THE ROLE OF ROLE MODELS: HOW DOES IDENTIFICATION WITH STEM ROLE MODELS IMPACT WOMEN’S IMPLICIT STEM STEREOTYPES AND STEM OUTCOMES?

AN ABSTRACT
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Abstract

Stereotypes associating men more strongly with science compared to women have harmful implications for women’s science, technology, engineering, and math (STEM) outcomes. Exposure to successful female STEM role models can buffer women from the effect of these stereotypes and lead to better performance and greater interest in STEM fields. Moreover, role model identification is especially important for improving women’s STEM outcomes. The current study posits that encouraging women to reflect on the ways in which they identify with a role model will improve women’s STEM identification, STEM sense of belonging, weaken explicit STEM stereotypes, and will strengthen implicit associations between women and science over the course of a semester, which will then lead to increased desire to pursue STEM opportunities and improved STEM GPA. Seventy-two incoming freshmen women interested in majoring in STEM completed the study. Participants read two role model biographies at different time points during the semester, and at both time points were asked to either write about the ways in which they identified with the role model, asked to write facts about the role model, or asked to write facts about a woman whose hobbies they read about (i.e., control condition). Results revealed that encouraging women to identify with a role model weakened explicit stereotypes and strengthened implicit women-science associations compared to merely exposing women to a role model. Furthermore, encouraging women to identify with a role model and merely exposing women to a role model tended to increase STEM sense of belonging compared to not exposing women to a role model. These findings suggest that encouraging women to identify with a role model is important for improving women’s STEM attitudes.
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Women are underrepresented in many areas of science, technology, engineering, and math (STEM) fields. For instance, of the bachelor degrees awarded in 2009-2010 at American colleges and universities, women received only 18% of the computer science degrees, 18% of the engineering degrees, 42% of the physical science degrees, and 43% of the math degrees (National Science Foundation, 2010). Furthermore, there are even fewer women entering into graduate programs in STEM (National Science Foundation, 2010). This gender disparity is striking when considering recent research demonstrating that young women and young men perform equally well in mathematics, a subject critical to success in many STEM fields (Lindberg, Hyde, Petersen, & Linn, 2010). Although there are many factors that contribute to the gender gap in STEM fields, negative ability-based stereotypes are a primary culprit (Eagly & Wood, 1991; Eccles, Jacobs & Harold, 1990; Nosek & Smyth, 2011). That is, in Western culture, women are stereotyped to be worse in STEM fields such as math and the sciences compared to men, and these stereotypes affect both men’s and women’s outcomes (Eagly & Wood, 1991; Eccles, Jacobs & Harold, 1990; Lane, Goh, Driver-Linn, 2012; Nosek & Smyth, 2011; Nosek et al., 2009).
Although cultural stereotypes play a large role in maintaining the gender gap in STEM fields, there are interventions that are effective in buffering women from the negative consequences of these stereotypes. For example, being exposed to female role models who have been successful in negatively stereotyped domains helps to improve women’s outcomes in these domains (Dasgupta & Asgari, 2004; Marx & Roman, 2002; Plant, Baylor, Doerr, & Rosenberg-Kima, 2009; Stout, Dasgupta, Hunsinger, & McManus, 2011). Female role models demonstrate to women that success is possible, despite the negative stereotype that is associated with their group. Furthermore, exposure to successful role models may change women’s gendered implicit stereotypes (e.g., Dasgupta & Asgari, 2004). The current study aims to demonstrate that exposure to female STEM role models over the course of a semester will weaken women’s STEM stereotypes and strengthen their identification and feelings of belongingness with STEM domains thus leading to an increased desire to pursue STEM opportunities and improved STEM GPA.

**Women and Negative STEM Stereotypes**

In Western culture, women are stereotyped to be worse at math and science compared to men (Eagly & Wood, 1991; Eccles, Jacobs & Harold, 1990; Lane, Goh, Driver-Linn, 2012; Nosek & Smyth, 2011; Nosek et al., 2009). Although negative stereotypes regarding women’s math and science ability can exist at a conscious, explicit level, literature documenting endorsement of stereotypes about women’s math and science ability is not always consistent. That is, while some studies demonstrate that both men and women endorse math and science stereotypes (Lane, Goh, Driver-Linn, 2012; Ramsey & Sekaquaptewa, 2011), other studies do not report significant endorsement of
explicit math and science stereotypes (e.g., Nosek, Banaji, & Greenwald, 2002; Nosek & Smyth, 2011). In a study conducted by Lane, Goh, and Driver-Linn (2012), participants reported that men were better at science and that women were better at humanities, and there were not any gender differences in the responses. Endorsement of explicit math stereotypes has also been shown to increase over the course of an undergraduate math class for men and women (Ramsey & Sekaquaptewa, 2011).

While there is inconsistency in the extent to which people will endorse explicit stereotypes, repeated exposure to cultural factors, such as the underrepresentation of women in math and science fields, leads individuals to internalize stereotypic associations at an implicit level. Numerous studies utilizing the Implicit Association Test (IAT, Greenwald, McGhee, & Schwartz, 1998) have demonstrated that people tend to associate men with science and math, and women with humanities more than they associate men with humanities and women with science and math (e.g., Lane, Goh, Driver-Linn, 2012; Nosek, Banaji, & Greenwald, 2002; Nosek & Smyth, 2011; Nosek et al., 2009). While most of the research described above focuses on either math or science stereotypes, the current study focuses on STEM stereotypes more broadly. As such, the current research will draw on research that measures math and science stereotypes independently as well as research that measures more generalized STEM stereotypes.

A number of correlational studies have demonstrated that stronger implicit STEM stereotypes among women are related to worse performance on standardized STEM tests, lower grades in STEM classes, lower identification with STEM fields, less interest in pursuing STEM careers, and more STEM anxiety (e.g., Lane, Goh, Driver-Linn, 2012; Nosek, Banaji, & Greenwald, 2002; Nosek & Smyth, 2011; Nosek et al., 2009; Ramsey
& Sekaquaptewa, 2011). While this research is informative, the correlational nature of these findings makes it difficult to determine if stereotypic associations lead to poor STEM outcomes, or if stereotypic associations are the result of having negative STEM experiences. However, several longitudinal and experimental studies help shed light on this question. Specifically, implicit STEM stereotypes measured at the beginning of the semester predicted women’s final calculus exam grades—the stronger women’s implicit STEM stereotypes the worse they performed on the final exam (Kiefer & Sekaquaptewa, 2007a). Furthermore, research has demonstrated that women’s implicit STEM stereotypes increased after taking a calculus class, and changes in the strength of STEM stereotypes predicted worse course performance for women, but not for men (Ramsey & Sekaquaptewa, 2011). Experimental research also provides support for the argument that implicit STEM stereotypes are harmful for women’s STEM outcomes. Specifically, women who were instructed to associate women with math and men with English (i.e., a stereotype retraining procedure; Forbes & Schmader, 2010) performed better on a math exam that was described as diagnostic of math ability compared to women who were instructed to associate women with English and men with math (i.e., a stereotype reinforcement procedure). Thus, research suggests that implicit STEM stereotypes lead to worse STEM outcomes for women. Furthermore, changing STEM stereotypes can also impact women’s STEM outcomes—strengthening women’s STEM stereotypes leads to worse STEM outcomes, while weakening women’s STEM stereotypes improves STEM outcomes.

To date, most of the research examining the relationship between implicit STEM stereotypes and STEM outcomes has used the IAT, which is a comparative measure. That
is, the STEM IAT compares the strength of the men-STEM/women-humanities association to the strength of the men-humanities/women-STEM association. However, examining the independent components of implicit stereotypes can offer additional information about the relationship between stereotypes and outcomes. Gilbert, O’Brien, Garcia, and Marx (2014) used the Go/No-Go Association Task (GNAT; Nosek & Banaji, 2001) to break down implicit math and English stereotypes into four independent components: the stereotypic men-math association, the counterstereotypic men-English association, the counterstereotypic women-math association, and the stereotypic women-English association. The stereotypic men-math association was stronger compared to the counterstereotypic women-math association, and the stereotypic women-English association was stronger compared to the counterstereotypic men-English association for both men and women, suggesting that most participants held implicit stereotypes. Furthermore, for women, stronger women-math associations were related to better math outcomes, but worse English outcomes, while stronger women-English associations were related to worse math outcomes, but unrelated to English outcomes. The men-math and men-English associations were unrelated to math and English outcomes for women after statistically controlling for the women-math and women-English associations. These results demonstrate that, for women, the independent associations tied to the ingroup are better predictors of math and English outcomes compared to the associations tied to the outgroup. Thus, applied to the case of implicit STEM stereotypes, this research suggests that strengthening women’s women-STEM association may be more important for improving women’s STEM outcomes than weakening women’s men-STEM association (e.g., Forbes & Schmader, 2010).
Implicit STEM stereotypes clearly have profound implications for women’s STEM outcomes. Furthermore, strengthening the association tied to women’s ingroup, the women-STEM association, may be a promising approach for improving women’s STEM outcomes. As such, the proposed study focuses on one effective intervention that buffers women from negative STEM stereotypes—exposure to successful female STEM role models (e.g., Dasgupta & Asgari, 2004; Marx & Roman, 2002; Plant et al., 2009; Stout, et al., 2011). The proposed study argues that one reason role models may be effective at improving STEM outcomes for women is that female role models strengthen women’s counterstereotypic associations, such as the women-science association (e.g., Duval, Ruscher, Welsh, & Catanese, 2000).

**STEM Role Models**

Seeing a woman succeed in a STEM domain demonstrates to other women that they personally can succeed despite the negative stereotype associated with their group. Indeed, being exposed to women who are successful in math and science fields (i.e., female role models) reduced explicit and implicit STEM stereotypes (Dasgupta & Asgari, 2004; Plant et al., 2009), and improves a number of women’s STEM attitudes and outcomes, such as interest in STEM fields, identification with STEM domains, sense of belonging in STEM fields, test performance, and grades in STEM courses (Dasgupta & Asgari, 2004; Marx & Roman, 2002; Plant et al., 2009; Stout, et al., 2011). Specifically, in an initial experimental demonstration of the STEM role model effect, Marx and Roman (2002) demonstrated that women perform better on a math exam under stereotype threat conditions when they have a female experimenter compared to when they have a male experimenter. Furthermore, the female experimenter was especially effective at
improving performance when she was described as being extremely competent in math. One reason female STEM role models might be effective is because of social comparison processes (Festinger, 1954). That is, role models provide an opportunity for women to engage in upward social comparison with a group member that has succeeded in the negatively stereotyped domain (Collins, 1996; Gibson, 2004; Lockwood & Kunda, 1997).

Upward social comparison is the process of comparing one’s abilities and standing to the abilities and standing of a successful comparison other (Festinger, 1954). Although in some cases upward social comparison can be threatening and result in decrements to self-esteem (Festinger, 1954; Morse & Gergen, 1970; Wood, 1996), research has demonstrated circumstances under which upward social comparison may have positive implications (for a review see Collins, 1996). Specifically, upward social comparison is especially beneficial when the successful comparison other’s (e.g., a role model’s) success is seen as relevant and attainable (Gibson, 2004; Lockwood & Kunda, 1997).

The relevance of a comparison other can be achieved in a number of ways—they may appear similar on demographic factors, such as gender or race, or the domain in which they have succeeded may be relevant. Thus, one reason female STEM role models are effective in improving women’s STEM outcomes is that they are women (i.e., relevant on a demographic factor) that have been successful in a STEM field (i.e., domain relevance). Furthermore, relevance of the role model’s gender may be particularly salient under conditions of threat, making upward social comparison even more effective (Blanton, Crocker, & Miller, 2000; Marx, Stapel, & Muller, 2005; Taylor & Lobel, 1989). That is, stereotype threat situations activate the negative STEM stereotypes
associated with women, making women’s group membership particularly salient (Marx, Stapel, & Muller, 2005). Under these conditions, receiving positive information about a group member’s success in the negatively stereotyped domain leads women to believe that they could also succeed, and as such perform better on a math exam (Marx, Stapel, & Muller, 2005). However, the same upward comparison information about an ingroup member under nonthreatening conditions can actually lead to worse performance for women on a math exam (Marx, Stapel, & Muller, 2005). Although relevance is an important quality of a role model, for women this may be especially true when they encounter a threatening STEM situation.

Attainability of the comparison other’s success is also an important factor in the effectiveness of upward social comparison. If the success of the comparison other is attainable, one will feel inspired and view the success of the comparison other as possible for their future selves (Gibson, 2004; Lockwood & Kunda, 1997). That is, in order for a role model to be effective at inspiring other women, their success must be seen as realistic and within the realms of possibility. Prior role model research has typically used role models whose success is portrayed as being noteworthy, but also achievable. Specifically, role models are often portrayed as being college students who have majored in math or science domains and who have succeeded in these domains (e.g., Cheryan, Siy, Vichayapai, Drury, & Kim, 2011; Dasgupta & Asgari, 2004; Marx & Ko, 2012; Marx, Monroe, Cole, & Gilbert, 2013, Plant et al., 2009; Stout et al., 2011). Furthermore, research has demonstrated that upward social comparison with a role model whose success seems unattainable can be detrimental for women’s outcomes (Hoyt & Simon, 2011).
Research has demonstrated two additional factors that impact the effectiveness of female STEM role models. In the domain of negative STEM stereotypes, successful role models need to appear confident of their STEM abilities. That is, potential role models who demonstrated success in STEM, but who also expressed some anxiety about their STEM ability were not effective role models for women. Exposure to role models who expressed anxiety about their ability led women to perform worse on a math exam than equally competent women who did not express anxiety (Marx et al., 2013). Furthermore, young girls who were exposed to elementary school teachers’ nonverbal expressions of math anxiety had worse math performance and reduced math ability-based beliefs compared to boys in the same classes (Beilock, Gunderson, Ramirez, and Levine, 2010).

Whether or not the role model embodies stereotypical traits of the negatively stereotyped STEM domain is also important for the role model’s effectiveness. Female STEM role models that personified traits that are stereotypical of computer scientists (e.g., being unfashionable and nerdy) were not effective at improving women’s desire to enter computer science fields compared to female role models that appeared counterstereotypic of computer scientists (Cheryan et al., 2011). Thus, role model relevance, the attainability of the role model’s success, role model confidence, and role model stereotypicality all seem to be important qualities of the role model that make them effective at improving women’s STEM outcomes. These qualities may be important for a role model’s effectiveness because they all help women to identify with the role model to whom they are being exposed (Cheryan et al., 2011; Gibson, 2004; Hoyt & Simon, 2011; Stout et al., 2011, Studies 2 and 3).

**Identifying with a STEM Role Model**
The extent to which women feel identified with role models has important implications for how effective role models are at improving women’s STEM attitudes and outcomes (Cheryan, Drury, Vichayapai, 2013; Cheryan et al., 2011; Dasgupta, 2011; Marx & Ko, 2012; Stout et al., 2011). Furthermore, the traits and qualities role models possess greatly influence role model identification. One such quality that research has demonstrated as being important for role model identification is sharing group membership. For example, female STEM role models are more effective at improving women’s STEM outcomes compared to male STEM role models (Marx et al., 2013; Lockwood, 2006; Stout et al., 2011; although see Cheryan et al., 2011 for an exception). Identification with the female STEM role model led to improved implicit STEM identification and STEM self-efficacy (Stout et al., 2011, Studies 2 and 3).

While sharing group membership increases identification with role models, possessing traits that are seen as being unfavorable decreases identification with role models. Women feel less identified with female STEM role models that embody negative stereotypic STEM attributes that are irrelevant to the role model’s success compared to role models that do not embody stereotypic attributes. That is, women identified less with role models who were portrayed as being nerdy and unfashionable (e.g., watching Star Wars and enjoying video games) compared to role models who had achieved the same level of success but were portrayed as not being nerdy (e.g., watching The Office and enjoying listening to music). Furthermore, a reduction in role model identification led to less of a desire to pursue a STEM degree (Cheryan et al., 2011).

The research discussed above highlights what factors lead to role model identification. This knowledge is important because identification with STEM role
models is related to a number of women’s STEM outcomes. Research has demonstrated a positive relationship between identification with an engineer role model and women’s intentions of pursuing an engineering career. In other words, the more women identified with a role model in engineering, the more they reported being interested in pursuing a career in engineering (Stout et al., 2011, Study 2). Women’s college professors can have a similar impact—the more women identified with their female STEM professors at the beginning of the semester the better their STEM self-efficacy (Stout et al., 2011, Study 3) and STEM identification (Young, Rudman, Buettner, & McLean, 2013) at the end of the semester. Furthermore, identification with a role model mediated the relationship between exposure to a nerdy or not nerdy role model and how much women believed they could succeed in computer science. That is, women who were exposed to a nerdy computer science role model felt less identified with the role model which then led to a reduction in how much they believed they could succeed in computer science (Cheryan et al., 2011). Identification with STEM role models also weakens implicit STEM stereotypes (Young et al., 2013). Thus, identifying with STEM role models improves a number of women’s STEM outcomes, such as better STEM grades and increased desire to pursue STEM degrees and careers (Cheryan et al., 2011; Marx & Ko, 2012; Stout et al., 2011, Studies 2 & 3).

Although several studies have demonstrated the importance of identifying with a role model, to my knowledge none of these prior studies have attempted to directly manipulate role model identification by encouraging women to reflect and write about the ways in which they identify with a role model (e.g., Cheryan et al., 2011; Hoyt & Simon, 2011; Stout et al., 2011). There are several reasons to believe that actively thinking about
how one identifies with a role model might improve outcomes. First, reflecting about the
ways in which one identifies with a role model and then writing about that identification
is a controlled process, and controlled processes are more effective at producing long-
lasting attitude change and improving outcomes (Cialdini, Petty, & Cacioppo, 1981;

In addition, writing about the ways in which one identifies with a role model
increases women’s level of involvement compared to when one merely reads about a role
model. In other words, instructing women to write about the ways they identify with a
role model increases the likelihood that woman will think about the ways in which the
information is personally relevant for them and their goals (i.e., increased involvement).
Research has demonstrated that increased levels of involvement while being exposed to a
persuasive argument leads to greater changes in explicit and implicit attitudes (Marini,
Furthermore, involvement leads to greater attitude change when the message is processed
via the central route of persuasion (Petty, Cacioppo, & Schumann, 1983). The central
route of persuasion occurs when the observer is motivated and able to take the time to
process the message being delivered. The other route of persuasion, the peripheral route,
ocurs when the observer is either unmotivated or unable to take the time to process the
message (for a review see Cialdini, Petty, & Cacioppo, 1981; Petty, Wheeler, Tormala,
2013). The current sample consists of women that have expressed an interest in pursuing
a STEM major, and should be motivated to carefully process information about a STEM
role model. Thus, being involved (i.e., actively writing about how one identifies with the
role model) and processing the message via the central route of persuasion (i.e., being
motivated to think carefully about the information provided) should then lead to a greater change in STEM identification, sense of belonging, and explicit and implicit stereotypes, which should also lead to improved STEM outcomes.

Along with manipulating whether or not women were encouraged to reflect about the ways in which they identified with the role model, the present study aimed to add to the growing body of literature examining how role models impact women longitudinally and in the field. Most of the research on the effectiveness of female STEM role models, including those studies that have examined role model identification, have been conducted in the lab (e.g., Cheryan et al., 2011; Marx & Ko, 2012; Stout et al., 2011 Studies 1 & 2). However, there are several noteworthy studies examining how role models might buffer women from negative stereotypes longitudinally. For instance, women undergraduate students tend to have more positive implicit math attitudes and stronger implicit math identification after taking a math course with a female professor compared to taking a course with a male professor (Stout et al., 2011, Study 3). Furthermore, women that identified with their female professor had even more positive implicit math attitudes and stronger implicit math identification compared to women that did not identify with their female professor. The sex of the math professor did not impact men’s implicit math attitudes or identification over the course of the semester. There is also research that suggests that exposure to female role models over the course of a school year weakens implicit stereotypes for women at a women’s university (Dasgupta & Asgari, 2004). However, the longitudinal studies that do examine the effectiveness of female STEM role models are correlational. There may be something fundamentally different about women that choose to register in a STEM course taught by a female
professor compared to women that enroll in a STEM course taught by a male professor. Thus, the current study utilized experimental procedures by randomly assigning women to either be exposed to role models or not (i.e., the control condition) at two time points over the course of a semester. In this way, the present study provided a causal test of whether exposure to female role models has an impact on STEM outcomes outside the laboratory and further examined the processes through which role model exposure impacts outcomes.

**Study Overview**

The current study examined how exposure to STEM role models and actively encouraging women to reflect on the ways in which they identify with potential role models impacts women’s STEM outcomes over the course of a semester. Specifically, the impact of role model exposure on women’s STEM identification, sense of belonging, and explicit and implicit STEM stereotypes was examined. The impact of role models on female STEM majors’ final grades in STEM courses and intentions to pursue a STEM degree was also examined.

It was hypothesized that encouraging women to reflect on the ways in which they identify with role models will improve women’s STEM identification and sense of belonging, weaken their explicit STEM stereotypes, as well as strengthen their women-science associations relative to merely exposing women to a role model without encouraging them to reflect on how they identify with the role model. However, mere exposure to a role model should also improve women’s STEM identification and sense of belonging, weaken their explicit STEM stereotypes, as well as strengthen their women-
science associations relative to a control condition in which women are exposed to information about a woman’s hobbies (i.e., the control condition).

Gilbert et al. (2014) demonstrated that stronger associations in math were related to weaker associations in English. Based on these findings it was expected that encouraging women to reflect on the ways in which they identify with role models may weaken their women-humanities associations relative to mere exposure to a role model. Furthermore, it was hypothesized that mere exposure to a role model may weaken women’s women-humanities associations relative to the control condition. Lastly, it was hypothesized that encouraging women to think about how they identify with a role model and mere exposure to a role model (i.e., the two role model conditions) would not impact participant’s men-science or men-humanities associations.

Encouraging women to reflect on the ways in which they identify with role models was expected to improve women’s final STEM grades and increase women’s intentions to pursue STEM opportunities relative to merely exposing women to role models. It was also expected that mere exposure to a role model would also improve women’s final STEM grades and increase women’s intentions to pursue STEM opportunities relative to the control condition. Furthermore, I hypothesized that improved STEM identification, sense of belonging, and the strengthened women-science associations would individually mediate the relationship between exposure to role models and STEM outcomes.
Method

Recruitment

Participants were recruited using flyers handed out on campus and by in-class announcements. Flyers (see Appendix A) included information such as the length of each study session, the total time commitment, and the compensation amount. Individuals interested in participating were directed to an online qualification survey to determine their eligibility for the study. The flyer did not include any detailed information pertaining to the purpose of the study or eligibility requirements. In-class announcements were scheduled after receiving permission from professors who were teaching science, math, and engineering courses during the Fall 2013 semester. The in-class recruitment script (see Appendix B) included identical information to the campus flyers that were handed out. Students were given the length of each study session, the total time commitment, and the compensation amount for participation. As with the flyer, the in-class announcement did not include the purpose of the study or the specific eligibility requirements. Students who were interested in participating were then given a sheet of paper with the link to the qualification survey.

Students interested in completing the study were asked to complete a qualification survey to determine if they met the eligibility requirements (see Appendix C). The survey included three questions that determined eligibility, What is your gender?, What is your year in school?, and What is your major? Students were instructed to select their major
from a list of choices. If they did not see their major listed, they were asked to pick a major that was most similar. The qualification survey also included filler items, such as *In what state did you attend high school?* and *Please indicate your mother’s highest level of education.* Students qualified for the study if they were women, first year students, and selected a STEM major. Eligible students were told they qualified, but were not given any information regarding what characteristics made them eligible to participate. They were asked to provide contact information and were told they would be contacted to schedule the first study session. Students who were not eligible were only told they did not qualify, and were not given any additional information as to why they were not eligible to participate.

**Retention**

Seventy-nine women were originally enrolled in the study and completed the pre-manipulation session. See Table 1 for the majors of all study participants. Approximately three weeks after the pre-manipulation session, participants were emailed their link to complete the first manipulation session and were given two weeks to complete the session. If participants did not complete the first manipulation session online within a week, a follow-up email was sent reminding participants of the deadline and giving them the link again. Participants were sent a third email if they had not completed the session three days before the deadline and were asked to complete the session as soon as possible. The links for the second manipulation session were emailed to participants approximately three to four weeks after the first manipulation session was completed. The same follow-up procedure that was used for the first manipulation session was also used to remind participants to complete the second manipulation session. Finally,
approximately two weeks after the second manipulation session was completed, participants were sent an email to schedule the post-manipulation session in the lab. Participants were sent a follow-up email a week later if they had not scheduled their lab session. A final email was sent three days later to request that participants schedule their lab session as soon as possible. One participant did not complete either of the manipulation sessions or the post-manipulation session. Three women did not complete the post-manipulation session. Furthermore, three women in the reflective identification condition indicated that they did not identify with the role model when asked to write about how they identified with her. These seven participants were dropped because they did not follow the task instructions. The post-manipulation data for another two participants was incomplete due to computer malfunctions. These participants were left in the dataset because they were able to complete some of the post-manipulation session before the computer malfunctioned, but were not able to finish the session. Thus, data from seventy-two women was analyzed; however, degrees of freedom vary for analyses of different outcomes.

**Participants**

Seventy-nine women who expressed interest in majoring in STEM were recruited for monetary compensation. Participants were all incoming freshman and were between 18 and 19 years of age \((M = 18.06, SD = .23)\). Sixty-three participants identified as White/Caucasian, seven participants identified as Asian American, two participants identified as African American, one participant identified as Middle Eastern, and six participants identified as biracial.
Design

The current study consisted of a longitudinal, experimental design. Participants were randomly assigned to one of three conditions: a standard role model condition, a reflective identification role model condition, or a control condition. Furthermore, participants completed measures at the beginning of the Fall 2013 semester, before being exposed to the role models (i.e., pre-manipulation), and again at the end of the Fall 2013 semester after being exposed to the role models (i.e., post-manipulation).

Procedure

Participants completed the pre-manipulation and post-manipulation sessions in the lab. Both of the manipulation sessions were completed online.

Pre-manipulation session. Participants came into the laboratory for the pre-manipulation session at the beginning of the Fall 2013 semester, between September 16th and October 5th. After giving informed consent to participate in the study (see Appendix D), participants completed the GNAT in order to assess their baseline gendered STEM and humanities associations. Participants were then asked to complete explicit measures of STEM stereotype endorsement, STEM identification, and STEM sense of belonging in one of three counterbalanced orders. Order did not impact responses on the measures (all $p$’s > .18) and was not included in any of the regression analyses discussed below. Participants were also asked to complete a measure assessing their intentions to pursue STEM opportunities. Lastly, participants completed demographic questions (see Appendix E). At the conclusion of the pre-manipulation session participants were asked for their consent to access their academic transcripts at the end of the semester.
Specifically, participants were told that we are interested in their final grades, but were not told we are specifically interested in their STEM grades. Participants were then given a form to either give their consent or withhold their consent for accessing their Fall 2013 transcripts (see Appendix F).

**Manipulation sessions.** Participants were exposed to the manipulation at two time points during the Fall 2013 semester, the first session online occurred between October 21st –October 31st and the second online session occurred between November 11th –November 22nd. Participants in the role model conditions read a biography of a STEM role model and completed a measure of role model identification. Participants in the control condition read a biography describing a woman’s hobbies, and then also completed a measure of identification.

**Manipulation.** In both of the role model conditions participants were sent information about a successful woman in a STEM career who is an alumni of their university. Specifically, participants were instructed to read a biography of a woman who has been successful in an industry STEM career. The biography included information about where the woman works and her job description (see Appendix G for role model biographies). For the first manipulation session, the role model’s race and major were matched to the participant’s race and major (see Appendix H for role model pictures for both sessions). For the second manipulation session, all of the participants read a biography of a white woman who had been a computer science major. This major was chosen because none of the participants in the current study were computer science majors and therefore all participants were exposed to one STEM role model in their major and one STEM role model outside their major. Furthermore, a white role model
was chosen for the second manipulation session in order to avoid suspicion among the ethnic minority participants. These participants may have become suspicious of the manipulation if they were exposed to two different role models that were of the same race and the same major as themselves.

In the *reflective identification role model condition*, participants were asked to think and then write about the ways in which they identified with the woman in the biography they read (see Appendix I). Participants were told that identification encompasses the extent to which they feel similar to the role model, can relate to the role model, and/or want to achieve a similar level of successes as the role model. In the *standard role model condition*, participants were told that we want to ensure they were engaged while reading the biography, and were instructed to write a paragraph summarizing the details they recalled about the woman from the biography they read (see Appendix J).

In the *control condition*, participants read a biography about a woman who is an alumni of their university, and the hobbies she enjoys. For the first manipulation session, participants read about a women who was the same race as themselves and who enjoyed cooking. For the second manipulation session, participants in the control condition read about a woman who enjoys hiking, kayaking, and being outdoors (see Appendix H for hobby biographies). Participants were told that we want to ensure they were engaged while reading the biography, and were instructed to write a paragraph summarizing the details they recalled about the woman from the biography they read (Appendix K).
Post-manipulation session. The post-manipulation session took place in the laboratory at the end of the Fall 2013 semester, between November 25th and December 10th. Participants completed the GNAT, followed by the same explicit measures of STEM stereotype endorsement, STEM identification, and STEM sense of belonging as the pre-manipulation session in a counterbalanced order. Again, order did not impact responses on the measures (all \( p \)'s > .09) and was not included in any of the regression analyses discussed below. Participants were also asked again to complete the same measure assessing their intentions to pursue STEM. Participants were given a full debriefing at the conclusion of the post-manipulation session (see Appendix L).

Final STEM grades. Fall 2013 academic transcripts were obtained for all participants that gave their consent. Each course participants took was categorized as being either a STEM course or a non-STEM course. Courses were classified as STEM if they were offered by science, math, and engineering departments and were not a psychology course. Grade point average (GPA) was calculated for STEM courses and non-STEM courses for each participant. Seventy participants gave their consent to have their final grades recorded.

Measures

Participants completed the following measures at both the pre-manipulation and post-manipulation session (see Table 2 for means and standard deviations for all study measures at each time point). Instructions for the explicit STEM measures (e.g., explicit STEM stereotype endorsement, STEM identification, STEM sense of belonging, and
intentions of pursuing a STEM degree) reminded participants that STEM stands for science, technology, engineering, and math.

**GNAT.** Participants completed four randomly presented blocks of the GNAT, with each block consisting of 96 trials (Nosek & Banaji, 2001). Each block consisted of twenty stimuli words (see Appendix M) adapted from Stout et al., (2011). Ten of the stimuli words were part of the target categories *science* and *humanities*, while the other ten stimuli words were part of the target categories *men* and *women*. Two of these target categories were presented in the right and left quadrants of the screen for each block. For example, one block had the target categories *men* and *science* in the right and left quadrants. Half of the stimuli in each block presented target stimuli while the other half of the stimuli in the block presented distracter stimuli. For the block with *men* and *science* as the target categories, for example, stimuli that represent the men and science categories are considered the target stimuli. Stimuli that represent the women and humanities target categories are considered distracter stimuli. Participants were instructed to press the space bar (a “go” response) when the stimuli matched the target categories. In addition, participants were told to not press the space bar (a “no-go” response) when the stimuli did not match the target categories. The four blocks were made up of the target categories *men-science, men-humanities, women-science,* and *women-humanities*. Stimuli were presented on the screen for 500 ms. If participants did not respond within this response window a red “X” flashed on the screen, followed by the next stimulus word. Correct responses were followed by a green “O” and incorrect responses were followed by a red “X”.

Pre-manipulation and post-manipulation d´ association scores (i.e., women-science, women-humanities, men-science, and men-humanities) were computed for each participant. D´ scores were calculated using signal detection procedures as outlined by Nosek and Banaji (2001). Specifically, d´ is a comparison between correct go responses (“hits”) to incorrect go responses (“false alarms”). Higher d´ scores indicate a stronger association between the target categories. Any d´ scores of zero or lower were removed from analyses as these indicate that the participant was performing at or below chance (Nosek & Banaji, 2001). The following number of d´ association scores were dropped from the pre-manipulation session: one men-science d´, one men-humanities d´, two women-science d´s, and zero women-humanities d´. The following number of d´ association scores were dropped from the post-manipulation session: one men-science d´, and zero men-humanities, women-science, or women-humanities d´ scores.

**Explicit STEM stereotype endorsement.** To measure explicit STEM stereotype endorsement, participants were asked to answer seven items (see Appendix N). Sample items included *It is possible that men have more STEM ability than do women* and *I don’t think that there are any real gender differences in STEM ability* (reverse scored; pre-manipulation α = .88 and post-manipulation α = .90). Responses were given on a 7-point Likert scale ranging from 1 (Strongly Disagree) to 7 (Strongly Agree). Higher scores indicated more endorsement of explicit STEM stereotypes.

**STEM identification.** Participants completed 11 items adapted from Brown and Josephs’ (1999) Math Identification Questionnaire, adapted to assess the extent to which participants’ are identified with STEM rather than math (see Appendix O). Sample items included *How important to you are your STEM abilities?* and *I’m hopeless when it comes
Participants indicated their agreement with each statement on a Likert scale ranging from 1 (Not at all) to 7 (Very much). Higher scores indicated stronger STEM identification.

**STEM sense of belonging.** Participants completed 28 items adapted from Good, Rattan, and Dweck’s (2012) Math Sense of Belonging Scale, adapted to assess the extent to which participants’ feel they belong in the STEM community rather than the math community (see Appendix P). Specifically, the instructions asked participants to think about their membership in the STEM community, and to think about how they feel about their membership in the STEM community while answering the questions. Sample items included *I consider myself a member of the STEM community*, *I feel disregarded* (reverse scored), and *I enjoy being an active participant* (pre-manipulation α = .95 and post-manipulation α = .96). Participants indicated their agreement with each statement on a Likert scale ranging from 1 (Strongly Disagree) to 7 (Strongly Agree). Higher scores indicated stronger feelings of belonging in STEM.

**Intentions to pursue STEM degree.** Participants completed six items that assessed their intentions to pursue future STEM opportunities (see Appendix Q). Sample items included *How likely are you to pursue an undergraduate degree in STEM?*, *How likely are you to pursue a professional job in STEM?*, *How likely are you to join the Society for Women Scientists?* (pre-manipulation α = .65 and post-manipulation α = .86). Responses were made on a 7-point Likert scale ranging from 1 (Very Unlikely) to 7 (Very Likely). Higher scores indicated greater intentions to pursue STEM.
Role model identification measure. Participants in all three conditions completed a five item identification measure adapted from the Stout et al. (2011) Subjective Identification measure (see Appendix R). For the reflective identification role model condition and the standard role model condition, the items were adapted to assess the extent to which participants identified with the scientist or engineer they read about. In the control condition, the items were adapted to assess the extent to which participants identified with the woman they read about. Sample items include How much do you identify with the scientist or engineer (woman) you just read about?, How similar are you to the scientist or engineer (woman) you just read about?, and How much do you admire the scientist or engineer (woman) you just read about? Participants responded on a Likert scale ranging from 1 (Not at all) to 7 (Very Much); manipulation session 1 $\alpha = .88$ and manipulation session 2 $\alpha = .84$.

Results

Contrast Coding Role Model Conditions

The conditions were contrast coded such that the first code compared the standard role model condition to the reflective role model condition and the second code compared the control condition to both of the role model conditions. Thus, a significant difference in the outcomes for the first contrast coded variable indicates that the standard role model condition significantly differs from the reflective role model condition. Likewise, a significant difference in the outcomes for the second contrast coded variable indicates that the control condition differs significantly from the role model conditions.

Manipulation Check
Role model identification with the women in the biographies was examined as a manipulation check. Because the role model identification measures from the two manipulation sessions were not correlated, \( r = .08, p = .53 \), role model identification from each session was analyzed in separate regression equations.

**Session 1 role model identification.** The overall model predicting role model identification in the first session was significant, \( R^2 = .32, F(2, 70) = 15.93, p < .001 \). The main effect comparing the reflective identity condition (\( M = 5.50 \)) to the standard role model condition (\( M = 5.44 \)) was not significant, \( \beta = .02, t(70) = .17, p = .86 \). However, the main effect comparing the control condition (\( M = 3.88 \)) to the role model conditions was significant, \( \beta = .56, t(70) = 5.63, p < .001 \). Compared to the control condition, participants in the role model conditions were more identified with the woman they read about.

**Session 2 role model identification.** The overall model predicting identification for the woman in the second manipulation session was not significant, \( R^2 = .03, F(2, 70) = 1.21, p = .31 \).

**Hypothesis Testing**

The relationships between the role model conditions and post-manipulation variables (implicit STEM stereotypes, explicit STEM stereotype endorsement, STEM identification, STEM sense of belonging, final STEM grade, and intentions to pursue STEM) were examined in separate regression equations that included the two sets of contrast coded condition predictors and the pre-manipulation measure (in order to assess change). The interaction terms for the pre-manipulation measures by contrast coded
condition variables were also initially included in the model. This was done to ensure that the homogeneity of regression assumption was not being violated by including the pre-manipulation variable in the model as a covariate. The interaction terms were not significant in any of the tested models and were therefore dropped from the models reported here.

**GNAT d’ association scores.** Each of the four post-manipulation d’ association scores were analyzed in separate regression equations that included the two dummy coded condition variables and the pre-manipulation d’ association score.

**Women-science association.** The overall model predicting post-manipulation women-science d’ association scores was significant, $R^2 = .36$, $F(3, 69) = 12.57$, $p < .001$ (see Figure 1). The pre-manipulation women-science d’ association score was significant, $\beta = .54$, $t(69) = 5.41$, $p < .001$. More importantly, the main effect of the reflective identity condition compared to the standard condition was significant, $\beta = .21$, $t(69) = 2.14$, $p < .05$. Participants in the reflective identity condition ($M_{adj} = 1.99$) had stronger post-manipulation women-science associations compared to participants in the standard condition ($M_{adj} = 1.62$). The main effect of the control condition ($M = 1.74$) compared to the role model conditions was not significant, $\beta = .04$, $t(69) = 0.71$, $p = .70$.

**Women-humanities association.** The overall model predicting post-manipulation women-humanities d’ association scores was significant, $R^2 = .40$, $F(3, 71) = 15.33$, $p < .001$ (see Figure 2). The pre-manipulation women-humanities d’ association score was significant, $\beta = .56$, $t(71) = 5.91$, $p < .001$. In addition, the main effect of the reflective identity condition compared to the standard condition was marginally significant, $\beta = .18$,
Participants in the reflective identity condition \((M_{\text{adj}} = 2.35)\) tended to have stronger post-manipulation women-humanities associations compared to participants in the standard condition \((M_{\text{adj}} = 1.98)\). The main effect of the control condition compared to the role model conditions was also marginally significant, \(\beta = -.18, t(71) = -1.91, p = .06\). Participants in the control condition \((M_{\text{adj}} = 2.50)\) had stronger women-humanities associations compared to participants in the role model conditions \((M_{\text{adj}} = 2.17)\).

**Men-science association.** The overall model predicting post-manipulation men-science \(d'\) association scores was significant, \(R^2 = .26, F(3, 69) = 7.54, p < .001\). The pre-manipulation men-science \(d'\) association score was significant, \(\beta = .49, t(69) = 4.44, p < .001\). Neither of the contrast coded condition main effects were significant, both \(p\)'s > .63.

**Men-humanities association.** The overall model predicting post-manipulation men-humanities \(d'\) association scores was significant, \(R^2 = .30, F(3, 70) = 9.61, p < .001\). The pre-manipulation men-humanities \(d'\) association score was significant, \(\beta = .50, t(70) = 4.82, p < .001\). Neither of the contrast coded condition main effects were significant, both \(p\)'s > .24.

**Explicit STEM stereotype endorsement.** The overall model predicting post-manipulation explicit STEM stereotype endorsement was significant, \(R^2 = .55, F(3, 69) = 26.47, p < .001\) (see Figure 3). There was a significant main effect of pre-manipulation explicit STEM stereotype endorsement, \(\beta = .72, t(69) = 8.55, p < .01\). In addition, the main effect comparing the reflective identity condition to the standard condition was...
significant, $\beta = -.18$, $t(69) = -2.17$, $p < .05$. Participants in the reflective identity condition ($M_{\text{adj}} = 2.16$) endorsed STEM stereotypes to a lesser extent compared to participants in the standard role model condition ($M_{\text{adj}} = 2.67$). The main effect comparing the control condition ($M_{\text{adj}} = 2.77$) compared to the role model conditions was not significant, $\beta = -.14$, $t(69) = -1.65$, $p = .10$.

**STEM identification.** The overall model predicting post-manipulation STEM identification was significant $R^2 = .50$, $F(3, 69) = 21.91$, $p < .001$. There was a significant main effect of pre-manipulation STEM identification, $\beta = .69$, $t(69) = 7.95$, $p < .01$. Neither of the contrast coded condition main effects was significant, both $p$’s > .19.

**STEM sense of belonging.** The overall model predicting post-manipulation STEM sense of belonging was significant, $R^2 = .62$, $F(3, 69) = 35.53$, $p < .001$ (see Figure 4). There was a significant main effect of pre-manipulation STEM sense of belonging, $\beta = .75$, $t(69) = 9.81$, $p < .001$. The main effect comparing the reflective identity condition ($M_{\text{adj}} = 5.03$) to the standard condition ($M_{\text{adj}} = 4.95$) was not significant, $\beta = .04$, $t(69) = .50$, $p = .62$. However, the main effect comparing the control condition to the role model conditions was significant, $\beta = .18$, $t(69) = 2.36$, $p < .05$. Participants in the role model conditions ($M_{\text{adj}} = 4.99$) had greater STEM sense of belonging compared to participants in the control condition ($M_{\text{adj}} = 4.63$).

**Intentions to pursue STEM.** The overall model predicting post-manipulation intentions to pursue STEM was significant, $R^2 = .36$, $F(3, 69) = 12.52$, $p < .001$. The main effect of pre-manipulation intentions to pursue STEM was significant, $\beta = .60$, $t(69)$
= 6.06, \( p < .001 \). Neither of the contrast coded condition main effects was significant, both \( p \)'s > .30.

**Final STEM GPA.** The overall model predicting final STEM grade was not significant, \( R^2 = .01, F(3, 64) = .23, p = .80 \).

**Test of Mediation**

It was hypothesized that STEM identity, explicit stereotypes, women-science associations, and sense of belonging would mediate the relationship between condition and final STEM GPA. It was also hypothesized that STEM identity, explicit stereotypes, women-science associations, and sense of belonging would mediate the relationship between condition and intentions to pursue STEM opportunities. Prior to testing the mediation models, regression analyses were conducted among the study variables to ensure that the preconditions for mediation were met. As reported above, neither of the dummy coded condition variables predicted STEM identity, both \( p \)'s > .16. Although the dummy coded variable comparing the reflective role model condition to the standard role model condition significantly predicted explicit stereotypes \( (p < .05) \), explicit stereotypes did not significantly predict either STEM GPA or intentions to pursue STEM (both \( ps > .15 \)). Furthermore, the contrast coded variable comparing the reflective role model condition to the standard role model condition significantly predicted women-science associations \( (p < .05) \). Interestingly, while women-science associations did not significantly predicted intentions to pursue STEM opportunities, \( p = .31 \), women-science associations did marginally predict STEM GPA, \( p = .06 \). When examined as a potential mediator between condition and STEM GPA, however, women-science associations did
not pass the test of homogeneity of regression, $p < .05$. Thus, STEM identity, explicit stereotypes, and women-science associations were not tested as mediators because pre-conditions for mediation with these variables were not met.

As discussed above, the main effect comparing the control condition to the role model conditions predicting STEM sense of belonging was significant, $\beta = .18$, $t(69) = 2.36$, $p < .05$. The main effect comparing the reflective identity condition to the standard condition was not significant, $p = .62$. Importantly, sense of belonging significantly predicted both STEM GPA, $\beta = .29$, $t(63) = 2.31$, $p < .05$, and intentions to pursue STEM, $\beta = .24$, $t(69) = 2.31$, $p < .05$. Thus, two mediational models were tested. The first mediational model examined the relationship between the condition variables and STEM GPA mediated by sense of belonging. The second mediational model examined the relationship between the condition variables and intentions to pursue STEM opportunities mediated by sense of belonging.

To test the mediation models, the multivariate bootstrapping approach outlined by Hayes and Preacher (2013) was used. This approach estimates direct and indirect effects for $c - 1$ coded variables, where $c$ is the number levels. As with the regression analyses reported above, two contrast coded variables were used to test the mediation models. Thus, a direct effect for each of the contrast coded variables on post-manipulation STEM sense of belonging was estimated. An indirect effect for each of the contrast coded variables on the STEM outcomes (STEM GPA and intentions to pursue STEM) through STEM sense of belonging was also estimated. To test these models, the Hayes and Preacher (2013) SPSS macro was utilized and five thousand resamples were requested in order to calculate the estimate of the indirect effect.
**Sense of belonging mediating condition and STEM GPA.** Participants’ post-manipulation STEM sense of belonging was tested as a mediator of the relationship between the conditions and STEM GPA (see Figure 5). The total effect of condition on STEM GPA was marginally significant, total effect $= 2.19$, $p = .08$. Furthermore, the indirect effect of the contrast coded condition variable comparing the control condition to the role model conditions on STEM GPA through STEM sense of belonging was significant, indirect effect $= .17$, with a 95% confidence interval of .039 to .418. The indirect effect of the contrast coded condition variable comparing the reflective identity condition to the standard condition on STEM GPA through STEM sense of belonging was not significant, indirect effect $= .03$, with a 95% confidence interval of -.154 to .216. Thus, compared to the control condition, participants in the role model conditions had higher post-manipulation STEM sense of belonging, and higher sense of belonging was related to higher end of semester STEM GPA.

**Sense of belonging mediating condition and intentions to pursue STEM.** Participants’ post-manipulation STEM sense of belonging was tested as a mediator of the relationship between the conditions and intentions to pursue STEM opportunities (see Figure 6). The total effect of condition on intentions to pursue STEM was not significant, total effect $= 2.04$, $p = .12$. However, the indirect effect of the contrast coded condition variable comparing the control condition to the role model conditions on intentions to pursue STEM through STEM sense of belonging was significant, indirect effect $= .26$, with a 95% confidence interval of .058 to .714. The indirect effect of the contrast coded condition variable compared the reflective identity condition to the standard condition on intentions to pursue STEM through STEM sense of belonging was not significant,
indirect effect = .06, with a 95% confidence interval of -.207 to .423. Thus, compared to the control condition, participants in the role model conditions had higher post-manipulation STEM sense of belonging, and higher sense of belonging was related to greater intentions to pursue STEM opportunities.

**Discussion**

Women are underrepresented in STEM fields compared to men (National Science Foundation, 2010). Negative stereotypes alleging that women have worse STEM abilities compared to men play a large role in maintaining the gender imbalance in STEM fields (e.g., Lane, Goh, Driver-Linn, 2012; Nosek & Smyth, 2011; Nosek et al., 2009). While negative stereotypes have serious consequences for a number of STEM attitudes and outcomes for women, positive STEM role models are effective at buffering women from the consequences of the negative stereotypes (Cheryan et al., 2011; Dasgupta & Asgari, 2004; Marx & Roman, 2002; Plant et al., 2009; Stout et al., 2011). Furthermore, there is evidence that role models are also effective at changing negative stereotypes (e.g., Young et al., 2013). The present research aimed to demonstrate that exposing women to role models would reduce explicit stereotypes, strengthen women-science associations, and improve STEM identity, sense of belonging, STEM GPA, and intentions to pursue STEM opportunities. Furthermore, encouraging women to identify with positive role models, should further reduce explicit stereotypes, strengthen women-science associations, and improve STEM identity, sense of belonging, STEM GPA, and intentions to pursue STEM opportunities above and beyond the effect of role model exposure.
The present research found support for some, but not all, of these predictions. First, women who were encouraged to write about the ways in which they identified with STEM role models had weaker explicit stereotypes and stronger women-science associations at the end of the semester compared to women who were merely exposed to role models. These results provide partial support for the study hypotheses—encouraging women to identify with STEM role models impacted long-term stereotypes at both an explicit and implicit level. Contrary to predictions, however, explicit stereotype endorsement and the strength of women-science associations did not differ for women who were merely exposed to role models and women who were not exposed to role models. Also contrary to predictions, women who were merely exposed to role models had weaker women-humanities associations at the end of the semester compared to women who were encouraged to identify with the role models and compared to women who were not exposed to role models.

Second, women who were exposed to role models had greater STEM sense of belonging compared to women who were not exposed to role models. Furthermore, greater sense of belonging at the end of the semester lead to better STEM GPA and greater desire to pursue STEM opportunities for women who were merely exposed to STEM role models. Contrary to predictions, however, sense of belonging was no higher among women who were encouraged to identify with the role models than women who were merely exposed to the role models.

As mentioned above, not all of the study predictions were supported. Specifically, encouraging women to identify with a role model did not impact STEM identity, STEM GPA, or intentions to pursue STEM compared to merely exposing women to a role
model. Likewise, merely exposing women to a role model did not impact STEM identity, STEM GPA, or intentions to pursue STEM compared to women who were not exposed to a role model. I will return to a discussion of these null effects in the limitations section.

In many ways, the most important findings of the present study were the effects of the reflective role model condition on participants’ explicit and implicit stereotypes. The current study demonstrated that encouraging women to think and write about the ways in which they identify with STEM role models improved long-term explicit and implicit stereotypes compared to merely exposing women to role models. There are a number of potential reasons why this process of identification was effective at long-term stereotype change. First, research on attitude change has demonstrated that self-involvement with a persuasive message results in both explicit and implicit attitude change (Marini, Rubichi, & Sartori, 2012; Petty & Cacioppo, 1979; Petty, Cacioppo, & Goldman, 1981). The women recruited for the current study all expressed interest in STEM majors. Furthermore, the women in the reflective identification condition were instructed to think about the ways in which they were similar to the role model, instructions that likely increased their self-involvement in the task. Thus, women in the reflective identification condition may have been persuaded to change their stereotypes after exposure to a female STEM role model due to their high level of self-involvement in the study.

Alternatively, the process of identification may have made women more motivated to form accurate judgments of their group (e.g., Moreno & Bodenhausen, 1999) and this accuracy motive may have facilitated stereotype change. It may also be the case that these two processes (e.g., self-involvement and accuracy motives) worked in conjunction to impact stereotype change. Self-involvement in the task may have lead
women in the reflective identification condition to process the role model information more thoroughly while simultaneously motivating women to make accurate judgments. The current research cannot speak to why encouraging role model identification impacted women’s long-term explicit and implicit stereotypes; however, this may be a potential avenue for future research.

The unexpected reduction of participants’ women-humanities associations after they were merely exposed to role models compared to women who were encouraged to identify with the role models and compared to women who were not exposed to role models may have interesting implications. Implicit stereotypes that are positive for the group (e.g., the women-humanities association for women) may be easier to change compared to associations that are negative for the group (e.g., the women-science association for women). Thus, merely exposing women to positive STEM role models, and not engaging them in a more self-involved identification process, might have been enough to weaken their women-humanities associations, but may not have been enough to strengthen their women-science associations. Why, then, do we not also see women-humanities associations weakened as a result of encouraging women to identify with role models? If by encouraging women to write about the ways in which they identify with the role models increases accuracy motives, then these women may be more likely to acknowledge that women can be good at humanities (i.e., maintain the strong women-humanities association), while also being good at science (i.e., strengthening the women-science association). While the current study is unable to address this hypothesis, this is an interesting potential avenue for future research.
While the current study demonstrates that the process of identifying with a role model changes explicit and implicit stereotypes, this process did not differentially impact STEM sense of belonging compared to women who were merely exposed to role models. That is, women exposed to role models, whether or not they were encouraged to identify with the role model, had similar levels of sense of belonging. It is important to note, however, that sense of belonging was higher among women exposed to a STEM role model compared to women who were not exposed to a STEM role model. These findings suggest that simply exposing women to role models may be enough to increase their sense of belonging in STEM, which in turn may also improve their STEM GPA and increase their desire to pursue STEM opportunities (e.g., Cheryan, Drury, & Vichayapai, 2013; Rosenthal et al., 2013). Thus, simply seeing other women in STEM helps women to feel like they belong in these fields. If researchers want to impact long-lasting change on explicit and implicit stereotypes, however, a more active, involved identification process may be required.

Limitations and Future Directions

One potential limitation of the current study is that there was no difference in women’s identification with the session 1 role model in the reflective identification condition and the standard role model condition. Given the hypothesis, one would have expected that the reflective identification process to lead to higher role model identification as compared to exposure to the standard role model. The lack of difference between the two role model conditions may be because, immediately following exposure to the role model biographies, women in both of these conditions felt identified with the role model. Indeed, women in both STEM role model conditions had higher role model
identification as compared to women in the control condition. It may be that both types of STEM role model exposure increased role model identification in the short term, but that the reflective identification process led to longer-lasting role model identification. Unfortunately, the current study did not examine long term changes in role model identification. Regardless of the short-term effects on role model identification, encouraging women to identify with the role model did have long-term effects on explicit and implicit stereotypes. Thus, although the reflective identification process did not immediately increase role model identification compared to mere role model exposure, the long-term effects suggests that this process is effective at changing stereotypes.

It should also be noted that there were no differences in session 2 role model identification among any of the conditions. That is, identification with the woman in the biography did not differ for the role model conditions compared to the control condition. The STEM role models presented to participants during session 1 were matched on both race and major. The role models presented during session 2 were not matched on race for some of the participants (the role model was White) and was not the same major as any of the participants (a computer science major). Thus, being that the session 1 role model was so similar to the participants, it is not surprising that women felt more identified to her compared to reading about the hobbies of a university alumni (i.e., the control condition). Not being similar to the role model in session 2, however, lead women to feel the same amount of identification with her as they did with the woman in the control biography.

A second potential limitation may be that the current study used an explicit measure of STEM identification rather than an implicit measure of STEM identification.
Neither of the role model conditions in the current study impacted women’s STEM identification compared to women who were not exposed to role models. On the surface, this null finding is surprising. However, a closer look at the literature examining the relationship between role model exposure and STEM identification reveals that exposure to role models may be most strongly related to *implicit* STEM identification. For example, women enrolled in STEM courses who were exposed to female role models had stronger implicit identification with STEM compared to women who were exposed to male role models (Stout et al., Study 1, 2011; Young et al., 2013). There were no differences in explicit identification with STEM for women exposed to female role models compared to women exposed to male role models (Stout et al., Study 1, 2011; Young et al., 2013).

A third limitation may be that participants in the current study only read about a role model rather than interacting with a real person. In studies where women met and interacted with STEM role models (e.g., interacting with engineering peer experts, Stout et al., Study 1, 2011 or having female STEM professors, Young et al., 2013), role model exposure led to higher STEM identification. However, a study that had women read engineer role model biographies rather than interact directly with role models found no impact on women’s STEM identification (Stout et al., Study 2, 2011). Thus, direct interaction with STEM role models may be necessary to change women’s STEM identification.

A fourth potential limitation may be with the intentions to pursue STEM measure, which included items asking participants how likely they were to pursue a professional job in STEM and how likely they were to pursue a graduate degree in STEM. While all
of the participants in the current study were interested in majoring in STEM, it could be
the case that some of them were majoring in STEM in order to pursue a medical career.
Thus, for women interested in a medical career, even though they were STEM majors,
they likely would not pursue a STEM graduate degree or career. This may be one reason
why the role model manipulation did not impact participants’ intentions to pursue STEM.
For those participants interested in a career in a medical field, reading about a woman
who has succeed in STEM fields may not have an impact on their intentions to pursue
STEM.

A fifth potential limitation to the current study is the lack of racial and ethnic
diversity in the sample. Seventy-nine percent of the sample identified as White. Thus, the
results from the current study may not be generalizable to members of other racial and
ethnic groups. Past research has demonstrated that test performance is improved for
Black individuals after they are exposed to Black role models. However, this research has
primarily examined the impact of role models on general academic performance for
minority students (e.g., Marx & Goff, 2004; Marx, Ko, & Friedman, 2009). To my
knowledge, there has been little research specifically investigating how STEM role
models improve STEM performance for minority women. Much of the research focuses
on White women, so it is unclear in the literature if role models have the same impact on
STEM performance for minority women as they do for White women. In fact, research
on the intersection of race and gender demonstrates the importance of taking into
consideration the impact of both race on how women perceive gendered academic
stereotypes. Black women hold weaker implicit gender-STEM stereotypes compared to
White women (O’Brien, Blodorn, Adams, Garcia, & Hammer, 2014). That is, compared
to Black women, White women are more likely to perceive STEM fields as being masculine. Being that Black women already tend to believe that STEM fields are not as stereotypically masculine as White women, providing them with a STEM role model may not be as beneficial as it is for White women. An important avenue for future research will be to replicate the current findings with minority individuals. This will provide researchers with a more comprehensive understanding of how to improve academic outcomes for negatively stereotyped individuals in general.

The current study demonstrated that encouraging women to identify with role models impacted explicit stereotypes and changed women-science associations over the course of a semester compared to merely exposing women to role models. While demonstrating this effect was present two months after initial exposure to the role model is an important contribution to the role model literature, the current study cannot speak to how long the change in explicit stereotypes and the change in women-science associations lasted for participants. Thus, a potential limitation of the current study is that participants were not followed over a longer period of time. Longer-term follow up sessions will allow researchers to understand how long stereotype change might last, and is an important direction for future research. It may be the case that the shorter-term effects demonstrated in the current study will compound into longer-lasting changes, resulting in a recursive cycle of change for the women who were encouraged to identify with the role models (e.g., Walton & Cohen, 2011). That is, changes in explicit and implicit stereotypes may improve our participants’ performance in their subsequent STEM classes, and improved performance may lead to even greater reduction in stereotypes over time. Alternatively, it could be the case that these effects might wear off
over time. As noted, however, the current study cannot speak to either of these possibilities and as such, future research should attempt to conduct longer-term follow up sessions after administering an intervention such as the one given in the current study.

The current study cannot speak to why writing about the ways in which one identifies with a role model changes implicit and explicit stereotypes. It could be that simply writing about one’s aspirations has beneficial effects, and the role model was irrelevant. However, if the role model were irrelevant, I would not expect the writing process to change implicit and explicit stereotypes. That is, writing about aspirations and goals should have no bearing on stereotypes. However, thinking about the ways in which a woman has succeed despite negative group stereotypes, and thinking about this success in relation to the self, should change stereotypes. Although the current study cannot speak to this directly, future studies could examine the impact of writing about one’s aspirations and goals on STEM stereotypes and outcomes.

**Implications**

Encouraging women to identify with role models may have implications for how women perform in STEM testing situations. When women are in performance situations in which they are negatively stereotyped they may suffer from stereotype threat—the fear of confirming an ability-based stereotype, resulting in underperformance on the task (Spencer, Steele, & Quinn, 1999; Steele & Aronson, 1995). The extent to which women endorse both explicit and implicit stereotypes about their group’s abilities in STEM impacts how they respond under stereotype threat situations. Reducing both explicit and implicit STEM stereotypes should decrease women’s risk for stereotype threat and
improve their performance (Kiefer & Sekaquaptewa, 2007b; Schmader, Johns, & Barquissau, 2004). Thus, encouraging women to identify with role models, and subsequently reducing their explicit and implicit STEM stereotypes, may also mitigate the harmful effects of stereotype threat on performance. By not endorsing negative ability-based stereotypes, women who are encouraged to identify with role models may perform as well in situations that once would have evoked stereotype threat as they perform in non-threatening situations. As such, the current research has important implications for STEM interventions.

Research examining the efficacy of exposing women to role models has demonstrated that role model exposure is an effective intervention. From a practical perspective, merely reading a biography of a woman who has been successful in STEM is enough to improve women’s attitudes and outcomes (e.g., Marx & Ko, 2012; Marx et al., 2013; Stout et al., 2011). Furthermore, identifying with female STEM professors also improves attitudes and outcomes (e.g., Stout et al., 2011; Young et al., 2013). However, being that women are underrepresented in STEM tenure track positions, undergraduate and graduate women are less likely to be exposed to female professors in order to utilize them as role models. At any rate, the current research demonstrates that role model interventions may need to only add a simple component—encourage women to identify with role models—in order to increase the impact of role model exposure. Although undergraduate and graduate women are less likely to be exposed to female professors, interventions that encourage them to identify with female professors or female peer experts that they encounter may go beyond the effects of just being exposed to these role models. Not only does encouraging identification increase sense of belonging to the same
extent as mere exposure, but the reflective identification process also changes long-term explicit and implicit stereotypes.

**Conclusion**

Increasing women’s representation in STEM fields is important for society to benefit from the unique insights and perspective women can offer these fields. Indeed, there have been calls at the national level for researchers to develop further understanding of why women are underrepresented, as well as encouragement for researchers to design interventions aimed at increasing women’s representation in STEM (see The White House Council on Women and Girls). Exposure to positive STEM role models undoubtedly has beneficial consequences for women’s STEM outcomes, such as increasing identification and sense of belonging, as well as improving grades in classes and performance on exams, and increasing intentions to pursue STEM opportunities (e.g. Cheryan et al., 2011; Marx & Roman, 2002; Plant et al., 2009; Rosenthal et al., 2013; Stout, et al., 2011). The current study demonstrates the utility in encouraging women to identify with the role models to whom they are exposed—encouraging role model identification changes long-term explicit and implicit stereotypes. Reducing women’s stereotypes will allow women to perform up to their true potential, and perhaps help to level the STEM playing field.
Table 1

*Major of participants*

<table>
<thead>
<tr>
<th>Major</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biochemistry</td>
<td>6</td>
</tr>
<tr>
<td>Biology</td>
<td>2</td>
</tr>
<tr>
<td>Biomedical Engineering</td>
<td>6</td>
</tr>
<tr>
<td>Cell and Molecular Biology</td>
<td>14</td>
</tr>
<tr>
<td>Cell Biology</td>
<td>3</td>
</tr>
<tr>
<td>Chemical Engineering</td>
<td>4</td>
</tr>
<tr>
<td>Chemistry</td>
<td>1</td>
</tr>
<tr>
<td>Ecology and Evolutionary Biology</td>
<td>8</td>
</tr>
<tr>
<td>Engineering Physics</td>
<td>4</td>
</tr>
<tr>
<td>Environmental Biology</td>
<td>2</td>
</tr>
<tr>
<td>Neuroscience</td>
<td>23</td>
</tr>
<tr>
<td>Physics</td>
<td>1</td>
</tr>
<tr>
<td>Psychology</td>
<td>1</td>
</tr>
<tr>
<td>Public Health</td>
<td>2</td>
</tr>
<tr>
<td>Undecided</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>79</td>
</tr>
</tbody>
</table>

Note. Break down of majors for all of the participants that started the study. Participants were asked their major during the post-manipulation session. However, participants qualified for the study if they indicated they were interested in a STEM major on the qualification survey. Thus, while all of the participants expressed interested in majoring in STEM during the qualification survey, one participant decided to major in Psychology and two participants were undecided during the time of the post-manipulation session.
Table 2

Means (standard deviations) for all measures for all time points

<table>
<thead>
<tr>
<th>Measure</th>
<th>Pre-Manip Session</th>
<th>Manip Session 1</th>
<th>Manip Session 2</th>
<th>Post-Manip Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>Role model identification</td>
<td>--</td>
<td>4.99 (1.32)</td>
<td>4.63 (1.10)</td>
<td>--</td>
</tr>
<tr>
<td>Women-science association</td>
<td>1.58 (.60)</td>
<td>--</td>
<td>--</td>
<td>1.76 (.75)</td>
</tr>
<tr>
<td>Women-humanities association</td>
<td>1.98 (.69)</td>
<td>--</td>
<td>--</td>
<td>2.28 (.87)</td>
</tr>
<tr>
<td>Men-science association</td>
<td>1.86 (.70)</td>
<td>--</td>
<td>--</td>
<td>2.14 (.69)</td>
</tr>
<tr>
<td>Men-humanities association</td>
<td>1.27 (.57)</td>
<td>--</td>
<td>--</td>
<td>1.45 (.66)</td>
</tr>
<tr>
<td>Explicit stereotype endorsement</td>
<td>2.38 (1.14)</td>
<td>--</td>
<td>--</td>
<td>2.52 (1.18)</td>
</tr>
<tr>
<td>STEM identification</td>
<td>5.72 (.74)</td>
<td>--</td>
<td>--</td>
<td>5.54 (.82)</td>
</tr>
<tr>
<td>STEM sense of belonging</td>
<td>5.13 (.87)</td>
<td>--</td>
<td>--</td>
<td>4.88 (.93)</td>
</tr>
<tr>
<td>Intentions to pursue STEM</td>
<td>6.18 (.84)</td>
<td>--</td>
<td>--</td>
<td>5.89 (1.31)</td>
</tr>
</tbody>
</table>

Note. Each of the four association scores represent a d´ score on the Go/No-Go Association Task (GNAT). The range of d´ scores from the current study range from 0.05 - 4.38, with higher numbers indicated a stronger association. All other measures assessed on 7-point Likert scales ranging from 1 (Strongly disagree/Not at all/Very unlikely) to 7 (Strongly agree/Very much/Very likely). Higher scores indicate a greater stereotype endorsement, STEM identification, STEM sense of belonging, and more likely to pursue STEM.
Figure 1. Relationship between role model condition and women-science d’ association scores. Higher values indicate stronger associations.
Figure 2. Relationship between role model condition and women-humanities d'association scores. Higher values indicate stronger associations.
Figure 3. Relationship between role model condition and explicit STEM stereotype endorsement. Likert scale ranging from 1 (Strongly disagree) to 7 (Strongly agree).
Figure 4. Relationship between role model condition and STEM sense of belonging. Likert scale ranging from 1 (Strongly disagree) to 7 (Strongly agree).
Figure 5. Relationship between role model condition and STEM GPA mediated by STEM sense of belonging. *p < .05. Indirect effect of the control condition compared to the standard condition on STEM GPA through STEM sense of belonging, indirect effect = .17, 95% confidence interval .0376 to .4036. Values reported are standardized.
Figure 6. Relationship between role model condition and intentions to pursue STEM opportunities mediated by STEM sense of belonging. *$p < .05$. Indirect effect of the control condition compared to the standard condition on intentions to pursue STEM through STEM sense of belonging, indirect effect = .26, 95% confidence interval .0511 to .7018. Values reported are standardized.
Appendix A

Recruitment Flyer

Tulane Students:
You have the opportunity to participate in:

The Information and Memory Study

Students who qualify have the opportunity to participate in 4 sessions over the 2013-2014 school year. Participants will be compensated $60 for completing all 4 sessions of the study.

The total time commitment for the 4 sessions is approximately 2 hours. Session 1 occurs in the lab at start of Fall semester (40 minutes), Session 2 occurs online during October (20 minutes), Session 3 occurs online during November (20 minutes), Session 4 occurs in the lab during December (40 minutes)

Go to: http://tinyurl.com/InfandMemQualify to see if you qualify for participation!
Appendix B

In-class Recruitment Script

Hi everyone,

I’m here to talk to you about an opportunity to participate in a paid psychology study. This research is being run by Patricia Gilbert and Dr. O’Brien in the Psychology Department at Tulane.

The study is called The Information and Memory Study. Participants who qualify for participation will have the opportunity to participate in 4 sessions that take place over the 2013-2014 school year. Participants will be compensated $60 for completing all 4 sessions. The total time commitment for the 4 sessions is approximately 2 hours. Session 1 occurs in the lab at the start of the Fall semester and lasts 40 minutes, Session 2 occurs online during October and lasts 20 minutes, Session 3 occurs online during November and lasts 20 minutes, and Session 4 occurs in the lab during December and lasts 40 minutes.

If you are interested in participating in the study, I have flyers with a link to a qualification questionnaire. Once you complete this brief questionnaire, you will be informed whether or not you are eligible to participate in the study. If you are eligible, you will be given more information about the study and instructions for how to participate.

(answer questions as handing out flyers)

- We are interested in things that impact people’s memory
Appendix C

Qualification Survey

Thank you for your interest in the Information and Memory Study. Please answer the following questions so that we can determine if you qualify for participation in this study. Please keep in mind that answering these questions does not obligate you to participate in this study – if you qualify for participation you can always choose not to participate in the study.

1. How old are you? _______

2. What is your gender?
   ____ Male   ____ Female   ____ Other (please specify: ____________)

3. What is your race/ethnicity? (check all that apply)
   _____ Asian/Asian American   _____ Hispanic/Latino(a)
   _____ Black/African American   _____ Native American
   _____ Caucasian/European American   _____ Other ______________

4. What is your year in school?
   ___ 1st Year/Freshman   ___ 5th year or beyond
   ___ 2nd Year/Sophomore   ___ Graduate student
   ___ 3rd Year/Junior   ___ I am not a student
   ___ 4th year/Senior

5. In what state did you attend high school? ______________

6. What is your college major(s)? (If your major is currently ‘undecided’, please indicate the major(s) that you are considering. If your major is not listed here, please select the one that is most similar.)
   ___Agriculture   ___Architecture/Urban Planning
   ___Anthropology   ___Astronomy
   ___Archaeology   ___Atmospheric Sciences & Meteorology
7. Please indicate your mother’s highest level of education:

___ Elementary School  ___ Some Graduate School
___ Junior High  ___ Master’s Degree
___ Some High School  ___ M.B.A.
___ High School Graduate  ___ J.D.
___ Some College  ___ M.D.
___ Associate’s Degree  ___ Ph.D.
___ Bachelor’s Degree  ___ Other Advanced Degree
___ I don’t know

8. Please indicate your father’s highest level of education:

___ Elementary School  ___ Some Graduate School
___ Junior High  ___ Master’s Degree
___ Some High School  ___ M.B.A.
___ High School Graduate  ___ J.D.
___ Some College  ___ M.D.
___ Associate’s Degree  ___ Ph.D.
___ Bachelor’s Degree  ___ Other Advanced Degree
___ I don’t know

Qualification message:

You qualify for participation in the Information and Memory Study!

As a reminder the Information and Memory study takes place in 4 sessions over the 2013-2014 school year and participants will be compensated $60 for completing all 4 sessions. The total time commitment for the 4 sessions is approximately 2 hours. Session 1 occurs in the lab at the start of the Fall semester (40 minutes), Session 2 occurs online during October (20 minutes), Session 3 occurs online during November (20 minutes), and Session 4 occurs in the lab during December (40 minutes).
Please fill in the following contact information so that we keep in touch with you regarding participation in the Information and Memory Study:

Name (First, Last): _____________ _____________

Email address: ______________________________

Secondary email address (optional): ________________

Street address (optional):
___________________________________________________
___________________________________________________

Now that you have qualified for participation in the Information and Memory Study, we will contact you in order to schedule a time for you to come into the lab to complete Session 1. If you have any questions please contact tulane.psychology@gmail.com.

**Disqualification message:**

Unfortunately you do not qualify for participation in the Information and Memory Study. If you would like to be contacted regarding opportunities to participate in other paid psychology studies, please provide your name and email address. We will not contact you about other paid studies unless you provide this information.

Name (First, Last): _____________ _____________

Email address: ______________________________
Appendix D

Tulane University Human Research Protection Office
Social/Behavioral IRB Consent Form for Participation in a Research Study
Information and Memory

Principal Investigator: Patricia Gilbert
Study Title: Information and Memory

The following informed consent is required by Tulane University for any research study conducted by investigators at the University. This study has been approved by the University’s Institutional Review Board for Human Subjects.

Introduction

You are invited to participate in a research study to examine factors that impact how well individuals remember information provided to them over long periods of time. No research activity is to be conducted until you have had an opportunity to review this consent form, ask any questions you may have, and sign this document if applicable.

This consent form will give you the information you will need to understand why this study is being done and why you are being invited to participate. It will also describe what you will need to do to participate and any known risks, inconveniences or discomforts that you may have while participating. We encourage you to ask questions at any time. If you decide to participate, you will be asked to sign this form and it will be a record of your agreement to participate. You will be given a copy of this form.

Why is this study being done?

The purpose of this research study is examine factors that impact people’s memory of information they read over a long period of time. You will be asked to read a variety of biographies and complete a number of questionnaires.

What are the study procedures? What will I be asked to do?

There are four sessions to this study that will take place over the 2013-2014 school year. The total time commitment for these 4 sessions is approximately 2 hours.

Session 1 will take place in a lab on Tulane’s uptown campus at the beginning of the Fall 2013 semester and lasts approximately 40 minutes. For this session you will be asked to complete a variety of questionnaires that ask about your interest in different academic fields and a computer task that involves categorizing words as quickly as possible. You will be paid $20 at the conclusion of Session 1.
Session 2 will take place online in October 2013 and lasts approximately 20 minutes. For this session you will be asked to read a biography and answer questions about the biography you read. You will be paid $10 after you complete Session 2.

Session 3 will take place online in November 2013 and lasts approximately 20 minutes. For this session you will be asked to read a biography and answer question about the biography you read. You will be paid $10 after you complete Session 3.

Session 4 will take place in a lab on Tulane’s uptown campus in December 2013 and lasts approximately 40 minutes. For this session you will be asked to complete a variety of questionnaires that ask about your interest in different academic fields and a computer task that involves categorizing words as quickly as possible. You will also be asked to complete a memory task about the biographies you read earlier in the semester. You will be paid $20 at the conclusion of Session 4.

As part of this project, we will ask if you give your consent for Dr. Laurie O’Brien to access your academic transcript in order to record the courses you took during these semesters and your grades in the courses. We will also record your overall grade point average (GPA). You will be given a separate Transcript Consent form in order to indicate if you give your consent.

We will enroll up to 100 participants for this study. Some research requires that the full purpose of the study not be explained before you participate. We will give you a full explanation as soon as you complete the study.

What are the risks or inconveniences of the study?

The risks of participating in this study are minimal and are no greater than those experienced in everyday life. The primary risk is a breach of confidentiality. In order to minimize this risk, a number of procedures will be put in place. First, your data will be given a unique code number and stored in a separate computer file from your name and identifying information. The code number will be the only way to link your data to your identity. All computer files will be password protected and stored on password protected computers. The only people who will have access to these files are the research team.

Only Dr. Laurie O’Brien will have access to student transcripts. Transcripts will be accessed online to avoid downloading them to a computer. For each participant, Dr. O’Brien will use the transcripts to add information on participant courses and grades to the data file. Once the study is complete, the file containing the link between your identity and code numbers will be destroyed.

What are the benefits of the study?

You may not directly benefit from participating in this study.

Will I receive payment for participation?
You will be paid at four time points for your participation in this study. At the conclusion of Session 1, you will be paid $20 cash.

You will be paid $10 once you complete Session 2 and will be paid $10 once you complete Session 3. Because Session 2 and Session 3 occur online, after each session you will be given the option to either schedule a time to pick up $10 cash on Tulane’s campus or have a $10 Amazon.com giftcard emailed to you.

You will be paid $20 cash at the conclusion of Session 4. Participants that complete all four sessions will be paid a total of $60. If you withdraw from the study, you will be allowed to keep all compensation you have received up to the point of your withdrawal. You will not be eligible for compensation for any session(s) in which you do not participate.

**Are there costs to participate?**

There are no costs to you to participate in this study.

**How will my personal information be protected?**

The following procedures will be used to protect the confidentiality of your data. First, your consent form will be stored in a locked, secure location separate from your responses. You will be assigned a unique code number that will identify your responses. The master list containing participants’ names and code numbers will be kept in a password protected computer file. We will use this master list to link the information from your academic transcripts to your survey responses. Once data collection is complete we will destroy the master list containing participants’ names and code numbers. Every precaution will be taken to ensure that participant names cannot be matched to responses.

The questionnaires that you complete online will be stored on secure, password protected servers. Once data collection is complete, we will download the responses from the secure server on which they are stored. The file will be permanently deleted from the server and stored on a password protected computer.

At the conclusion of this study, the researchers may publish their findings. Information will be presented in summary format and you will not be identified in any publications or presentations. All study materials will be maintained in accordance with the security provisions of this paragraph until destroyed by the researchers.

You should also know that the Tulane University Human Research Protection Office, Social/Behavioral Institutional Review Board (IRB) and/or the Office of Research Compliance may inspect study records as part of its auditing program, but these reviews will only focus on the researchers and not on your responses or involvement. The IRB is a group of people who review research studies to protect the rights and welfare of research participants.
**Can I stop being in the study and what are my rights?**

You do not have to be in this study if you do not want to. If you agree to be in the study, but later change your mind, you may drop out at any time. There are no penalties if you decide that you do not want to participate. Also, please keep in mind that you do not have to answer any question that you do not want to answer.

**Who do I contact if I have questions about the study?**

Take as much time as you like before you make a decision to participate in this study. We will be happy to answer any question you have about this study. If you have further questions about this study or if you have a research-related problem, you may contact the principal investigator, Patricia Gilbert at pmcfarla@tulane.edu or Dr. Laurie O’Brien at lobrien2@tulane.edu. If you have any questions concerning your rights as a research participant, you may contact the Tulane University Human Research Protection Office at 504-988-2665 or email at irbmain@tulane.edu.

**Documentation of Consent:**

I have read this form and decided that I will participate in the research project described above. Its general purposes, the particulars of involvement and possible risks and inconveniences have been explained to my satisfaction. I understand that I can withdraw at any time. My signature also indicates that I have received a copy of this consent form.

____________________________________________      _____________
Subject                                             Date

____________________________________________      _____________
Person Obtaining Consent                             Date
Appendix E

Demographic Questionnaire

Please take a moment to fill out this demographic sheet. The information that you provide will be used to tabulate a summary of the participants who took part in the study. Be assured that your responses are completely confidential.

1. What is your race/ethnicity? (select all that apply)
   - African American, Caribbean American _____
   - Latino/a, Hispanic _____
   - Middle Eastern _____
   - Caucasian _____
   - Asian American _____
   - Alaskan native, Native American _____
   - Other; please specify __________________

2. What is your gender?  Female  Male

3. What is your age? _______

4. Are you a native speaker of English? (select one)  Yes  No

5. Where you born in the United States? (select one)  Yes  No
   a. If you were not born in the United States, where were you born? _____________________
   b. If you were not born in the United States, how long have you lived in the United States? ____________________

6. What is your major, or intended major? ________________

7. What year are you in school? (select one)
   - Freshman  Sophomore  Junior  Senior
Appendix F

Permission to Access Transcripts

As part of this project, Dr. O’Brien would like to access your academic transcript information in order to record the courses you took and your grades in the courses. In order to do this, she will access the information by conducting an audit using Gibson online. Only Dr. O’Brien will have access to your audit. Furthermore, she will NOT have access to other personal information such as your social security number. Dr. O’Brien will access your audit online to avoid downloading it to a computer. Your name will not be linked to the data file containing the audit information.

If you do not wish to consent, you will still be eligible to participate in the remaining three sessions and will be compensated for all of the sessions you participate in.

Do you give your consent for Dr. O’Brien to record the information from your Tulane University academic records for research purposes?

____ Yes. I give my permission for Dr. O’Brien to record the information in my academic audit for research purposes.

____ No. I do not want the information on my academic audit recorded for research purposes.

___________________________________  ______________
Signature                                      Date

___________________________________
Printed Name
Appendix G
Role Model Biographies

First manipulation session:

Chemistry/chemical engineering

<Name> is employed at General Electric (GE) where she works on engine parts for the helicopters used in military and rescue missions. <Name> enjoyed chemistry from a young age, and decided a career in chemistry might be for her when she was in high school. “When I was in high school, I was particularly good in chemistry, but I never thought much about it. Then, believe it or not, I saw a hallway poster one day that said, ‘Why not a career in chemistry?’ And I thought, ‘Why not?’” <Name> is a Tulane University alumni, where she got her undergraduate degree in chemistry/chemical engineering. While studying chemistry/chemical engineering at Tulane, <Name> decided she was interested in materials, from natural materials to engineered materials. After college, she went on to complete a master’s program in archeological materials. “Let’s say someone needs a helicopter to fly higher or faster than it does today. It’s up to people like me to find the materials that can take the heat and stress that that kind of performance would put on the helicopter engine.” <Name>’s work inspecting helicopter parts is critical for national security, and public health and safety.

Engineering physics

<Name> is employed at Lockheed Martin Space Systems where she is part of the team working on NASA’s Orion mission—a spacecraft that will carry astronauts to the moon by 2020. <Name> always had an interest in space and spacecraft. She is a Tulane University alumni, where she got her undergraduate degree in engineering physics and took every undergraduate astronomy course available. <Name> then decided to pursue a master’s program that specialized in astronauts’ health called bioastronautics. “I wanted to work at NASA. And that’s all I knew…I just knew that space seemed like a lot of fun.” <Name> is part of the Orion spacecraft design integration team, which ensures that all parts of the spacecraft are functioning properly and work well together. This includes the life-support systems, the computer network, and ground operations. <Name>’s job requires that she work with many different types of people, so having good people skills and communications skills is critical. She believes that “people skills will get you as far or farther than the necessary technical skills. When you are working in any sort of program that’s interdisciplinary, if you cannot work well with others, you’re not going to get what you need from them.”

Cell and molecular biology

<Name> works at the Center for Disease Control (CDC) helping to bring safe drinking water to people around the world. <Name> grew up in rural Washington and she was a self proclaimed environmentalist by the time she was in high school. She knew by the
time she was a teenager that she wanted to protect the planet. She is a Tulane University alumni, where she got her undergraduate degree in cell and molecular bio. One of<br>\(<\text{Name}>\)’s first jobs involved protecting the Ipswich River and its wildlife sanctuary in Massachusetts. In this job \(<\text{Name}>\) worked closely with volunteers and people from the community. “I work with people who are passionate about the environment, passionate about wanting to make the world a better place, and give them the technical information needed to do that.” Working with the CDC now, \(<\text{Name}>\) travels around the world evaluating water sources, testing for contamination, and designing practical and inexpensive ways for the local people to disinfect their water. What she loves most about her job is “helping people who want to make a change, make it.”

*Environmental biology/ ecology and evolutionary biology*

\(<\text{Name}>\) works at the Louisiana Coastal Protection and Restoration Authority (LCPRA), working to help protect Louisiana’s wetlands against devastating erosion. \(<\text{Name}>\) grew up in rural Washington and she was a self proclaimed environmentalist by the time she was in high school. She knew by the time she was a teenager that she wanted to protect the planet. She is a Tulane University alumni, where she got her undergraduate degree in <environmental biology/ ecology and evolutionary biology>. One of \(<\text{Name}>\)’s first jobs involved protecting the Ipswich River and its wildlife sanctuary in Massachusetts. In this job \(<\text{Name}>\) worked closely with volunteers and people from the community. “I work with people who are passionate about the environment, passionate about wanting to make the world a better place, and give them the technical information needed to do that.” Working with the LCPRA now, \(<\text{Name}>\) travels along Louisiana’s shoreline, helping to evaluate the current state of the state’s wetlands and marshes, as well as developing plans to create new wetlands. What she loves most about her job is “helping to save such a beautiful landscape that is invaluable to so many people and to so many sources of wildlife.”

*Biochemistry*

\(<\text{Name}>\) works at Proctor & Gamble, where she is involved in the manufacturing process for many different kinds of products. She became interested in how chemicals work together in everyday household products when she completed a high school chemistry assignment that had her identify the chemical ingredients used in various household products, including toothpaste, soap, and shampoo. Completing this assignment, \(<\text{Name}>\) began to understand how chemicals and chemistry are entwined with our everyday lives. “We had been writing formulas in class for different chemicals, but this assignment connected the chemicals to things you use every day. I realized that chemistry isn’t just theory. It’s relevant.” She is a Tulane University alumni, where she got her undergraduate degree in biochemistry. One of the things \(<\text{Name}>\) enjoys about her job is finding solutions to make products better. “My approach to solving a problem is realizing that there are a million ways to solve it, so you have to be creative in finding the best way.”

*Biology/ Biomedical engineering*
<Name> works at the biomedical company Abbott, where she designs medical devices called stents. Stents are mesh tubes that are inserted into clogged arteries to open them up and improve blood flow to the heart. <Name> loves her job, and being able to help people is one of the most appealing aspects to her. “I am able to help people stay healthy, live longer, and have a better quality of life through the products I design.” She is a Tulane University alumni, where she got her undergraduate degree in biomedical engineering. In high school, <Name> knew she wanted to be a scientist, but she wasn’t sure which area of the sciences she wanted to pursue. <Name> and her mother collected brochures from dozens of colleges and science groups until one weekend her mother showed her a brochure on biomedical engineering and job opportunities in biomedical engineering. “She handed me the information on <biology/biomedical engineering> and said, ‘This sounds like a great match for you.’ And, you know, she was absolutely right.”

Neuroscience

<Name> works at a biomedical company, where she helps develop medical neuroimaging equipment, such as CAT and MRI equipment. These imaging tools are used across a wide variety of medical disciplines, allowing doctors to diagnose a range of physical ailments. <Name> loves her job, and being able to help people is one of the most appealing aspects to her. “I am able to help people stay healthy, live longer, and have a better quality of life through the products I design.” She is a Tulane University alumni, where she got her undergraduate degree in neuroscience. In high school, <Name> knew she wanted to be a scientist, but she wasn’t sure which area of the sciences she wanted to pursue. <Name> and her mother collected brochures from dozens of colleges and science groups until one weekend her mother showed her a brochure on neuroscience and job opportunities in biology. “She handed me the information on neuroscience and said, ‘This sounds like a great match for you.’ And, you know, she was absolutely right.”

Second manipulation session:

<Name> is a computer scientist in affective, or emotional, computing, and works on designing software that can recognize and respond to our emotions. From a young age <Name> was interested in taking things apart, and often took apart appliances at home. In high school <Name> thought she wanted to go into the FBI. A science teacher had set up a crime scene for the students to investigate, and <Name> was intrigued by how much solving a crime was like solving a puzzle. She is a Tulane University alumni, where she got her undergraduate degree in computer science. Recently <Name> developed software to help girls understand their feelings called Girls Involved in Real Life Sharing (G.I.R.L.S). The program has girls type in a story about a situation they are currently going through, and then the software creates a comic-book-like version of the situation with pictures and captions. The software then reads each caption and tries to determine what emotions the girl is going through. <Name> says that it is “software that helps you reflect on yourself.”
Appendix H

Role Model Pictures

First Manipulation Session:

Katherine Bicer:

Shauntel Poulson:

Judy Lee:

Dalia Naser:

Vanessa Hernandez:

Second Manipulation Session:

Danielle Lantagne:
Appendix I

Reflective Role Model Condition Task

Instructions: Please think about the ways that you identify with the woman you just read about. Identification is the extent to which you feel similar to the role model, can relate to the role model, and/or want to achieve a similar level of successes as the role model.

In the space below, please write how you identify with the woman you read about. You can write as much as you like, and there are no right or wrong answers.

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Appendix J

Standard Role Model Condition and Control Condition Task

Instructions: In order to make sure that you were engaged while reading the biography, we would like you to write a paragraph summarizing as many facts as you can from the biography you read.

Please write your summary about the woman you read about in the space below.

___________________________________________________________________________

___________________________________________________________________________

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Appendix K

Control Condition Biographies

First manipulation session:

{Name} is a Tulane University alumni. In her spare time, she enjoys cooking and creating new, exciting dishes. {Name} finds that cooking is a great way to express her creativity. She says you wouldn’t know it by looking at her, but there is a creative, artistic side to her. “The side my colleagues know is quiet and composed. But there’s this artist side of me too. I love self-expression.” She really enjoys cooking, especially when she has an opportunity to cook for other people. “One of my favorite things is to try and figure out what kinds of flavors other people like in their food. To cook something unexpected, but that they love.” Taking the individual ingredients and turning them into a meal is something that {Name} finds incredibly gratifying. “I find cooking to just be a really great way to relax after a long work day. I really enjoy it.”

Second manipulation session:

Danielle Lantagne is a Tulane alumni and in her spare time she enjoys heading outside to go hiking, kayaking, and camping. “I love being outdoors! For my job, I am usually cooped up inside. Whenever I get an opportunity to spend some time outdoors, I definitely take advantage of it.” One of Danielle’s favorite outdoor activities is going camping, and bringing either her mountain bike or her kayak to go exploring. Her golden retriever also likes to tag along with her when she goes camping. “Not knowing what is around the bend or down the river—I find that to be really exciting. Having that adventure and then being able to spend some quiet time outside, I just don’t think it can get any better.” Danielle believes, that for her, being outdoors is therapeutic and helps her to unwind after working all week. “It is definitely my stress release!”
Appendix L

Debriefing

Now that you have completed the Information and Memory Study we would like to tell you more about it.

Over the course of your first semester at Tulane, we have had you complete numerous questionnaires and read two biographies. Because of the nature of our study, there were several points during the study where we gave you deceptive information.

When we recruited you to be in the study, you were told that we were interested in factors that impact people’s memory for information over the long term. This actually was not the true purpose of the study. We are actually interested in whether or not reading a biography of a woman who has been successful in science and math fields improves women’s science and math grades over the course of a semester. Women in this study were randomly assigned to read one of two kinds of biographies during the second and third sessions. The first kind of biography was of women who have been successful in math and science fields. The second kind of biography was of interesting plants. The purpose of having these two different biographies was to examine whether reading about women who have been successful in math and science fields improves women’s math and science outcomes, such as their GPA and interest in math and science fields.

Half the women that were assigned to read biographies of women successful in math and science fields were instructed to write about how much they identify with the woman they read about. The other half were instructed to just write about facts they recalled about the woman from the biography. The purpose of having these two different instructions was to examine whether actively encouraging women to think about they identify with successful women improves science and math outcomes, such as GPA and interest in math and science fields.

Lastly, we had you complete several of the same questionnaires at a variety of time points, once in the lab at the beginning of the Fall 2013 semester and again in the lab at the end of the Fall 2013 semester. The reason we had you complete these questionnaires multiple times is because we were interested in how your interests and enjoyment toward a variety of math and science classes changed over the course of your first semester.

There are just a couple more things before you go. It is very important that you don’t discuss this study with other students or friends who might participate in this study. As you can imagine, if they knew the purpose of our study their data would be meaningless. Just a reminder, your responses are completely confidential, and your name will not be connected to your data in any way.
If you are feeling any psychological distress from participating in this research, please contact this toll-free helpline: 1-800-273-TALK. You can also contact the Principle Investigator, Patricia Gilbert at pmcfarla@tulane.edu, or the faculty advisor, Dr. Laurie O’Brien, at lobrien2@tulane.edu or at any time with questions about this research.

**Post-Study Decision Form**

All of your responses today are completely anonymous—there is no way that anyone can link any of your responses to your identity.

Do you, the participant, after having learned the true nature and purpose of this study, agree to allow your data to be used for scientific analysis?

_____ Yes. I give permission for my data to be used for scientific analysis.

_____ No. I do not want my data to be used for scientific analysis.

___________________________________  ______________
Signature                      Date

___________________________________
Printed Name
Appendix M
Go/No-Go Association Task (GNAT) Stimuli

Humanities Items: Science Items:

English Physics
Philosophy Chemistry
Music Biology
Arts Math
History Engineering

Masculine Items: Feminine Items:

He She
Him Her
His Hers
Man Woman
Male Female
Appendix N

Explicit STEM Stereotype Endorsement

Instructions: Please read the following statements. Indicate the extent to which you personally agree or disagree with the following statements using the scale provided.

STEM stands for science, technology, engineering, and math.

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<tbody>
<tr>
<td></td>
<td>Strongly Disagree</td>
<td>Neither Agree or Disagree</td>
<td>Strongly Agree</td>
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1. It is possible that men have more STEM ability than do women.
2. In general, men may be better than women in STEM fields.
3. I don’t think that there are any real gender differences in STEM ability.
4. Men typically have better STEM skills than women.
5. Men typically have better spatial skills than women.
6. Men are just naturally better at STEM compared to women.
7. Men and women are equally good in STEM fields.
Appendix O

STEM Identification

Instructions: Please answer each item using the scale provided.

STEM stands for science, technology, engineering, and math.

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<tr>
<td></td>
<td>Not at all</td>
<td>Very much</td>
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1. How important to you are your STEM abilities?
2. How important do you feel that STEM abilities and skills are to your success in college?
3. If you were to fail a test in a STEM class, but you were also allowed to drop that test grade, how bothered would you be by your failure?
4. How important to you is it that other people believe you are good at STEM?
5. How important do you feel that STEM abilities and skills are to your future career?
6. I get good grades in STEM classes.
7. Work in STEM classes is easy for me.
8. I’m hopeless when it comes to STEM.
9. I’ve always done well at STEM.
10. I learn things quickly in STEM.
11. How important to your view of yourself is your performance on STEM tasks?
Appendix P

STEM Sense of Belonging Measure

Instructions: As a reminder, STEM stands for science, technology, engineering, and math. Today we have some questions we would like you to answer about your experiences with STEM courses and in the STEM academic community. When we mention the STEM academic community, we are referring to the broad group of people involved in those fields, including the students in STEM courses.

We would like you to consider your membership in the STEM community. By virtue of having taken many STEM courses, you could consider yourself a member of the STEM community. Given this broad definition of belonging to the STEM community, please respond to the following statements based on how you feel about that group and your membership in it.

There are no right or wrong answers to any of these statements; we are interested in your honest reactions and opinions. Please read each statement carefully, and indicate the number that reflects your degree of agreement.

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<tr>
<td></td>
<td>Strongly Disagree</td>
<td>Neither Agree or Disagree</td>
<td>Strongly Agree</td>
<td></td>
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</table>

When I am in a STEM setting,

1. I feel that I belong to the STEM community.
2. I consider myself a member of the STEM world
3. I feel like I am part of the STEM community.
4. I feel a connection with the STEM community.
5. I feel accepted.
6. I feel respected
7. I feel disregarded.
8. I feel valued.
9. I feel neglected.
10. I feel appreciated.
11. I feel excluded.
12. I feel insignificant.
13. I feel at ease.
15. I feel comfortable.
16. I feel tense.
17. I feel nervous.
18. I feel content.
19. I feel calm.
20. I feel inadequate.
21. I wish I could fade into the background and not be noticed.
22. I try to say as little as possible.
23. I enjoy being an active participant.
24. I wish I were invisible.
25. I trust the testing materials to be unbiased.
26. I have trust that I do not have to constantly prove myself.
27. I trust my instructors to be committed to helping me learn.
28. Even when I do poorly, I trust my instructors to have faith in my potential.
Appendix Q

Intentions to Pursue STEM

Instructions: Please think about your future goals and aspirations. Answer the following questions using the scale provided.

STEM stands for science, technology, engineering, and math.


1. How likely are you to pursue an undergraduate degree in STEM?
2. How likely are you to pursue a graduate degree in STEM?
3. How likely are you to pursue a professional job in STEM?
4. How likely are you to take a STEM course taught by a female professor?
5. How likely are you to join the Society for Women Engineers?
6. How likely are you to join the Society for Women Scientists?
Appendix R

Role Model Identification Measure

*Participants read “scientist or engineer” in both the reflective identification role model condition and the standard role model condition. Participants read “woman” in the control condition.*

Instructions: Please think about the scientist or engineer (woman) you just read about. Answer the following questions using the scale provided.

1. How much do you identify with the scientist or engineer (woman) you just read about?
2. How much do you relate to the scientist or engineer (woman) you just read about?
3. How similar are you to the scientist or engineer (woman) you just read about?
4. How much do you want to be as successful as the scientist or engineer (woman) you just read about?
5. How much do you admire the scientist or engineer (woman) you just read about?

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<tbody>
<tr>
<td>Not at all</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Very Much</td>
</tr>
</tbody>
</table>
References


Gilbert, P.N., O’Brien, L.T., Garcia, D.M, Marx, D.M. *Not the sum of its parts: Decomposing implicit academic stereotypes to understand academic outcomes for men and women.* Unpublished data.


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Biography

Patricia Gilbert was born on January 14, 1983 in La Mirada, California. Patricia graduated from Serrano High School in 2001 and then earned her B.A. in Psychology from California State University, San Bernardino in 2005. Patricia earned her M.S. in Psychology from San Diego State University in 2009. Patricia’s dissertation was partially supported by the Society for the Psychological Study of Social Issues (SPSSI) Grants-in-Aid and by National Science Foundation Grant HRD0936722. Patricia is a member of the Society for Personality and Social Psychology, Society for the Psychological Study of Social Issues, and the American Psychological Association.