, perceptions of role-specific support might buffer against known negative effects of social identity threat (e.g., Hall et al., 2019). However, our data were not sufficient to speak to experiences of minoritized students, who are more likely to experience social identity threats (Cohen & Garcia, 2008) and more attuned to cues signaling these threats (Purdie-Vaughns et al., 2008). Future research might investigate whether role-specific support also affects other psychological processes to boost interest and identification, such as reducing social identity threat among minoritized individuals.

Another worthwhile future direction is to understand bidirectional relationships or recursive processes. For instance, when students feel strong belonging in a field, they might elicit, or seek out, more role-specific support from faculty. The current data are limited in this respect. Our experimental studies focus on only single observations of faculty behavior. Our prospective research (Study 4) included perceptions on the basis of

multiple observations, but we only collected data about role-specific support at one point in time and did not measure or manipulate faculty behavior. Future research should test these processes longitudinally and examine how students' construals of role-specific support may change over time with repeated observations of faculty behavior.

STEM faculty aiming to foster student belonging, interest, and identification should carefully consider how behaviors communicate important pieces of information about what students will experience in STEM roles. Faculty hold power and thus manifest, shape, and express the values of a discipline. Our research suggests faculty can signal supportive contexts by promoting visible aspects of communality to their students (e.g., talking about collaborative relationships or discussing benefits of research for society). Yet, it is important to note that a number of communal behaviors may not be valued or encouraged within academic cultures—incentives for faculty often discourage communal behavior, and faculty may incur costs for exhibiting such behaviors. For example, a focus on establishing independence for tenure decisions might mean early-career faculty do not foster collaborations with more established colleagues. At the structural level, departments could combat the lack of institutional value accorded to communality in STEM by noting that communal behaviors, relative to independent, confer advantages for student belonging and involvement.

In conclusion, our findings provide quantitative support to May-Britt Moser's sentiment that faculty make "a difference" through their behaviors. Faculty–student relationships hold the potential to not only change students' beliefs about the culture of STEM fields but also inform students' expectations of whether they will be supported by faculty, subsequently enhancing belonging and involvement in STEM.

Authors' Note

Any opinions, findings, and conclusions or recommendations expressed in this article are those of the authors and do not necessarily reflect the views of the National Science Foundation.




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Supplemental Material

The supplemental material is available in the online version of the article.

Notes

1. We focus on independence as a subfactor of agency (Folberg et al., 2020), defining independent behavior as less other-focused and more self-directed than communal behavior.
2. Due to the small sample size of nonbinary and third genders, we treated gender dichotomously, excluding 12 participants from these analyses.
3. The indirect effect through Time 2 belonging was no longer significant when controlling for Time 1 belonging. There are a few possibilities for this finding, which are discussed further in Supplemental Materials.

References

- Allen, J., Smith, J. L., Thoman, D. B., & Walters, R. W. (2018). Fluctuating team science: Perceiving science as collaborative improves science motivation. *Motivation Science, 4*(4), 347–361. <https://doi.org/10.1037/mot0000099>
- Bakan, D. (1966). *The duality of human existence*. Rand McNally.
- Belanger, A. L., Joshi, M. P., Fuesting, M. A., Weisgram, E. S., Claypool, H. M., & Diekmann, A. B. (2020). Putting belonging in context: Communal affordances signal belonging in STEM. *Personality and Social Psychology Bulletin*. Advance online publication. <https://doi.org/10.1177/0146167219897181>
- Burke, A. (2019). *Science and engineering labor force*. National Center for Science and Engineering Statistics. <https://nces.nsf.gov/pubs/nsb20198/introduction>
- Calarco, J. M. (2020). *A field guide to grad school: Uncovering the hidden curriculum*. Princeton University Press.
- Canning, E. A., Muenks, K., Green, D. J., & Murphy, M. C. (2019). STEM faculty who believe ability is fixed have larger racial achievement gaps and inspire less student motivation in their classes. *Science Advances, 5*(2), eaau4734. <https://doi.org/10.1126/sciadv.aau4734>
- Cheryan, S., Siy, J. O., Vichayapai, M., Drury, B. J., & Kim, S. (2011). Do female and male role models who embody STEM stereotypes hinder women's anticipated success in STEM? *Social Psychological and Personality Science, 2*(6), 656–664. <https://doi.org/10.1177/1948550611405218>
- Clark, E. K., Fuesting, M. A., & Diekmann, A. B. (2016). Enhancing interest in science: Exemplars as cues to communal affordances of science. *Journal of Applied Social Psychology, 46*(11), 641–654. <https://doi.org/10.1111/jasp.12392>
- Clark, S. L., Dyar, C., Maung, N., & London, B. (2016). Psychosocial pathways to STEM engagement among graduate students in the life sciences. *CBE—Life Sciences Education, 15*(3), Article 45. <https://doi.org/10.1187/cbe.16-01-0036>
- Cohen, G. L., & Garcia, J. (2008). Identity, belonging, and achievement: A model, interventions, implications. *Current Directions*

- in *Psychological Science*, 17(6), 365–369. <https://doi.org/10.1111%2Fj.1467-8721.2008.00607.x>
- Crisp, G., & Cruz, I. (2009). Mentoring college students: A critical review of the literature between 1990 and 2007. *Research in Higher Education*, 50(6), 525–545. <https://doi.org/10.1007/s11162-009-9130-2>
- Dasgupta, N., Scircle, M. M., & Hunsinger, M. (2015). Female peers in small work groups enhance women's motivation, verbal participation, and career aspirations in engineering. *Proceedings of the National Academy of Sciences*, 112(16), 4988–4993. <https://doi.org/10.1073/pnas.1422822112>
- Diekmann, A. B., Brown, E. R., Johnston, A. M., & Clark, E. K. (2010). Seeking congruity between goals and roles: A new look at why women opt out of science, technology, engineering, and mathematics careers. *Psychological Science*, 21(8), 1051–1057. <https://doi.org/10.1177/0956797610377342>
- Diekmann, A. B., Steinberg, M., Brown, E. R., Belanger, A. L., & Clark, E. K. (2017). A goal congruity model of role entry, engagement, and exit: Understanding communal goal processes in STEM gender gaps. *Personality and Social Psychology Review*, 21(2), 142–175. <https://doi.org/10.1177/1088868316642141>
- Eagly, A. H., Nater, C., Miller, D. I., Kaufmann, M., & Sczesny, S. (2020). Gender stereotypes have changed: A cross-temporal meta-analysis of U.S. public opinion polls from 1946 to 2018. *American Psychologist*, 75(3), 301–315. <https://doi.org/10.1037/amp0000494>
- Folberg, A. M., Kercher, K., & Ryan, C. S. (2020). The hidden role of dominance in career interests: A bifactor analysis of agentic and communal goal orientations. *Sex Roles*, 83, 193–210. <https://doi.org/10.1007/s11199-019-01104-1>
- Fuesting, M. A., & Diekmann, A. B. (2017). Not by success alone: Role models provide pathways to communal opportunities in STEM. *Personality and Social Psychology Bulletin*, 43(2), 163–176. <https://doi.org/10.1177/0146167216678857>
- Good, C., Rattan, A., & Dweck, C. S. (2012). Why do women opt out? Sense of belonging and women's representation in mathematics. *Journal of Personality and Social Psychology*, 102(4), 700–717. <https://doi.org/10.1037/a0026659>
- Haber, M. G., Cohen, J. L., Lucas, T., & Baltes, B. B. (2007). The relationship between self-reported received and perceived social support: A meta-analytic review. *American Journal of Community Psychology*, 39(1–2), 133–144. <https://doi.org/10.1007/s10464-007-9100-9>
- Hall, W., Schmader, T., Aday, A., & Croft, E. (2019). Decoding the dynamics of social identity threat in the workplace: A within-person analysis of women's and men's interactions in STEM. *Social Psychological and Personality Science*, 10(4), 542–552. <https://doi.org/10.1177/1948550618772582>
- Hayes, A. F. (2018). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach* (2nd ed.). Guilford Publications.
- Herrmann, S. D., Adelman, R. M., Bodford, J. E., Graudejus, O., Okun, M. A., & Kwan, V. S. (2016). The effects of a female role model on academic performance and persistence of women in STEM courses. *Basic and Applied Social Psychology*, 38(5), 258–268. <https://doi.org/10.1080/01973533.2016.1209757>
- Holt-Lunstad, J., Smith, T. B., & Layton, J. B. (2010). Social relationships and mortality risk: A meta-analytic review. *PLoS Medicine*, 7(7), e1000316. <https://doi.org/10.1371/journal.pmed.1000316>
- Kasof, J. (1993). Sex bias in the naming of stimulus persons. *Psychological Bulletin*, 113(1), 140–163. <https://doi.org/10.1037/0033-2909.113.1.140>
- London, B., Rosenthal, L., Levy, S. R., & Lobel, M. (2011). The influences of perceived identity compatibility and social support on women in nontraditional fields during the college transition. *Basic and Applied Social Psychology*, 33, 304–321. <https://doi.org/10.1080/01973533.2011.614166>
- Margolis, E. (2002). *The hidden curriculum in higher education*. Routledge.
- Master, A., Cheryan, S., & Meltzoff, A. N. (2017). Social group membership increases STEM engagement among preschoolers. *Developmental Psychology*, 53(2), 201–209. <https://doi.org/10.1037/dev0000195>
- Morgan, C., Isaac, J. D., & Sansone, C. (2001). The role of interest in understanding the career choices of female and male college students. *Sex Roles*, 44(5/6), 295–320. <https://doi.org/10.1023/A:1010929600004>
- Murphy, M. C., Steele, C. M., & Gross, J. J. (2007). Signaling threat: How situational cues affect women in math, science, and engineering settings. *Psychological Science*, 18(10), 879–885. <https://doi.org/10.1111/j.1467-9280.2007.01995.x>
- National Academies of Sciences, Engineering, and Medicine. (2017). *Effective mentoring in STEM: Practice, research, and future directions: Proceedings of a workshop—in brief*. The National Academies Press. <https://doi.org/10.17226/24815>
- National Science Foundation Center for Science and Engineering Statistics. (2019). *Women, minorities, and persons with disabilities in science and engineering*. <https://nces.nsf.gov/pubs/nsf19304/digest>
- Paglis, L. L., Green, S. G., & Bauer, T. N. (2006). Does advisor mentoring add value? A longitudinal study of mentoring and doctoral student outcomes. *Research in Higher Education*, 47(4), 451–476. <https://doi.org/10.1007/s11162-005-9003-2>
- Perez, T., Cromley, J. G., & Kaplan, A. (2014). The role of identity development, values, and costs in college STEM retention. *Journal of Educational Psychology*, 106(1), 315. <https://doi.org/10.1037/a0034027>
- Purdie-Vaughns, V., Steele, C. M., Davies, P. G., Dittmann, R., & Crosby, J. R. (2008). Social identity contingencies: How diversity cues signal threat or safety for African Americans in mainstream institutions. *Journal of Personality and Social Psychology*, 94(4), 615–630. <https://doi.org/10.1037/0022-3514.94.4.615>
- Rigg, J., Day, J., & Adler, H. (2013). Emotional exhaustion in graduate students: The role of engagement, self-efficacy and social support. *Journal of Educational and Developmental Psychology*, 3(2), 138. <https://doi.org/10.5539/jedp.v3n2p138>
- Robnett, R. D., Nelson, P. A., Zurbriggen, E. L., Crosby, F. J., & Chemers, M. M. (2018). Research mentoring and scientist identity: Insights from undergraduates and their mentors. *International*

- Journal of STEM Education*, 5(1), 41. <https://doi.org/10.1186/s40594-018-0139-y>
- Schwarzer, R., & Jerusalem, M. (1995). Generalized Self-Efficacy scale. In J. Weinman, S. Wright, & M. Johnston (Eds.), *Measures in health psychology: A user's portfolio. Causal and control beliefs* (pp. 35–37). Windsor, UK: NFER-NELSON.
- Shin, J. E. L., Levy, S. R., & London, B. (2016). Effects of role model exposure on STEM and non-STEM student engagement. *Journal of Applied Social Psychology*, 46(7), 410–427. <https://doi.org/10.1111/jasp.12371>
- Steinberg, M., & Diekmann, A. B. (2018). Considering “why” to engage in STEM activities elevates communal content of STEM affordances. *Journal of Experimental Social Psychology*, 75, 107–114. <https://doi.org/10.1016/j.jesp.2017.10.010>
- Stout, J. G., Dasgupta, N., Hunsinger, M., & McManus, M. A. (2011). STEMing the tide: Using ingroup experts to inoculate women's self-concept in science, technology, engineering, and mathematics (STEM). *Journal of Personality and Social Psychology*, 100(2), 255–270. <https://doi.org/10.1037/a0021385>
- Syed, M., Zurbriggen, E. L., Chemers, M. M., Goza, B. K., Bearman, S., Crosby, F. J., Shaw, J. M., Hunter, L., & Morgan, E. M. (2019). The role of self-efficacy and identity in mediating the effects of STEM support experiences. *Analyses of Social Issues and Public Policy*, 19(1), 7–49. <https://doi.org/10.1111/asap.12170>
- Tenenbaum, H. R., Crosby, F. J., & Gliner, M. D. (2001). Mentoring relationships in graduate school. *Journal of Vocational Behavior*, 59(3), 326–341. <https://doi.org/10.1006/jvbe.2001.1804>
- Thoman, D. B., Arizaga, J. A., Smith, J. L., Story, T. S., & Soncuya, G. (2014). The grass is greener in non-science, technology, engineering, and math classes: Examining the role of competing belonging to undergraduate women's vulnerability to being pulled away from science. *Psychology of Women Quarterly*, 38(2), 246–258. <https://doi.org/10.1177/0361684313499899>
- Walton, G. M., & Brady, S. T. (2017). The many questions of belonging. In A. J. Elliot, C. S. Dweck, & D. S. Yeager (Eds.), *Handbook of competence and motivation, second edition: Theory and application* (2nd ed., pp. 272–293). Guilford Publications.
- Zimet, G. D., Dahlem, N. W., Zimet, S. G., & Farley, G. K. (1988). The multidimensional scale of perceived social support. *Journal of Personality Assessment*, 52(1), 30–41. https://doi.org/10.1207/s15327752jpa5201_2

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