

# Exploring Identity-Safety Cues and Allyship Among Black Women Students in STEM Environments

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## Abstract

Black women are underrepresented in science, technology, engineering, and math (STEM) and report feeling unwelcome in STEM. A successful scientist exemplar or role model may signal to Black women they are valued in STEM environments. We investigated who acts as an identity-safety cue for Black women. In Study 1, Black women students who learned about a Black man or a Black woman professor in a hypothetical School of Science and Engineering reported greater anticipated belonging and trust, relative to those learning about a White man or a White woman professor. In Study 2, we recruited Black women STEM majors from a predominantly White institution and a women-only historically Black college. We examined how both groups identified role models in STEM and assessed how perceptions that role models were allies related to belonging in the institution and belonging in STEM. Across both educational environments, having Black women and Black men role models, and perceiving role models who lacked a common racial identity as allies, positively related to belonging in the institution. We encourage the use of Black exemplars and role models, as well as allies, in interventions geared toward increasing belonging among Black women in STEM. *Additional online materials for this article are available on PWQ's website at <http://journals.sagepub.com/doi/suppl/10.1177/0361684319830926> and a podcast for instructors who want to use this article for teaching is available on PWQ's website at <http://journals.sagepub.com/page/pwq/suppl/index>*

## Keywords

intersectionality, STEM and gender, Black women, social identity threat

Black women are among the least represented groups in science, technology, engineering, and mathematics (STEM; National Science Foundation [NSF], National Center for Science and Engineering Statistics, 2017). Black women college students report interest in pursuing majors in STEM equivalent to their White women counterparts but describe unique difficulties in STEM environments tied to both their racial and gender identities (Bonous-Hammarth, 2000; Ong, Wright, Espinosa, & Orfield, 2011; Smyth & McArdle, 2004; Staniec, 2004). For example, Black undergraduates face social isolation and feelings of alienation in STEM classes and report having to work harder to convince peers and professors that they can handle the rigor of STEM courses (Charleston, George, Jackson, Berhanu, & Amechi, 2014; Palmer, Maramba, & Dancy, 2011). Such challenges may cause Black women to question their belonging in STEM settings and ultimately to avoid STEM altogether (Lewis et al., 2017; Murphy, Steele, & Gross, 2007).

Our goals in the present research were 2-fold. First, we examined who serves as an effective *identity-safety cue* (i.e., a signal suggesting one's identity is valued; Avery, Hernandez, & Hebl, 2004; Davies, Spencer, & Steele, 2005; Walton,

Murphy, & Ryan, 2015) in STEM environments among a sample of Black women students. Recently, researchers have found that only scientists sharing a racial identity with Black women encourage Black women to anticipate feelings of belonging and trust in STEM environments (Pietri, Johnson, & Ozgumus, 2018). However, Pietri and colleagues recruited Black women from the general population, and participants' *anticipated belonging and trust* (i.e., perceptions one will feel welcome and be treated fairly in a particular environment) was only examined in a hypothetical

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STEM environment, limiting the generalizability of these findings. In two studies, we investigated whether exposure to a successful *exemplar* (i.e., a counterstereotypical example; Stout, Dasgupta, Hunsinger, & McManus, 2011; Study 1) or a *role model* (i.e., someone who a person feels similar to and would like to be like; Gibson, 2004; Study 2) who shares a racial and/or gender identity with Black women acts as an effective identity-safety cue in a sample of Black women students.

Because previous work suggested only exemplars and role models who share a racial identity with Black women will act as identity-safety cues among Black women students, our second goal was to explore how perceiving an individual, who lacks a shared racial identity as an ally, relates to belonging among Black women. Academic environments can differ in the extent to which available role models promote feelings of belonging among members of groups underrepresented in STEM (Perna et al., 2009; Ramsey, Betz, Sekaquaptewa, 2013; Rayman & Brett, 1995). However, little work has examined how perceiving a role model as an ally affects belonging among Black women students. To address this gap in the research, we recruited Black women STEM majors from two different academic environments and examined how students' identified role models and perceptions of role model *allyship* (i.e., extent to which an advantaged group member's actions suggest they value helping Black women succeed; Ashburn-Nardo, 2018; Brown & Ostrove, 2013; Ostrove & Brown, 2018) were related to belonging in STEM.

### Identity-Safety Cues to Assuage Social Identity Threat

Black women may avoid STEM classes and careers due to concerns of *social identity threat* or the fear that they will be devalued in STEM environments because of their membership in a negatively stereotyped group (Steele, Spencer, & Aronson, 2002). Negative stereotypes stemming from Black women's race and gender (G. L. Cohen & Garcia, 2005; Moss-Racusin, Dovidio, Brescoll, Graham, & Handelsman, 2012) may heighten social identity threat concerns, and this apprehension can ultimately lead to a variety of deleterious consequences (Murphy & Taylor, 2012). For example, social identity threat is associated with decreased anticipated belonging and trust (Murphy et al., 2007; Purdie-Vaughns, Steele, Davies, Diltmann, & Crosby, 2008), suggesting that increasing or promoting Black women's anticipated belonging and trust is one way to assuage social identity threat concerns.

Introducing an identity-safety cue (Avery et al., 2004; Davies et al., 2005; Walton et al., 2015) can help mitigate social identity threat concerns. Identity-safety cues occur in a variety of formats, and the efficacy of such cues has been widely studied in both workplace (Avery et al., 2004; Emerson & Murphy, 2014) and educational settings (Dasgupta, 2011; Lockwood, 2006). For example, researchers have found that featuring organizational messages endorsing

diversity and inclusivity in workplace settings (Purdie-Vaughns et al., 2008; Stevens, Plaut, & Sanchez-Burks, 2008) can effectively undermine social identity threat concerns among members of underrepresented groups. Likewise, including racial and ethnic minorities in recruitment materials (Avery et al., 2004; Pietri et al., 2018) has also been found to serve as efficacious identity-safety cues for members of negatively stereotyped groups.

Several researchers have highlighted the value of exposing women to a successful exemplar or role model, such as a relatable scientist, who may act as an identity-safety cue and assuage social identity threat concerns (see Dasgupta, 2011; Morgenroth, Ryan, & Peters, 2015 for a review). Dasgupta's (2011) stereotype inoculation model suggests that successful women exemplars and role models "inoculate" women against negative stereotypes about their gender group. In support of this model, past work has found long-term personal contact with successful and relatable ingroup experts increased belonging in fields where women have traditionally been underrepresented (Asgari, Dasgupta, & Cote, 2010; Dasgupta & Hunsinger, 2015). Likewise, even limited exposure to a counterstereotypical exemplar (i.e., a successful woman scientist) can help ease social identity threat concerns (Stout et al., 2011). Thus, one tool to encourage belonging in STEM environments among Black women may be via exposure to successful scientist exemplars and role models.

Psychological research examining who serves as an effective identity-safety cue among Black women, however, is lacking. Past work testing the efficacy of identity-safety cues has focused on women or Black individuals generally and has failed to adopt an intersectional approach (see Mohr & Purdie-Vaughns, 2015; Remedios & Snyder, 2015, for discussions). Identifying effective identity-safety cues for Black women is challenging because it is unclear, based on previous research, whether Black women will identify with a successful scientist who shares only their gender or only their racial identity. Previous research exploring the benefits of exposing women to identity-safety cues has found individuals must feel similar to the exemplar or role model in order for the individual to function as an effective identity-safety cue and assuage social identity threat concerns. For example, when women learn of a successful woman leader, but she is portrayed as unique and the exception to the rule, women's identification with leadership can inadvertently decrease (Asgari, Dasgupta, & Stout, 2012). Furthermore, when women students interacted with a woman computer scientist, who was perceived as nerdy and socially awkward and fitting the "scientist stereotype," students did not feel similar to the scientist and, in turn, reported lower career aspirations in computer science (Cheryan, Drury, & Vichayapai, 2013; Cheryan, Siy, Vichayapai, Drury, & Kim, 2011). In the current studies, we examined exemplars and role models with whom Black women perceived as similar to identify efficacious identity-safety cues for Black women in STEM environments.

## Intersectional Identity and Identity-Safety Cues for Black Women

Several perspectives in the intersectional literature highlight how effective identity-safety cues may function for Black women. First, from the ethnic-prominence perspective, Levin, Sinclair, Veniegas, and Taylor (2002) adopt a *primary identity* viewpoint. They suggest that for Black women, racial and ethnic identity are most likely to be prioritized over other identities. From the primary identity perspective, both race and ethnicity have an historic and contemporary basis for discrimination in the United States and consequently are a salient source of stigma. Several investigators have found Black women are more likely to anticipate and attribute experiences of discrimination to their ethnicity than to their gender (King, 2003; Pietri et al., 2018; Remedios, Chasteen, & Pack, 2012). Likewise, the more individuals believe their ingroup experiences discrimination, the more likely they are to identify with members of their ingroup (Branscombe, Schmitt, & Harvey, 1999; Schmitt, Branscombe, Kobrynowicz, & Owen, 2002). Because Black women are more sensitive to racial than gender discrimination, they may be more likely to identify with successful exemplars and role models who are part of their race ingroup than those who are part of their gender ingroup.

Some intersectional approaches argue that focusing on one, primary identity paints too simplistic a picture, and instead adopt a *compound identity* approach and highlight the multifaceted challenges Black women face because of their dual, stigmatized identities (Beale, 1970; Klonoff, Landrine, & Scott, 1995; Ong et al., 2011; Thomas, Witherspoon, & Speight, 2008). Researchers have found that Black women face *double jeopardy discrimination* (Berdahl & Moore, 2006) and are punished more harshly for failures than White women or Black men (Rosette & Livingston, 2012). Black women also experience discrimination in the form of invisibility or going unnoticed because they do not represent the prototypical Black person (a Black man) or woman (a White woman; Mohr & Purdie-Vaughns, 2015; Purdie-Vaughns & Eibach, 2008; Sesko & Biernat, 2010). Using qualitative data, scholars find that Black women, particularly in environments where they are underrepresented, such as STEM, are aware of their unique struggles. Black women report facing discrimination in the form of double jeopardy (e.g., having to work twice as hard as White women and Black men counterparts to be perceived as legitimate) and invisibility (e.g., ideas being attributed to another colleague during a meeting; Charleston et al., 2014; Palmer et al., 2011; Settles, 2006; Williams, Phillips, & Hall, 2014). Intersectional approaches that focus on both Black women's racial and gender identity suggest an effective identity-safety cue for Black women must signal that both their race and gender are valued. However, researchers using a primary identity approach claim, at a minimum, a cue for Black women must signal race is valued. From both a primary identity and compound identity

approach, a role model who lacks a shared racial identity will do little to assuage social identity threat concerns.

In a recent experiment, Pietri, Johnson, and Ozgumus (2018) adopted an intersectional lens to examine how to best signal identity-safety for Black women. Black women participants viewed a company website for a fictitious STEM company. The website provided either no profile or the profile of a successful scientist employee who shared an identity with participants—a White woman, Black woman, or Black man. Participants then reported their anticipated belonging and trust at the company, perceived similarity or identification with the featured scientist, and their level of *stigma consciousness* (i.e., sensitivity to the possibility of experiencing discrimination because of their gender and racial identity; Pinel, 1999). Supporting a primary identity perspective, relative to viewing no scientist or a White woman scientist, participants reported the greatest anticipated belonging and trust and greatest identification with the scientist, after viewing the profile of a Black woman or a Black man scientist. However, consistent with the compound identity perspective, participants high in stigma consciousness anticipated less belonging and trust at the company unless they viewed the Black woman profile. This research suggests that only those sharing a racial identity with Black women may serve as effective identity-safety cues, and among Black women high in stigma consciousness, only exposure to an exemplar sharing both their racial and gender identity (i.e., a Black woman scientist) assuages social identity threat concerns.

## Educational Environments and Allyship That Encourage Belonging Among Black Women

Perceiving an individual as an ally may also serve as an important tool to combat social identity threat. Academic institutions can potentially play a key role in producing educational environments that encourage perceptions of allyship (Perna, Gasman, Gary, Lundy-Wagner, & Drezner, 2010; Perna et al., 2009). Nonetheless, past work has primarily focused on how different environments affect belonging and academic degree attainment; researchers have overlooked the role of allyship. For instance, women-only colleges can encourage the attainment of STEM degrees among women undergraduates (Rayman & Brett, 1995) and promote greater feelings of belonging relative to a traditional STEM environment (Ramsey et al., 2013). Such institutions not only generate an educational climate where women's success in STEM is normalized but also provide access to many successful role models and exemplars for women pursuing STEM degrees (Perna et al., 2009; Shmurak & Handler, 1992). Research also has documented the positive outcomes associated with attending a historically Black college or university (HBCU); scholars have found HBCU environments to be conducive to Black students' success in STEM fields

(Malcom, 1996; Owens, Shelton, Bloom, & Cavil, 2012; Perna et al., 2009, 2010). Of the top 20 leading producers of bachelor's degrees for Black-identified students in STEM fields, all but three are HBCUs (Borden & Brown, 2004). One of the top producers of STEM undergraduate degrees for Black women is a women-only HBCU (Perna et al., 2009), and STEM majors at the institution often report having access to many faculty whom they perceive as vested in their success (Perna et al., 2009). Such academic environments provide access to successful exemplars and role models who serve as effective identity-safety cues; they may also combat Black women's social identity threat by encouraging perceptions that all faculties—even those who lack a shared racial identity with Black women—are allies and value their success in STEM.

## Current Research

Building upon previous research (Pietri et al., 2018), we examined who serves as an effective identity-safety cue among Black women students and Black women currently enrolled in STEM majors. In Study 1, we examined whether featuring a Black woman, Black man, White woman, or White man professor (i.e., successful scientist exemplar) would encourage Black women students to anticipate feeling belonging and trust in a hypothetical School of Science and Engineering. Participants also reported their perceived similarity with the featured professor, and we measured individual differences in stigma consciousness.

In Study 2, we examined the benefits of exposure to role models in STEM who shared Black women students' racial and/or gender identity in an actual (not hypothetical) STEM environment. In particular, we looked at how access to Black role models in STEM and STEM majors' perceived similarity with Black role models related to belonging in the institution and belonging in STEM. We examined how stigma consciousness related to belonging in the institution and belonging in STEM among majors as well. In Study 2, we also explored the relation between perceiving role models who lack a shared racial identity as allies (i.e., perceived allyship) and belonging in the institution and belonging in STEM. We recruited Black women STEM majors from two different educational environments: a predominantly White institution (PWI) and from a women-only historically Black college (HBC).

In Study 1, we hypothesized that participants would perceive greater similarity with the Black professors, and higher similarity would be related to greater anticipated trust and belonging (Hypothesis 1a). In Study 2, we predicted a shared racial identity would facilitate Black women STEM majors perceiving greater similarity with Black (vs. non-Black) role models (Hypothesis 1b); however, consistent with previous work (Cheryan et al., 2011, 2013; Dasgupta, 2011), we also expected that perceived similarity with role models (both Black and non-Black) would positively correlate with belonging in STEM (Hypothesis 1c).

In Study 1, we also hypothesized that exposure to a Black woman or Black man professor (i.e., Black scientist

exemplar) would encourage greater anticipated belonging and trust among Black women participants (Hypothesis 2a). In Study 2, we predicted that having Black women or Black men role models in STEM would significantly relate to belonging across both educational environments (Hypothesis 2b). However, consistent with previous research (Perna et al., 2009, 2010), we also predicted that STEM majors at the HBC would report greater belonging in the institution and in STEM (Hypothesis 2c), and identify a greater number of Black men and Black women role models (Hypothesis 2d), relative to their STEM counterparts at the PWI.

In Study 1, we also hypothesized that only exposure to a Black woman scientist exemplar would encourage anticipated belonging and trust among Black women high in stigma consciousness (Hypothesis 3a). In Study 2, because the women-only HBC is an environment that provides access to a great number of Black women role models, we predicted that belonging in STEM would not significantly relate to stigma consciousness. However, among PWI STEM majors, stigma consciousness would be negatively related to belonging in STEM (Hypothesis 3b).

Unique to Study 2, we also examined how perceived allyship of identified role models related to belonging in the institution and belonging in STEM among STEM majors. We predicted that the women-only HBC, an institution serving predominantly Black and women students, would result in greater perceived allyship of role models relative to perceptions at the PWI (Hypothesis 4a). However, we also predicted that perceptions of allyship for role models lacking a shared racial identity would have important implications for social identity threat concerns and would positively relate to belonging in STEM across both institutions (Hypothesis 4b).

## Study 1

In Study 1, we examined which successful scientist exemplar—a Black woman, Black man, White woman, or White man professor—would function as an effective identity-safety cue and increase Black women students' anticipated belonging and trust in a hypothetical School of Science and Engineering. We also investigated participants' perceived similarity with the featured professor. Consistent with previous research (Pietri et al., 2018), we explored whether participants' perceived similarity was an important mechanism for increased anticipated belonging and trust. Finally, we measured individual differences in stigma consciousness in relation to gender and race (i.e., being a Black woman) to examine whether stigma consciousness moderated each professor profile condition.

## Method

### Participants

We recruited 366 Black women currently enrolled in school to take part in this experiment via TurkPrime.com, a

**Table 1.** The Means and Standard Deviations Across Professor Profile Condition in Study 1.

Study 1				
Measures	White Man ( <i>n</i> = 89) <i>M</i> ( <i>SD</i> )	White Woman ( <i>n</i> = 84) <i>M</i> ( <i>SD</i> )	Black Man ( <i>n</i> = 89) <i>M</i> ( <i>SD</i> )	Black Woman ( <i>n</i> = 89) <i>M</i> ( <i>SD</i> )
Perceived similarity	3.12 (0.70)	3.20 (0.83)	3.64 (0.66)	3.64 (0.78)
Anticipated belonging and trust	3.25 (0.67)	3.27 (0.79)	3.53 (0.74)	3.56 (0.70)
Anticipated belonging and trust (z-scores)	-0.20 (0.85)	-0.18 (1.00)	0.15 (0.94)	0.18 (0.90)

crowdsourcing platform that recruits and administers online studies to specific populations (see Litman, Robinson, & Abberbock, 2017). Six (1.6%) participants were excluded for indicating they did not identify as a Black woman. Seven (1.9%) participants were excluded for answering “NO” when asked were they a student in school, and two (0.5%) participants were excluded due to missing data. These 15 participants did not vary consistently across condition,  $\chi^2(3, N = 366) = 2.23, p = .525$ . Of the remaining participants, an analysis of missing data showed that 100.0% of remaining participants had no missing data. This left a final sample of 351 Black women student participants whose ages were  $M = 22.31, SD = 6.28, \text{range} = 18\text{--}53$ . Participants had the following additional characteristics: 43 (12.3%) were enrolled in high school or high school equivalent degree program, 97 (27.6%) were enrolled in a 2-year/associate’s degree granting institution, 166 (47.3%) were enrolled at a 4-year/bachelor’s degree granting institution, 27 (7.7%) in a master’s degree program, 3 (0.9%) in a doctorate program, 7 (2.0%) in a professional degree program, and 8 (2.3%) participants were enrolled in a program not classified above. In addition, 321 (91.5%) participants answered “yes” when asked if they were currently enrolled in college, and of these 321 participants, 122 (34.8%) answered “yes” when asked were they majoring in a STEM field. Among participants enrolled in college, information about the type of institution where participants were enrolled (e.g., HBCU, PWI) was not collected. The current study was a replication of Experiment 1 from Pietri et al. (2018) with Black women students, which had an effect size of  $\eta_p^2 = .031$ . Using this effect size and the G\*Power software (Faul, Erdfelder, Lang, & Buchner, 2007), we estimated we would need approximately 345 participants to have 80% power to find an effect at  $p < .05$  (see Table 1 for the exact number of participants per condition).

### Procedure

The experiment was advertised through Turk Prime’s website as a study examining impressions of colleges and people. After consenting to participate in the study via the informed consent form, we presented participants first with a picture of a website for a fictional School of Science and Engineering, and participants were asked to imagine that they were a student in the school. The picture presented information about the School of Science and Engineering, detailing majors

commonly found in STEM (e.g., mathematics, computing sciences, and physics) and noted that the university’s School of Science and Engineering was ranked number 1 in the world for undergraduate research STEM outcomes according to U.S. News and World Report. Immediately after viewing the School of Science and Engineering’s homepage, participants were randomly assigned to read identical profiles of one of the four professors employed in the School of Science and Engineering: a Black woman, Black man, White woman, or White man. These profiles were modified from previous research (see Pietri et al., 2018) and described a successful scientist who was “a professor in the School of Science and Engineering, and chair of the department of Biological Sciences.” The profile began by discussing how the scientist became interested in science (“was a curious child who loved science, animals, and nature . . .”) and continued with a description of the scientist’s research (“ . . . is excited to be developing novel biomarkers and therapies for severely debilitating neurodegenerative disease”). The profiles were identical except the Black and White woman professor was named “Melissa Evans,” while the Black and White man professor was named “Michael Evans.” The picture associated with the profile also differed across conditions and either depicted a Black woman, Black man, White woman, or White man. Each photo featured the professor in professional dress and smiling, and the featured photos were akin to photos commonly used in faculty profiles and biographies. These pictures were pilot tested in a separate study to ensure they appeared equally competent, attractive, and similar in age (see Supplemental Materials at <http://journals.sagepub.com/doi/suppl/10.1177/0361684319830926> for a description of the pilot study; we encourage readers to contact the first/corresponding author of this article to receive any materials or data presented in this article). Our experiment had a four-profile condition design (Black woman vs. Black man vs. White woman vs. White man).

After reading their randomly assigned professor profile, participants first rated their agreement (1 = *strongly disagree* to 5 = *strongly agree*) with statements assessing how similar they felt to the featured professor to assess perceived similarity (e.g., “This person seems similar to me”; 4 items taken from Pietri et al., 2018;  $M = 3.40, SD = 0.78, \alpha = .88$ ). Participants next rated their level of agreement (1 = *strongly disagree* to 5 = *strongly agree*) with eight statements assessing their anticipated belonging in the School of Science and

Engineering (e.g., “I would belong in the School of Science and Engineering”; taken from Good, Rattan, & Dweck, 2012; Walton & Cohen, 2007) and 4 items (1 = *strongly disagree* to 5 = *strongly agree*) assessing their anticipated trust in the School of Science and Engineering (e.g., “I think I would be treated fairly by students and professors in the School of Science and Engineering”; adapted from Purdie-Vaughns et al., 2008; see Supplemental Materials for all 12 items at <http://journals.sagepub.com/doi/suppl/10.1177/0361684319830926>).

Consistent with previous research (Pietri et al., 2018), we next averaged the 8 items measuring anticipated belonging ( $M = 3.31$ ,  $SD = 0.71$ ,  $\alpha = .84$ ) and the 4 items measuring anticipated trust ( $M = 3.50$ ,  $SD = 0.87$ ,  $\alpha = .86$ ) for each participant. We calculated the z-scores for each and averaged these two scores to create a composite measure indexing anticipated belonging and trust ( $\alpha = .90$ ), similar to the primary outcome measure used in previous research (Pietri et al., 2018; see also Supplemental Materials at <http://journals.sagepub.com/doi/suppl/10.1177/0361684319830926> for a factor analysis of the 12 items demonstrating they load on a single factor). We utilized this measure as our outcome variable in all subsequent analyses in Study 1.

Participants next completed a 9-item measure assessing their level of stigma consciousness (items taken from Pinel, 1999) related to being a Black woman. Pietri and colleagues (2018; Experiment 1) compared differences in race stigma consciousness, gender stigma consciousness, and gender-race stigma consciousness among their sample of Black women; they found participants were significantly higher in race stigma consciousness and gender-race stigma consciousness than gender stigma consciousness. The authors also found that race stigma consciousness, gender stigma consciousness, and gender-race stigma consciousness each produced a similar pattern of results in relation to who serves as an effective identity-safety cue for Black women (Pietri et al., 2018; Experiment 1). Demonstrating the validity of this measure among Black women, gender-race stigma consciousness also negatively related to anticipated belonging and trust in a STEM environment (Pietri et al., 2018; Experiment 2). Consequently, in the present investigation, we chose to only assess stigma consciousness in relation to being a Black woman (i.e., gender-race stigma consciousness). Participants rated their level of agreement (1 = *strongly disagree* to 5 = *strongly agree*) with items examining how much their race and gender influenced their interactions with other people (e.g., “When interacting with people, I feel like they interpret all of my behaviors in terms of my gender and race”; for the current participants,  $M = 3.35$ ,  $SD = 0.64$ ;  $\alpha = .71$ ; see Supplemental materials at <http://journals.sagepub.com/doi/suppl/10.1177/0361684319830926> for complete items). Although the measure of stigma consciousness was administered after the manipulation of professor profile, stigma consciousness did not significantly differ by profile condition,  $F(3, 347) = 0.42$ ,  $p = .74$ ,  $\eta_p^2 = .004$ . Finally, participants completed demographic measures, were thanked for their participation, and debriefed.

**Table 2.** Correlation Matrix for Study 1.

Measures	1	2	3
1. Perceived similarity	—	—	—
2. Anticipated belonging and trust (z-scores)	.54*	—	—
3. Stigma consciousness	-.20*	.26*	—

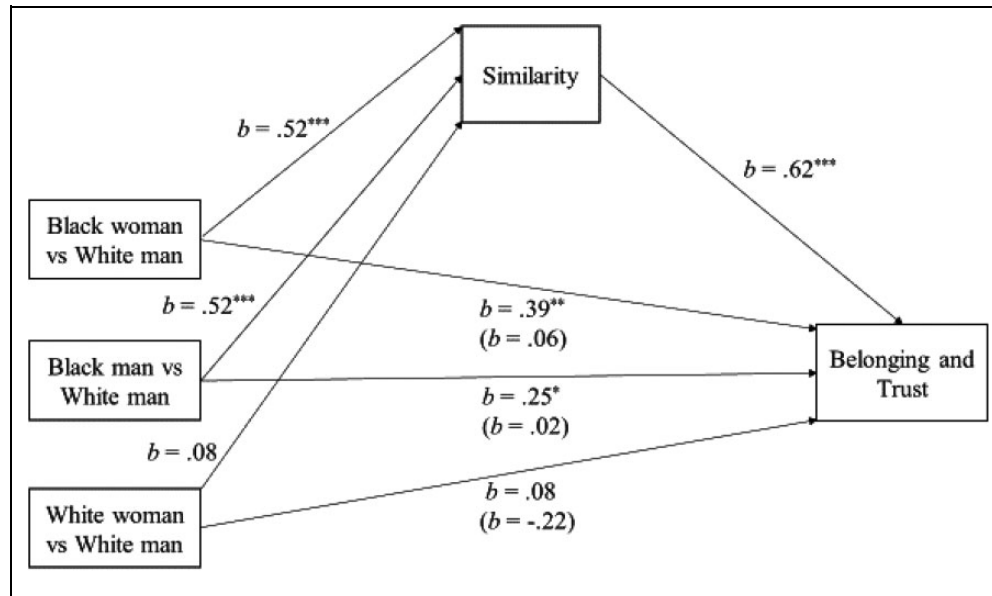
\* $p < .01$ .

## Results

Including demographic variables in the analyses did not meaningfully change our results; thus, we ran the most parsimonious model without these variables. Correlations between the demographic variables and our primary outcome measures are available in the Supplemental Materials at <http://journals.sagepub.com/doi/suppl/10.1177/0361684319830926>. Of the 321 participants currently enrolled in college, 122 were currently majoring in STEM. Participants majoring in STEM were equally distributed across professor profile condition,  $\chi^2(3, N = 321) = 1.62$ ,  $p = .656$ , and the overall general pattern of results was consistent for STEM and non-STEM majors. To examine how professor profile condition affected our outcome measures, for all subsequent analyses, we ran a between-subjects analysis of variance (ANOVA) and used Tukey honest significant differences (HSD) posthoc tests to compare mean differences across condition. Means and standard deviations, as well as a correlation matrix, for all outcome measures across profile condition can be found in Tables 1 and 2.

A significant effect of profile condition emerged for perceived similarity,  $F(3, 347) = 12.15$ ,  $p < .001$ ,  $\eta_p^2 = .095$ . In support of Hypothesis 1a, relative to the White man professor profile, the Black woman professor profile,  $t(347) = 4.61$ ,  $p < .001$ ,  $d = 0.69$ , and the Black man professor profile,  $t(347) = 4.62$ ,  $p < .001$ ,  $d = .76$ , resulted in significantly greater levels of perceived similarity. The White woman professor profile condition did not significantly differ from the White man professor,  $t(347) = 0.70$ ,  $p = .897$ ,  $d = .10$ . Of note, the Black woman professor profile did not significantly differ from the Black man professor profile,  $t(347) = 0.01$ ,  $p = 1.00$ ,  $d = .00$ .

To examine which professor profile served as an identity-safety cue for Black women students, we ran a between-subjects ANOVA predicting anticipated belonging and trust and found a significant effect of condition,  $F(3, 347) = 4.39$ ,  $p = .005$ ,  $\eta_p^2 = .037$ . The means were in the anticipated direction with the Black woman profile resulting in the highest level of anticipated belonging and trust, followed by the Black man profile, the White woman, and the White man. Supporting Hypothesis 2a, compared to the White man profile, the Black woman profile,  $t(347) = 2.78$ ,  $p = .006$ ,  $d = .44$ , and the Black man profile,  $t(347) = 2.50$ ,  $p = .012$ ,  $d = .39$ , significantly increased anticipated belonging



**Figure 1.** Mediation model testing the indirect effect of professor profile condition on anticipated belonging and trust through perceived similarity in Study 1. The total effects of professor profile condition on anticipated belonging and trust are shown in parentheses, and the direct effects (i.e., the effect of professor profile condition controlling for perceived similarity) are shown without parentheses.  $b$  = unstandardized regression coefficient. \* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$ .

and trust. In contrast, the White woman did not significantly differ from the White man profile,  $t(347) = 0.16$ ,  $p = .874$ ,  $d = .02$ . Also, the Black woman professor profile did not significantly differ from the Black man professor profile,  $t(347) = 0.28$ ,  $p = 0.781$ ,  $d = .05$ .

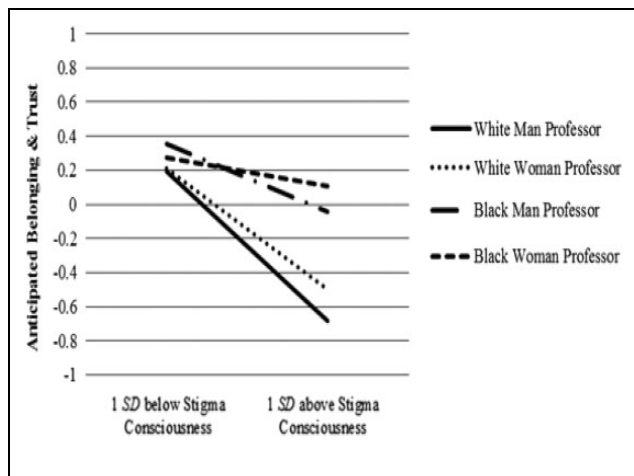
### Mediation by Perceived Similarity

To examine if higher perceived similarity related to greater anticipated belonging and trust (Hypothesis 1a), we also explored whether similarity mediated the professor profile condition's effect on anticipated belonging and trust. We dummy coded the professor profile conditions with the White man professor condition as the reference group. We ran this mediational model with Hayes's (2018) PROCESS Macro Model 4 and 10,000 bootstrap resamples with professor profile condition as the independent variable, perceived similarity as the mediator, and anticipated belonging and trust in the School of Science and Engineering as the outcome. This analysis yielded the predicted significant indirect effect (i.e., the confidence interval did not cross 0) for the Black woman professor condition versus the White man professor condition (.32; 95% CI [.18, .49]) and the Black man professor condition versus the White man professor condition (.32; 95% CI [.19, .47]) on anticipated belonging and trust via perceived similarity. In contrast, the indirect effect for the White woman professor versus the White man professor condition on anticipated

belonging and trust via perceived similarity was non-significant (.07; 95% CI [-.10, .20]; see Figure 1).

### Moderation by Stigma Consciousness

To examine whether stigma consciousness (SC) was an important moderator for the professor profile condition effects on anticipated belonging and trust, we ran a hierarchical regression analysis predicting anticipated belonging and trust with (1) profile condition dummy coded with the White man condition as the reference group and mean-centered SC and (2) the interaction between SC and profile condition. Main effects were interpreted in the first step, whereas two-way interactions were interpreted in the second step (J. Cohen, Cohen, West, & Aiken, 2003). The first step revealed that relative to the White man condition, both the Black woman,  $b = 0.43$ ,  $t(318) = 3.08$ ,  $p = .002$ , and Black man condition,  $b = 0.39$ ,  $t(318) = 2.71$ ,  $p = .007$ , resulted in greater anticipated belonging and trust. Also, higher levels of SC significantly predicted lower levels of anticipated belonging and trust,  $b = -0.39$ ,  $t(318) = -4.96$ ,  $p < .001$ . Consistent with previous work (Pietri et al., 2018), a significant interaction between the Black woman condition and SC,  $b = 0.56$ ,  $t(315) = 2.51$ ,  $p = .013$ , emerged. In contrast, the interaction between the Black man condition and SC,  $t(315) = 1.66$ ,  $p = .098$ , and the interaction between the White woman profile and SC were both non-significant,  $b = 0.13$ ,  $t(315) = 0.55$ ,  $p = .579$  (see Table 3).



**Figure 2.** The effect of profile condition on anticipated belonging and trust as a function of stigma consciousness in Study 1. SD = standard deviation.

For participants low in SC, the effect of the Black woman profile condition did not differ significantly from the White man condition,  $b = 0.80$ ,  $t(315) = 0.41$ ,  $p = .683$ . Conversely, among participants high in SC, the Black woman profile condition resulted in significantly greater levels of anticipated belonging and trust than the White man condition,  $b = 0.79$ ,  $t(315) = 3.95$ ,  $p < .001$  (see Figure 2).

Finally, to look at the effect of SC in each condition on anticipated belonging and trust, we recoded the profile condition using dummy coding (see West, Aiken, & Krull, 1996) and modified which condition was the reference group. Replicating previous work (Pietri et al., 2018), in the White man condition,  $b = -0.68$ ,  $t(318) = -4.05$ ,  $p < .001$ , the White woman condition,  $b = -0.55$ ,  $t(318) = -3.33$ ,  $p = .001$ , and the Black man condition,  $b = -0.31$ , 95%  $t(318) = -2.05$ ,  $p = .042$ , SC predicted significantly lower levels of anticipated belonging and trust. However, in support of Hypothesis 3a, only the Black woman condition,  $b = -0.13$ ,  $t(318) = -0.88$ ,  $p = .382$ , alleviated the negative effect of SC and the relation between the two was not significant,  $r(89) = -.09$ ,  $p = .386$ .

## Discussion of Study 1

Consistent with a primary identity viewpoint and in support of Hypothesis 1a, participants felt more similar to both the Black woman and Black man professor profiles than the White woman or White man professor profile conditions, and this perceived similarity positively related to anticipated belonging and trust in the School of Science and Engineering. Likewise, in line with Hypothesis 2a, only the Black professor profiles functioned as effective identity-safety cues among our Black women student participants, resulting in greater anticipated belonging and trust relative to the White man professor profile.

Supporting Hypothesis 3a, the current study also highlighted the importance of stigma consciousness, as it was a critical moderator. As predicted, only the Black woman professor profile acted as an effective identity-safety cue and protected participants with higher levels of stigma consciousness. Compared to the White man professor, participants who reported higher stigma consciousness (i.e., one standard deviation above the mean) anticipated experiencing more belonging and trust in the fictitious School of Science and Engineering after reading the Black woman professor profile. In contrast, the beneficial effects of the Black woman professor profile disappeared among participants with low stigma consciousness (i.e., one standard deviation below the mean). Consistent with previous research (Pietri et al., 2018), we also found support for a compound identity viewpoint. Specifically, higher levels of stigma consciousness significantly related to lower anticipated belonging and trust in the School of Science and Engineering, unless participants viewed the profile of the Black woman professor. That is, only the professor sharing a racial and gender identity with participants (i.e., a Black woman scientist) protected participants from high levels of stigma consciousness. In short, the present study replicates previous research (Pietri et al., 2018) among a student population of Black women and highlights the importance of having access to Black exemplars to promote belonging among Black women students.

## Study 2

In Study 1, we only examined how cursory exposure to an exemplar identity-safety cue affected Black women students anticipated belonging and trust in a hypothetical STEM environment. To address this limitation, in Study 2, we explored how actual contact with role model identity-safety cues affects Black women students' social identity threat concerns in a real STEM environment. Black women majoring in STEM were recruited from both a public, predominantly White institution (PWI) and from a private, women-only historically Black college (HBC). The PWI has a student population of about 30,000, and a majority of students and faculty identify as White; less than 5% of all faculty at the institution are Black, and the majority of STEM faculty and majors are White and men. In contrast, of the approximately 2,000 students enrolled at the women-only HBC, the majority are Black women. In addition, the HBC institution is unique in that approximately 80% of all faculty at the institution identify as Black, and one-third of full-time faculty in STEM are Black women. By recruiting from these two institutions, we ensured diversity in the Black women STEM majors' experiences and access to role models matching their gender and race.

We recruited Black women majoring in STEM from each institution; participants identified their role models in STEM at the institution and indicated the race and gender of each role model. Consistent with Study 1, participants reported



their perceived similarity with each role model and completed a measure of stigma consciousness. In a departure from Study 1, to get at social identity threat concerns, participants completed two separate measures—belonging in the institution and belonging in STEM. Because the PWI and HBC differed in the availability of role models in STEM sharing a racial identity with participants, we opted to measure belonging in the institution and belonging in STEM separately to capture the benefits of access to role model identity-safety cues within one's major.

We anticipated participants across both institutions would report feeling more similar to Black role models than non-Black role models, and this perceived similarity would positively relate to belonging. We also anticipated perceiving non-Black role models as similar would positively relate to belonging across both institutions. When looking across both institutions, we also expected that access to role models sharing a common racial identity (i.e., Black women and Black men role models) would serve as an important identity-safety cue and mitigate social identity threat concerns (i.e., would positively relate to belonging). Consistent with Study 1 and a primary identity viewpoint, we predicted having more Black role models would be positively correlated with belonging across both institutions.

Given the unique nature of the HBC's educational environment, we also anticipated STEM majors would report greater belonging in the institution and in STEM, and a greater number of Black role models, relative to their STEM counterparts at the PWI. As in Study 1, we also expected stigma consciousness would relate to social identity threat concerns (i.e., belonging) across the two different environments. Specifically, we predicted if Black women STEM majors reported having many Black women role models at the HBC and not the PWI, then the stigma consciousness would only relate to lower belonging in STEM at PWI and not the HBC, providing support for a compound identity perspective.

In Study 2, we also had participants report their perceived allyship of each role model to explore whether perceiving a role model with a different racial identity as an ally (i.e., was not a Black woman or Black man) would also encourage Black women's belonging in STEM. STEM majors at Black women colleges often report having access to a great deal of faculty, all whom they perceive as vested in their success (Perna et al., 2009). Consequently, we anticipated role models at the women-only HBC would result in greater perceived allyship. However, we also hypothesized that perceiving role models lacking a shared racial identity as allies would positively relate to belonging in STEM across both institutions. Recent experimental evidence supports this prediction. Pietri and colleagues (2018) also examined whether perceptions of allyship promoted anticipated belonging and trust among Black women. Black women were randomly assigned to read the profile of a successful scientist who shared an identity with participants. However, because the authors initially

found the White woman scientist was an ineffective identity-safety cue, the authors also examined whether framing the White woman scientist as an ally (i.e., she acknowledged the unique perspectives of Black women and actively recruited them into her research team) would bolster her effectiveness as an identity-safety cue. Relative to viewing no profile, we predicted the White woman scientist ally would enhance anticipated belonging and trust at the STEM company.

## Method

### Participants

In the previous study, we found an effect size of  $d = .44$  between the Black woman condition and the White man condition. Using this effect size and the G\*Power software (Faul et al., 2007), we estimated we would need approximately 166 participants (83 per school) to achieve 80% power at  $p < .05$ . Eighty-seven Black women currently majoring in STEM at a large, public, and predominantly White institution (PWI) and 118 Black women currently majoring in STEM at a small, private, women-only historically Black college (HBC) were recruited to take part in Study 2. Only those participants majoring in a field classified as STEM according to federal guidelines (e.g., Chen & Weko, 2009) were recruited at each institution. An analysis of missing data found that all 205 STEM majors recruited provided complete data for all measures, so our sample did not include any missing data for participants. Of our STEM majors at the PWI whose ages were  $M = 21.13$ ,  $SD = 2.77$ , range = 18–32; 26 were first-year students (29.9%), 16 were second-year students (18.4%), 15 were third-year students (17.2%), 15 were fourth-year students (17.2%), and 15 were fifth-year or above (17.2%). For our majors at the HBC, whose ages were  $M = 19.94$ ,  $SD = 1.24$ , range = 18–23; 22 were first-year students (18.5%), 38 were second-year students (31.9%), 27 were third-year students (22.7%), 30 were fourth year students (25.2%), and two were fifth-year or above (1.7%). Participants were compensated with a US\$25.00 Amazon e-gift card for their participation.

### Measures

Unless otherwise noted, all outcome measures employed a 1 (*strongly disagree*) to 5 (*strongly agree*) scale. Participants' responses across all items for each outcome measure were averaged, and higher numbers indicate higher levels of that construct.

**Perceived similarity with role models.** To measure their perceived similarity with their identified role model in STEM, participants responded to a single item, "How similar do you feel to this role model?" on a 1 (*not at all similar*) to 7 (*very similar*) scale ( $M = 4.70$ ,  $SD = 1.30$ ).

**Belonging in the institution and belonging in STEM.** To assess *belonging in the institution*, participants indicated their level of agreement with the same 8 items, we utilized in Study 1 to assess belonging; however, for all 8 items, “in the School of Science and Engineering” was replaced with the name of participants’ respective institution ( $M = 3.87$ ,  $SD = 0.71$ ,  $\alpha = .84$ ). In a departure from Study 1, we replaced our measure of belonging and trust with a measure examining *belonging in STEM*. To assess belonging in STEM, we employed the same 8 items from Study 1, replacing “in the School of Science and Engineering” with “in STEM” ( $M = 3.49$ ,  $SD = 0.69$ ,  $\alpha = .84$ ). Of note, participants were instructed to answer these latter items based on how they feel in STEM environments. Specifically, the instructions read, “Please indicate the degree to which you agree or disagree with each statement based on how you feel in STEM environments (for example, in a science class or in a science research lab).”

**Identification of role models.** Participants were instructed to identify between 0 and 10 of their role models in STEM at their institution. To ensure participants only identified role models within STEM at their institution, participants answered the following:

How many role models do you have at [your institution] who are in your major or studying in a similar field as you? The role model does not have to be specifically in your current major but should be affiliated in some way. For example, you may be a chemistry major and may have a role model (professor, an older student) who is in biochemistry.

We also provided a definition of a role model for participants, noting a role model was:

... a person you feel similar to and aspire to be like... you do not need to have consistent contact or interactions with a role model. For example, a role model may be a professor at your college who does interesting or important research, but someone who you’ve never spoken with.

This definition was taken from previous work defining a role model as someone to whom a person feels similar and would like to be like but, in contrast to a mentor, does not necessarily require quality and consistent contact (Gibson, 2004; see also Dasgupta, 2011). After indicating the number of STEM role models at their institution, participants provided the race and gender for each identified role model, selecting from eight racial/ethnic categories: African-American/Black, Caucasian/White, Asian, Middle Eastern, Native American, Multi-Racial, or Other (see Supplementary Materials at <http://journals.sagepub.com/doi/suppl/10.1177/0361684319830926> for mean percentages of role models in each racial category as a function of gender and educational environment).

**Stigma consciousness.** Participants completed the same 9-item measure assessing their level of stigma consciousness

**Table 3.** Full Regression Model Predicting Anticipated Belonging and Trust in the School of Science and Engineering in Study 1.

Predictors	b	SE	T	p
White woman	.08	.15	0.56	.569
Black man	.39	.14	2.71	.007
Black woman	.43	.14	3.08	.002
Stigma consciousness	-.39	.08	-4.95	<.01
White Woman $\times$ Stigma Consciousness	.13	.24	0.56	.579
Black Man $\times$ Stigma Consciousness	.38	.23	1.66	.098
Black Woman $\times$ Stigma Consciousness	.557	.22	2.51	.013

Note. The residual degrees of freedom for predictors entered on Step 1 and Step 2 are = 315 and = 318, respectively.

related to being a Black woman (items taken from Pinel, 1999) utilized in Study 1 (for the current participants,  $M = 3.87$ ,  $SD = 0.67$ ,  $\alpha = .71$ ).

**Perceived allyship with role models.** To measure *perceived allyship*, participants responded to a single item “How much do you think this role model cares about helping Black women?” on a 1 (*does not care at all about helping*) to 7 (*cares about helping very much*) scale ( $M = 6.24$ ,  $SD = 1.09$ ).

## Procedure

Participants recruited from the PWI were contacted via e-mail by the investigators and invited to participate in an online study examining the experiences of Black women currently majoring in STEM. Participants recruited from the HBC were also recruited via flyers placed in STEM classrooms and a listserv sent to STEM majors by the investigators, asking students who identified as Black women and were majoring in STEM to participate. After completing the informed consent to participate in the online study, participants completed a measure of stigma consciousness, identified their role models at their institution in STEM (up to 10), and provided each identified role model’s race and gender. Participants then reported their perceived similarity and allyship of each role model. Next, participants completed measures assessing their belonging at their institution and belonging in STEM (in random order). Finally, participants completed demographic measures and were thanked for their participation and debriefed.

## Results

We present the descriptive statistics for each outcome variable at the PWI versus HBC in Table 4 and a correlation matrix of our key variables across both institutions in Table 5.

**Perceived similarity with role models.** To examine Hypothesis 1b, we ran independent samples *t*-test to examine differences across educational environments. Of the Black women

**Table 4.** The Means and Standard Deviations Across Educational Environments in Study 2.

Measures	Predominately White Institution ( <i>n</i> = 87)	Historically Black College ( <i>n</i> = 118)
	<i>M</i> ( <i>SD</i> )	<i>M</i> ( <i>SD</i> )
Belonging at the institution	3.46 (0.71)	3.72 (0.69)
Belonging in STEM	3.30 (0.70)	3.63 (0.66)
All role models	2.87 (1.88)	4.46 (2.43)
Women role models	1.24 (1.34)	2.75 (2.00)
Men role models	0.49 (0.81)	0.55 (0.73)
Black women role models	0.53 (0.97)	2.34 (1.79)
Black men role models	0.13 (0.33)	0.36 (0.55)
Non-Black women role models	2.34 (1.67)	2.13 (1.42)
Non-Black men role models	1.51 (1.13)	1.35 (1.00)
Similarity of women role models	4.91 (1.39)	5.07 (1.14)
Similarity of men role models	3.96 (1.63)	4.52 (1.25)
Similarity of Black women role models	5.29 (1.19)	5.07 (1.22)
Similarity of Black men role models	4.73 (1.01)	4.73 (1.11)
Similarity of non-Black women role models	4.19 (1.53)	4.68 (1.42)
Similarity of non-Black men role models	3.94 (1.72)	4.42 (1.55)
Allyship of women role models	5.72 (1.48)	6.59 (0.74)
Allyship of men role models	5.57 (1.39)	6.55 (0.77)
Allyship of Black women role models	6.34 (1.06)	6.59 (0.74)
Allyship of Black men role models	6.09 (1.30)	6.68 (0.69)
Allyship of non-Black women role models	5.42 (1.64)	6.78 (0.59)
Allyship of non-Black men role models	5.59 (1.31)	6.29 (0.99)

Note. STEM = science, technology, engineering, and math.

students who reported having at least one role model, we found that the Black women STEM majors at the HBC reported greater similarity with their role models in general compared to students at the PWI,  $t(172) = 2.66, p = .008, d = .41$ . However, this may have been driven by the fact that students at the HBC reported having more Black role models than students at the PWI. In support of Hypothesis 1b, across both samples of participants who identified Black and non-Black women role models, participants reported significantly more perceived similarity to the Black women role models than the non-Black women role models,  $t(43) = 4.15, p < .001, d = .66$ . Among students who reported having both Black and non-Black men role models, we did not find differences in perceived similarity for Black men role models relative to non-Black men role models,  $t(11) = .83, p = .423, d = .24$ . However, we had a low number of participants who had both Black men and non-Black men role models and lacked power to test this difference.

There were no significant differences between the institutions on perceived similarity of non-Black women role models,  $t(74) = 1.44, p = .153, d = .33$ , and non-Black men role models,  $t(41) = 0.94, p = .352, d = .29$ . The institutions also did not differ on perceived similarity with Black women role

models,  $t(130) = 0.85, p = .397, d = .15$ , or Black men role models,  $t(49) = 0.01, p = .995, d = .00$ .

In partial support of Hypothesis 1c, perceived similarity with Black women role models significantly related to belonging in the institution,  $r(131) = .35, p < .001$ , and belonging in STEM,  $r(131) = .26, p = .003$  (see Table 5). In contrast, perceived similarity with Black men was not significantly related to belonging in the institution,  $r(131) = .24, p = .088$ , or belonging in STEM,  $r(131) = .09, p = .555$ . Finally, in support of Hypothesis 1c, perceived similarity with non-Black women role models also significantly correlated with belonging in STEM,  $r(75) = .42, p < .001$ . In contrast, feeling similar to non-Black men role models did not significantly relate to belonging in the institution,  $r(205) = -.20, p = .219$ , or belonging in STEM,  $r(205) = -.10, p = .528$ .

*Belonging at the institution and belonging in STEM.* Turning to Hypothesis 2b, we also examined how role models related to belonging at the institution and belonging in STEM in both educational environments. As shown in Table 5, across both institutions, having more role models of all identities was significantly correlated with belonging in the institution,  $r(205) = .32, p < .001$ , and belonging in STEM,  $r(205) = .15, p = .031$ . However, this relation appears to be driven by Black women role models. Supporting Hypothesis 2b, having more Black women role models significantly related to belonging at the institution,  $r(205) = .32, p < .001$ , and belonging in STEM,  $r(205) = .14, p = .046$ . In partial support of Hypothesis 2b, having more Black men role models was also significantly related to belonging in the institution,  $r(205) = .21, p = .003$ , but was not significantly related to belonging in STEM,  $r(205) = .09, p = .187$ . Non-Black women role models (i.e., women role models who are not Black) also significantly related to belonging in the institution,  $r(205) = .17, p = .013$ , but did not significantly relate to belonging in STEM,  $r(205) = .04, p = .619$ . Having non-Black men role models did not significantly relate to belonging in the institution,  $r(205) = .06, p = .405$ , or belonging in STEM,  $r(205) = .04, p = .533$ ; however, this relation may not have emerged because very few majors reported non-Black men role models.

Next, to examine Hypothesis 2c, we ran an independent samples *t*-test to examine differences in belonging across educational environments. In support of Hypothesis 2c, relative to Black women STEM majors enrolled at the PWI, Black women STEM majors enrolled at the HBC reported greater belonging in the institution,  $t(205) = 2.64, p = .009, d = .37$ , and greater belonging in STEM,  $t(205) = 3.50, p = .001, d = .49$ .

*Identification of role models.* Turning to Hypothesis 2d, we next examined participants' identified role models in STEM at their respective institution. Because number of role models was a count variable with a non-normal distribution, we predicted number of role models from condition dummy coded

**Table 5.** Correlation Matrix for Study 2.

Measures	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Belonging in the institution	1															
2. Belonging in STEM	.44***	1														
3. All role models	.32***	.15*	1													
4. Black women role models	.32***	.14*	.76***	1												
5. Black men role models	.21**	.09	.37***	.25***	1											
6. Non-Black women role models	.17*	.04	.38**	-.07	-.02	1										
7. Non-Black men models	.06	.04	.58***	-.06	-.03	.70***	1									
8. Similarity of Black women role models	.35***	.26***	.14	.10	.08	.12	.07	1								
9. Similarity of Black men role models	.24+	.09	.19	.06	.05	.17	.25+	.55***	1							
10. Similarity of non-Black women role models	.21+	.42***	.17	.07	.27*	.04	.11	.66***	.71***	1						
11. Similarity of non-Black men role models	-.20	-.10	-.10	.13	-.01	-.29+	-.40**	-.77***	-.93***	-.63*	1					
12. Allyship of Black women role models	.29***	.19*	.10	.12	.01	.15+	.02	.27**	.25	.28+	-.27+	1				
13. Allyship of Black men role models	.07	.19	.22	.23	-.19	.06	.11	.12	.20	.18	-.17	.78***	1			
14. Allyship of non-Black women role models	.21+	.42***	.29*	.33**	.12	-.12	-.01	.33*	.43+	.51***	-.17	.62***	.37	1		
15. Allyship of non-Black men role models	-.21	-.18	-.14	-.13	.34*	-.03	-.16	-.23	-.23	-.19	.24	-.95***	-.95***	-.95***	1	
16. Stigma consciousness	.11	-.09	.11	.19**	.09	.04	-.08	-.01	.21	-.14	-.25	.10	.49**	-.01	-.39*	1

Note. STEM = science, technology, engineering, and math.

+ $p < .10$ . \* $p < .05$ . \*\* $p < .01$ . \*\*\* $p < .001$ .

(1 = HBC, 0 = PWI), using a Poisson regression (Coxe, West, & Aiken, 2009). All the initial models we ran showed a significant overdispersion (i.e., all the models had greater variability than expected for a standard Poisson regression or  $\phi = \chi^2_{\text{Pearson}}/df$  is greater than 1; Coxe et al., 2009). Thus, we ran an overdispersed Poisson model, which employed a scaling parameter (Coxe et al., 2009; Land, McCall, & Nagin, 1996). The means for identified Black men and Black women role models, as well as non-Black women and non-Black men role models at each institution, are presented in Table 4. STEM majors enrolled at the HBC identified significantly more role models at their institution, relative to majors enrolled at the PWI,  $b = 0.60$ , Wald's  $\chi^2(1, N = 205) = 23.23, p < .001$ . However, in support of Hypothesis 2d, this increase in role models was primarily driven by the participants at the HBC having more Black role models than participants at the PWI. Black women STEM majors at the HBC identified a significantly greater number of Black women role models than students at the PWI,  $b = 1.47$ , Wald's  $\chi^2(1, N = 205) = 60.68, p < .001$ . Moreover, the STEM majors reported a greater number of Black men role models, relative to their counterparts at the PWI,  $b = 1.06$ , Wald's  $\chi^2(1, N = 205) = 9.82, p = .002$ .

In contrast, we found that STEM majors at the PWI, reported more non-Black women role models (i.e., women role models with a different racial identity),  $b = -0.58$ , Wald's  $\chi^2(1, N = 205) = 7.65, p = .006$ , relative to their counterparts at the HBC. In addition, the students at the PWI indicated having more non-Black men role models (i.e., men role models with a different racial identity) than students at the HBC,  $b = -0.68$ , Wald's  $\chi^2(1, N = 205) = 7.28, p = .007$ .

**Stigma consciousness.** Although participants attending the HBC indicated higher belonging in the institution and in STEM, they also reported significantly higher levels of stigma consciousness (SC), relative to participants enrolled at the PWI,  $t(205) = 3.165, p = .002, d = 0.44$ . Supporting Hypothesis 3b, we found that at the PWI, participants with higher SC reported lower belonging in STEM,  $r(87) = -.22, p = .043$ . In contrast, the relation between SC and belonging in STEM was not significant at the HBC,  $r(118) = -.08, p = .368$ . At the PWI, SC did not relate to belonging in the institution,  $r(87) = -.06, p = .562$ . In contrast, at the HBC, SC related to significantly more belonging in the institution,  $r(118) = .21, p = .023$ .

**Perceived allyship with role models.** To examine Hypothesis 4a, we ran an independent samples *t*-test to test the differences in perceived allyship across the two institutions. We found that, compared to students at the PWI, students at the HBC believed that their non-Black women role models cared more about helping Black women,  $t(73) = 4.70, p < .001, d = 1.10$ . However, students at the HBC did not significantly differ in perceptions their non-Black men role models were better allies than students at the PWI,  $t(41) = 1.91, p = .063,$

$d = 0.60$ . We also found that Black men role models were perceived as caring more about helping Black women succeed at the HBC, relative to the PWI,  $t(49) = 2.01, p = .050, d = 0.56$ , but perceptions of Black women role models did not differ as a function of educational environment,  $t(130) = 1.40, p = .164, d = 0.27$ .

In partial support of Hypothesis 4b, we also found that perceived allyship of non-Black women role models (i.e., women role models lacking a shared racial identity) significantly related to belonging in STEM,  $r(75) = .42, p < .001$ , but was unrelated to belonging in the institution,  $r(131) = .21, p = .080$ , for Black women STEM majors across both institutions (see Table 5). Perceiving Black women role models as valuing Black women's success in STEM,  $r(131) = .19, p = .029$ , related to belonging in STEM, and belonging in the institution,  $r(131) = .29, p = .001$ . In contrast, neither the perceived allyship of Black men role models nor non-Black men role models was significantly related to belonging in the institution or belonging in STEM (all  $ps \geq .190$ ; this relation may have failed to emerge due to the small number of participants with Black men and non-Black men role models; see Table 4).

## Discussion of Study 2

Study 2 demonstrated the importance of having access to Black role models among Black women STEM majors across two different educational environments. As expected, and in support of Hypothesis 1b, we found that majors attending the HBC reported significantly greater similarity to their identified role models in STEM, relative to their counterparts attending the PWI. In both samples, participants who identified both Black and non-Black women role models reported perceiving significantly more similarity with the Black women role models than the non-Black women role models, paralleling our findings for Study 1 and supporting Hypothesis 1b. Also, in support of Hypothesis 1b, we found perceived similarity of Black women role models significantly related to belonging in the institution and in STEM. Thus, Study 2 provided partial support for a primary identity viewpoint, highlighting the importance of Black STEM majors having access to role models sharing a common racial identity. In support of Hypothesis 1c and consistent with previous research (Cheryan et al., 2011, 2013; Dasgupta, 2011), we found perceived similarity of non-Black women role models also significantly related to belonging in STEM.

In support of Hypothesis 2b and a primary identity perspective, we found that across both institutions, access to Black women and Black men role models positively related with belonging in the institution (i.e., assuage social identity threat concerns). Although we anticipated that both Black women and Black men role models would significantly relate to belonging in STEM, only Black women role models positively related to belonging in STEM. Among STEM majors, it is possible that only access to role models sharing both

identities promotes belonging in STEM. Although further work is warranted given the correlational nature of Study 2, previous work has found for women who have already chosen a domain, such as STEM majors or STEM-identified students, access to ingroup role models (i.e., Black women) improves women's attitudes toward STEM (Stout et al., 2011). Finally, supporting Hypotheses 2c and 2d, we found that Black women STEM majors attending the HBC reported greater belonging in the institution and greater belonging in STEM, and identified more role models sharing a common racial identity (i.e., Black men and Black women), relative to their counterparts at the PWI.

We also unexpectedly found that HBC participants reported significantly more stigma consciousness than their PWI counterparts. However, in support of Hypothesis 3b and consistent with a compound identity perspective, our HBC participants may have been protected from the negative effects of stigma consciousness on belonging (likely due to being immersed in an environment with Black women role models) and we found the relation between stigma consciousness and belonging in STEM was non-significant; stigma consciousness significantly related to belonging in the institution at the HBC. In contrast, and replicating Study 1, among participants at the PWI, there was a significant negative correlation between stigma consciousness and belonging in STEM, providing support for Hypothesis 3b.

In support of Hypothesis 4a, we found significant differences on perceived allyship across the two institutions. Perceptions that a Black woman role model cared about helping Black women succeed in STEM did not differ across institutions; however, majors at the HBC reported both non-Black women role models and Black men role models as caring more about helping Black women succeed relative to their PWI counterparts. Thus, working at a college that primarily served Black women acted as a strong cue that the role model was an ally. We also found support for Hypothesis 4b, highlighting the importance of allyship. We found that perceiving role models who lacked a shared racial identity as allies, positively related to both belonging in the institution and belonging in STEM. Thus, consistent with previous research (Pietri et al., 2018), perceiving an individual lacking a shared racial identity (e.g., a White woman role model) as an ally may encourage a sense of belonging among Black women STEM majors.

## General Discussion

We investigated who acts as an identity-safety cue for Black women students by examining whether exposure to successful exemplars or role models who share a common race and/or gender identity with Black women participants encouraged belonging in both a hypothetical and actual STEM environment. In Study 2, we also examined how role model perceptions of allyship related to belonging in the institution and belonging in STEM among Black women students across two

educational environments. Supporting a primary identity viewpoint, in Study 1, we found that participants reported greater perceived similarity with the Black woman and Black man professors than the White man professor; and this perceived similarity significantly related to more anticipated belonging and trust. Furthermore, Black women reported they would anticipate feeling more belonging and trust in a fictitious School of Science and Engineering, after learning about a Black woman or Black man professor, compared to learning about a White woman or White man professor. We also found stigma consciousness was an important moderator. Participants high in stigma consciousness (i.e., one standard deviation above the mean) reported the lowest overall levels of anticipated belonging and trust, unless they viewed the profile of a Black man or a Black woman professor. Providing support for a compound identity perspective, only viewing the profile of the Black woman professor alleviated the negative effect of stigma consciousness on anticipated belonging and trust.

In Study 2, we explored how access to role models in STEM who shared a racial identity with Black women, and perceptions that role models who lack a shared racial identity were allies, related to belonging in the institution and belonging in STEM for Black women STEM majors. We recruited Black women STEM majors from two different educational environments: a predominantly White institution (PWI) and a women-only, historically Black college (HBC). We found that majors attending the HBC reported significantly greater similarity with all identified role models, relative to their counterparts attending the PWI. However, this difference in similarity across the two institutions was driven by HBC participants who identified a significantly greater number of Black women role models relative to PWI majors. Across both institutions, individuals reported feeling significantly more similar to the Black women role models than the non-Black women role models, parallel with our findings for Study 1, and consistent with a primary identity viewpoint. Perceived similarity of Black women role models also significantly related to belonging in the institution and belonging in STEM, conceptually replicating our findings in Study 1 and providing partial support for a primary identity viewpoint.

As we predicted, when looking at STEM majors across both institutions, we found that having more Black women and Black men role models each significantly related to belonging at the institution, supporting a primary identity viewpoint. However, we also found that students majoring in STEM and attending the HBC reported greater belonging in the institution and greater belonging in STEM, and identified significantly more Black role models, relative to PWI majors.

We also examined the role of stigma consciousness in Study 2 and unexpectedly found that HBC participants reported significantly more stigma consciousness than their PWI counterparts. This finding may be a result of an educational environment with many Black women role models

available; the HBC participants may have been protected from the negative effects of stigma consciousness on belonging concerns, providing evidence for a compound identity perspective. Consistent with our predictions, and in support of a compound identity viewpoint, we found the relation between stigma consciousness and belonging in STEM was only negatively related among PWI majors. We found that stigma consciousness significantly predicted belonging in the institution at the HBC, suggesting that in a protective environment stigma consciousness can be of value.

Finally, we also explored how perceptions of allyship differed across the institutions. Although perceptions that a Black woman role model cared about helping Black women succeed in STEM did not differ across institutions, majors at the HBC reported non-Black women role models and Black men role models as caring more about helping Black women succeed, relative to their PWI counterparts. Extending the findings of Study 1, we also found perceived allyship of non-Black women role models (i.e., women role models who lacked a common racial identity with students) significantly related to belonging in STEM.

### *Practice Implications*

Black women are underrepresented in STEM classes and careers (NSF, National Center for Science and Engineering Statistics, 2017); consequently, it is imperative to identify strategies to attract Black women students to STEM. The results of the present studies suggest, at a minimum, one strategy to increase Black women's attraction to STEM classes and careers is to increase their exposure to successful exemplars and role models in STEM sharing a common racial identity. Black women do not readily identify with White men and White women working in STEM fields (Pietri et al., 2018). Rather, the current research suggests that individuals sharing a common racial identity (i.e., Black men and Black women) serve as the most effective identity-safety cues for Black women students. Previous work has found that women who report a sense of belonging in STEM environments are more likely to pursue STEM majors and persist in STEM fields (Lewis et al., 2017; Murphy et al., 2007), and even cursory or brief exposure to positive exemplars can assuage social identity threat concerns (Dasgupta, 2011; Dasgupta & Asgari, 2004; Pietri et al., 2018). Thus, exposure to identity-safety cues sharing a common racial identity may effectively increase Black women's sense of belonging and ultimately increase their representation in STEM classes and careers.

Our results also suggest that individuals who design interventions geared toward increasing the representation of women in STEM should adopt an intersectional approach to ensure such interventions are effective among ethnic and racial minority women. Research has highlighted the benefits of exposing women to relatable role models and encouraging a sense of belonging in STEM (Asgari et al., 2010; Dasgupta,

2011; Stout et al., 2011). For example, women-majority (vs. women-minority) peer groups can help women majoring in STEM feel more confident and increase their desire to have a career in the STEM workforce (Dasgupta, Scircle, & Hunsinger, 2015). Advanced women students can act as peer role models for younger women students and encourage their confidence, belonging, and interest in STEM (Dennehy & Dasgupta, 2017). However, past work has mostly failed to examine whether interventions that are effective for White women are also effective for Black women or other racial minorities. The results of the present research suggest that for Black women, a women-majority peer group or peer role model may do little to encourage career aspirations in STEM unless the majority of group members also share their racial identity. To ensure interventions are effective among minority women, scholars should recruit greater numbers of racially and ethnically diverse women in their participant pool.

The findings of the present studies also suggest that if those lacking a common racial identity with Black women signal allyship, Black women may perceive them as potential role models and they may serve as an effective identity-safety cue. In Study 2, we found across both educational environments that the perceived allyship of non-Black women role models (i.e., White women role models) was positively correlated with belonging in STEM. To signal allyship, available role models that lack a common racial identity should strive to adopt behaviors that convey they sincerely value helping Black women succeed in the sciences. For example, previous research has found that Black individuals view a White person more positively and as an "ally" when this person acknowledges the unique challenges and perspectives Black individuals face due to racial discrimination and actively work to combat these injustices (Ashburn-Nardo, 2018; Brown & Ostrove, 2013; Droogendyk, Wright, Lubensky, & Louis, 2016; Ostrove & Brown, 2018). Thus, a White woman role model in STEM who actively recruits Black women students into her research lab and acknowledges the challenges Black women face in STEM environments may be perceived as an ally (Pietri et al., 2018) and, consequently, as an effective identity-safety cue.

### *Theoretical Implications*

The present work has important theoretical implications for research on role models. In line with past research and theories, we found that positive exemplars and role models were beneficial for encouraging women's belonging in STEM (Dasgupta, 2011; Morgenroth et al., 2015). The current studies add to this work by demonstrating that successful and relatable White women scientists may not act as identity-safety cues for all women. For Black women students, the role model's race was more critical for predicting effective exemplars than their gender. Moreover, other women also may have an identity that is more salient and important than

their gender (e.g., Latina women, first-generation women college students, sexual minority women); thus, it will be important to investigate who will act as an efficacious identity-safety cue for these women. In Study 2, we also found evidence that Black women can have role models who do not share their racial identity, yet, they encouraged belonging if the role model was perceived as a convincing ally. Thus, researchers investigating the benefits of role models should examine under what conditions a potential role model is perceived as an ally. Finally, our studies enrich understanding of theories pertaining to the effects of stigma consciousness in academic environments. Researchers have found that high levels of stigma consciousness can be harmful for ethnic minority students' well-being and adjustment in college (Guyll, Madon, Prieto, & Scherr, 2010; Pinel, Warner, & Chua, 2005). However, in the present work, we found that the type of environment was related to harmful, neutral, or even beneficial stigma consciousness.

### *Limitations and Future Research*

One notable limitation of the current work is that the design of Study 2 (i.e., participants identified role models and indicated the race and gender of each) did not allow us to adequately examine how Black men and non-Black men role models related to social identity threat concerns or perceived similarity and allyship. Few participants identified both Black and non-Black role models across both institutions; thus, we lacked the necessary power to investigate such relations. Looking across both institutions, we also found the identification of Black men role models significantly related to belonging in the institution but not belonging in STEM. The correlational nature of Study 2 also limits the extent to which causal conclusions can be drawn. Previous work has found exposure to women role models over time plays a critical role in how educational environments affect social identity threat concerns and beliefs about science among women in STEM (Dasgupta & Asgari, 2004). Study 2 also examined how exposure to role models who shared a common racial identity related to belonging among Black women STEM majors; however, how access to Black role models relates to retention in STEM is unclear based on the present research. Researchers should adopt a longitudinal design to examine the long-term effects of access to both non-Black and Black role models among Black women STEM majors, focusing on factors relevant to retention, such as persistence in STEM or degree attainment.

Future work should also experimentally examine how allyship influences belonging among Black women undergraduates. In Study 2, non-Black women role models affiliated with the HBC were perceived as caring more about helping Black women succeed in STEM relative to those identified at the PWI. However, because Study 2 was correlational, it is unclear whether the perceptions of allyship were tied to specific behaviors enacted by identified role models,

the nature of the institution itself, or a combination of the two. Better delineating how allyship can help White individuals—particularly White men who are overrepresented in STEM (NSF, National Center for Science and Engineering Statistics, 2017)—act as effective identity-safety cues and facilitate Black women's sense of belonging in STEM should be explored. Research examining extended contact suggests that the mere knowledge of positive contact between a fellow ingroup member (i.e., a Black woman) and an outgroup member (i.e., a White man scientist) can promote more positive attitudes toward other outgroup members (Pettigrew, Christ, Wagner, & Stellmacher, 2007; Schofield, Hausmann, Ye, & Woods, 2010; Wout, Murphy, & Steele, 2010). Whether a White man professor who mentors a racially diverse group of incoming engineering majors, for example, is perceived as an ally and as an effective identity-safety cue (i.e., encourages belonging in STEM) is an important question for future research.

It is also important to examine in future research why a common racial identity encourages perceived similarity with exemplar and role model identity-safety cues. Previous research suggests that Black women tend to be more aware of racism than sexism (King, 2003; Levin, Sinclair, Veniegas, & Taylor, 2002), and such awareness can encourage identification with those sharing one's racial identity (Branscombe et al., 1999). Future investigations should directly examine Black women's awareness of racism and sexism in STEM environments to examine if a greater awareness of racial bias promotes identification with successful role models who share a common racial identity. It is also unclear from our studies what conditions lead Black women to identify with role models who lack a shared racial identity. Perhaps teaching Black women students about the pervasive nature of gender bias in STEM may encourage identification. Recent work by Pietri, Johnson, Ozgumus, and Young (2018) found that teaching women (with a majority White sample) about gender bias in STEM encouraged perceptions that a successful White woman scientist had encountered similar unfair treatment as participants; in turn, perceptions of shared experience promoted identification with the woman scientist. Teaching Black women about gender bias in STEM may encourage them to perceive White women scientists in STEM as individuals who have faced bias and, consequently, encourage them to identify with these role models. However, future work is needed to test this question directly.

The present investigation is also limited to Black women. Recent work examining identity-safety transfer has found that identity-safety cues signaling identity safety for racial and ethnic minorities, also signal identity safety for White women, and vice versa (Chaney, Sanchez, & Remedios, 2016). A Black woman role model may also encourage belonging and trust among other identities underrepresented in STEM environments, such as Black men, and White and Latina women. Also, research investigating identity-safety transfer has yet to be examined among Black women or other



groups possessing multiple stigmatized identities. Although the current studies focused on STEM, Black women are underrepresented in many domains (e.g., business, management) and face unique challenges in these environments (Cook & Glass, 2014; Rosette & Livingston, 2012). The current results most likely are not limited to STEM, and future research should explore if exposure to Black women role models encourages belonging in areas outside of STEM.

It is also important to better understand what environments affect levels of stigma consciousness and promote feelings of belonging. Our HBC STEM majors in Study 2 were significantly higher in stigma consciousness relative to their PWI counterparts; however, higher levels of stigma consciousness positively related to belonging in the institution. Previous work has found that when Black students enter an environment where their racial identity is salient, this can heighten stigma consciousness (Pinel et al., 2005); thus, it may be possible that a women-only HBCU is an environment that elicits greater concerns about being the target of discrimination. On the other hand, it may be that Black women who are higher on average in stigma consciousness may seek out environments and persons to strategically avoid people or places that possess a high likelihood of discrimination (Pinel, 1999; Swim, Cohen, & Hyers, 1998; Utsey, Ponterotto, Reynolds, & Cancelli, 2000). Several recent studies have highlighted that stigma consciousness can be associated with positive outcomes under certain conditions (Clark, Thiem, Hoover, & Habashi, 2017; Wang, Stroebe, & Dovidio, 2012), but future work is needed to better understand when higher levels of stigma consciousness encourage a sense of belonging.

## Conclusions

Until Black women are equally represented in STEM, identifying strategies to encourage Black women students to feel a sense of belonging in STEM environments is imperative for the effective recruitment and retention of Black women in STEM. The current research represents a critical first step by demonstrating that access to exemplars and role models sharing a racial identity with Black women, as well as perceiving those lacking a shared racial identity as allies, encourages Black women to feel a sense of belonging in STEM environments.

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