The Existence of Implicit and Explicit Stereotypes about Unfemininity in STEM and the Effect of Feminine Role Models

By

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A Thesis Submitted in Partial Fulfillment of the

Requirements for the Degree of Bachelor of Arts

with Honors in Psychology from the

University of Michigan

2012

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Abstract

This research examines whether college women hold implicit and explicit stereotypes that women in STEM fields are more unfeminine than feminine. Because negative stereotypes reduce women's interest in STEM, it will then look into the extent that feminine STEM role models help improve women's science aspirations. Finally, it asks if feminine STEM role models help women who (a) have stronger unfeminine-STEM stereotypes or (b) perceive the role models as positive, similar to themselves, and attainably successful. Through regression analyses, we found that women with stronger implicit (but not explicit) stereotypes were more motivated to pursue science by a feminine STEM role model than a feminine humanities role model. However, a better overall rating of the role model did not mediate the relationship between the role model condition by stereotype interaction and STEM aspirations. Nevertheless, strong stereotypes were negatively associated with aspirations in natural science. In the future this stereotype may need to be weakened in order to promote future STEM aspirations.

Keywords: stereotype, femininity, role models

The existence of implicit and explicit stereotypes towards women in STEM and the affect of feminine role models

Women are consistently underrepresented in both education and careers involving science, technology, engineering, and mathematics (STEM). In the United States, only 29.5% of female freshmen students intend to major in a STEM field (NSF, 2011). In the United Kingdom only 1.5% of girls aspire to enter jobs in natural sciences (Hanover & Kessels, 2004). When they do show an interest in science, girls tend to favor biological sciences whereas boys favor physical sciences (Andre, Whigham, Hendrickson, & Chambers, 1999). Although the statistics have improved over the past 20 years, women still represent less than 30% of engineers and mathematicians (NSF, 2011).

Our main focus is to understand whether stereotypes further widen these gaps and deter women from entering these fields. We aim first to understand a particular stereotypical association between STEM and "unfemininity" at both an implicit and explicit level. Next, we will try to see how role models who counter the unfeminine STEM stereotype affect STEM aspirations, relative to no role model or to other kinds of role models (i.e. feminine women in humanities fields, gender-neutral women in STEM). Further, we hope to see if participants' stereotypes help determine the effect of these role models. Finally, we test a mediation model to see if the interactive effect of participant stereotypes and role model type is driven by participants' perceptions of the role model as positive, similar to themselves, or attainably successful.

From previous research, we know that girls feel that they are worse in math & science than boys, and these science self-concepts predict future course selection (Simpkins, Davis-Kean, & Eccles, 2006). Understanding the relationship between stereotypes and successful role models may help future researchers to create an intervention strategy that might ultimately enable more women to feel comfortable in STEM fields.

This research specifically looks at the associations between femininity, or rather unfemininity, and STEM fields. Prior research shows that strong stereotypes exist between gender categories and these school subjects. Nosek, Banaji, & Greenwald (2002) found that implicitly (or nonconsciously) men are more strongly associated with STEM fields than women. Even when exposed to a successful female in math, women and men held consistent implicit stereotypes that men are associated with math (Stout, Dasgupta, Hunsinger, & McManus, 2011). However, other research suggests that STEM stereotypes also implicate specific appearance and personality traits related to “femininity” and “masculinity”, not just “female” and “male” categories. For example, computer science companies portrayed in a stereotypical environment (i.e. room filled with Star Trek poster, comics, video games, etc.) were rated as more masculine than one in a nonstereotypical environment, which included objects such as a nature poster or general interest magazines (Cheryan, Plaut, Davies, & Steele, 2009).

These stereotypes matter for perceptions of people in those careers. For instance, research shows that women in gender-incongruent occupations (e.g. engineering) were perceived as less feminine than women in gender-congruent occupations (e.g. nursing). Furthermore, men were perceived as more feminine in gender-incongruent occupations (Yoder & Schleicher, 1996). Stereotypes negatively impact career plans and decisions; as mentioned previously, women were deterred from furthering computer science careers in the more stereotypical environments (Cheryan et al., 2009).

But what do we mean when we think of nurses as feminine and computer scientists as masculine? When thinking about a feminine woman, it is easy to picture a woman wearing make-up, jewelry, clothes that accentuate her body, and perfectly manicured hair and nails. In contrast, when looking for the opposite of femininity, intuitively masculinity may be the first concept that comes to mind. However, masculinity is not the opposite of the femininity, but rather the two traits are orthogonal and independent of each other (Komori, Kawamuri, & Ishihara, 2011). If a woman is perceived as “not feminine”, it does not mean that she is also perceived as masculine. A masculine image embodies qualities of strength and aggressiveness, whereas a feminine image focuses more on sensitivity and affection (Bem, 1974). The present study focuses on stereotypes about femininity only in terms of appearance in order to eliminate any ambiguity about stereotypic beliefs about feminine or unfeminine activities or interests. All of the previous qualities of the hypothetical feminine woman require some amount of effort to personify a feminine image (Cole & Zuker, 2007; Mahalik et al., 2005). When picturing an unfeminine woman, she lacks these feminine traits, but does not necessarily embody masculine traits. Therefore, women in science who are stereotyped as unfeminine may be characterized by showing a lack of effort necessary to create a feminine image.

This research will address several questions about the associations between STEM and unfemininity and its impact on the perceived attainability or desirability of STEM success. First, we will look into the existence of these associations both implicitly (or outside of women’s awareness) and explicitly (or consciously endorsed). Once we determine if women hold stereotypical beliefs, we will look to see how they influence women’s reactions to an interview with a successful role model. Specifically, we will measure attitudes towards the role models, who will either be feminine or gender-neutral in appearance, and who will either succeed in “unfeminine” STEM or more feminine humanities fields. Participants will report how positively they rate the role models, how similar they feel to them, and whether they believe they can achieve the same type of success as the students they read about.

Prior research on STEM and femininity has only included explicit measures where participants self-report their attitudes and beliefs (Kessels, 2005; Yoder & Schleicher, 1996). The present research aims to look at whether college students associate STEM with unfemininity at both an explicit and implicit level. Explicit measures use self-reports to determine the attitudes of a participant, whereas implicit measures utilize methods that identify a participant's unconscious attitudes (Payne, Burkley, & Stokes, 2008). Our study will examine whether women hold both types of associations, mainly focusing whether implicit and explicit stereotypes are consistent with each other and whether they similarly predict STEM aspirations.

We measure implicit attitudes by having participants complete an Implicit Association Test. The Implicit Association Test (IAT) was designed to act as a method quantifying implicit, or unconscious, attitudes or beliefs (Rudman, Greenwald, Mellott, & Schwartz, 1999). This is separate from explicit prejudices because people are often unaware or unable to voice implicit judgments, whereas explicit prejudices can be spoken aloud and quantified in a self-report questionnaire. Measuring implicit associations is important because people may respond to a questionnaire based on societal norms rather than what they truly believe. Using implicit measures allows us to tap into the automatic associations that are unbiased by societal or prescriptive norms. To illustrate, Rudman et al. (1999) found that participants displayed a large implicit stereotypical effect across all categories (e.g. Jewish vs. Christian, old vs. young, or American vs. Soviet with pleasant vs. unpleasant); however, when the same participants were asked to explicitly rate stereotypical beliefs through self-report questionnaires, the amount of prejudice became significantly smaller. Our research will determine if implicit associations between unfemininity and STEM exist for women at the college level, and whether they predict explicit unfeminine STEM stereotypes.

We decided to use a Single-Category Implicit Association Test (SC-IAT) instead of the standard IAT for multiple reasons. Unlike the standard IAT, which compares associations made to two contrasting concepts (e.g. science vs. humanities), the SC-IAT uses evaluative rather than comparative measures to determine associations. That is, it only uses three constructs (in the present study, Math/Science, Unfeminine, and Feminine, as it does not require a contrasting category for Math/Science, such as Humanities). Including both fields of study, as in the IAT, assumes that respondents hold complementary stereotypic associations between unfemininity and STEM and between femininity and humanities. We are not interested in comparing stereotypes of STEM compared to associations of humanities; rather, we only want to measure perceptions of STEM alone. Further, the SC-IAT predicts intentions of behavior more so than an IAT or explicit measures (Karpinski & Steinman, 2006). It is difficult to interpret responses in an IAT because participants may either actually hold the stereotype, or only show a preference for one category over another. Since explicit measures are already subject to selection and response biases that may cloud the accuracy of the response, using both highly predictive implicit measures and explicit measures will help yield insights towards people's conscious attitudes and their relationship with unconscious beliefs.

In addition to understanding if implicit associations exist and how they relate to explicit associations, we are interested in determining if they affect perceptions of feminine and unfeminine women's success in STEM fields. Femininity and its compatible interests are positively valued, which might make feminine women's success seem more desirable than less feminine women's success. Previous research found that high school students who are perceived to favor science are seen as more unpopular, unattractive, less socially competent, and less integrated than students who are perceived to like humanities (Hannover & Kessels, 2004). All four of these traits are extremely undesirable for any high school student trying to determine a successful pathway for the future. An explicitly feminine woman in STEM would counter these undesirable traits, and thus be viewed positively.

Similarly, competitive traits are often seen as stereotypically masculine or unfeminine. To avoid being labeled in this way, women may either devalue themselves and avoid realizing their full potential, or strive for superfemininity in appearance and personality (Salisbury & Passer, 1982). This may include moving away from success in stereotypically unfeminine fields. Therefore, a female role model's success in STEM may seem less desirable or attainable when students hold the stereotype that women in STEM are unfeminine. Alternatively, if women can see more feminine women achieve success in STEM, these fields may seem like a more viable option.

One way to send the message that STEM success can be compatible with femininity is by showing students a successful feminine role model in STEM. Role models can have positive effects for women in STEM. For instance, when exposed to an advanced female in STEM, women displayed more positive implicit attitudes and identification towards math (Stout et al., 2011). Research involving stereotype threat and the presence of role models showed that women performed better on a math test when a woman administered the experiment rather than a man (Marx & Roman, 2002). Seeing a woman counter the gender-STEM stereotype was motivating. Similarly, individuals exposed to a successful woman in STEM increased positive attitudes towards STEM (Stout et al. 2011). However, the role model must be deserving of her success to be inspiring, meaning that she must earn the success and it was not handed to her or attained through luck (McIntyre et al, 2001). It makes sense then, that Betz and Sekaquaptewa (2012) found that college aged women responded positively to the presence of hardworking, successful, feminine STEM role models.

But what makes a good role model? Women describe science role models as people who are accomplished in their field, enjoy what they do, and promote science in beneficial ways for children (Buck, Plano Clark, Leslie-Pelecky, Yu & Cerda-Lizarraga, 2007). When students feel that STEM prototypes are relatable and similar to themselves, they in turn favor that particular subject as well (Hannover & Kessels, 2004). Younger girls also need to feel a deep personal connection to someone to identify them as a role model (Buck et al. 2007). The presence of a role model might promote women's success in these fields if women feel that the role model is similar, attainable, or positively valued. There are limitations of exposing students to successful role models, however, because role models can either be perceived as an inspiration or as a discouragement (Lockwood & Kunda, 1997). In order for a role model to have a positive effect, the role model must be relevant and attainable in relation to the evaluating student.

Past research has looked at female role models in STEM, but not explicitly at feminine women in STEM. Therefore, we aim to see if the femininity of a role model has a significant effect on women's aspirations in STEM fields. Specifically, we have a three-fold prediction about the impact of a feminine STEM role model. First, we predict that participants will feel more motivated to pursue STEM fields after seeing a feminine STEM role model, compared to no role model or different kinds of role models (e.g. less feminine STEM role models or feminine role models in humanities fields). Second, we qualify the first prediction by arguing that women's preexisting stereotypes will moderate the effect of the role model on STEM aspirations.

The strength of women's stereotypic associations is expected to have a significant effect on the motivational effects of different role models. The feminine role model is incongruent with the stereotypical STEM prototype, but even more so for women with strong implicit associations between STEM and unfemininity. These women are expected to see a feminine role model's STEM success as more strongly defying their stereotype, and this novelty may make that role model particularly motivating. In other words, the role model should be more counterstereotypic for women with strong implicit stereotypes, than women with weak stereotypes. The role model is expected to be more influential for the former kind of student, who may benefit more from seeing someone counter her stereotype.

This brings us to our third hypothesis regarding the effects of feminine STEM role models. Feminine STEM role models are expected to benefit women with strong stereotypes because these women will see the role model as positive, similar to themselves, and attainably successful. Although a feminine STEM role model counters stereotypes just as a female STEM role model does, her emphasis on appearance may yield more positive attitudes toward her. High school students have been found to feel less positively towards and less similar to students who favored science and more positively towards and similar to students who favored humanities (Hannover & Kessels, 2004). Also, women felt dissimilar from stereotypically "geeky" science-oriented female role models, which negatively affected perceptions of achieving success in STEM fields and undermined their beliefs about their STEM abilities (Cheryan, Siy, Vichayapai, Drury, & Kim, 2011). Finally, if women with strong implicit associations between STEM and unfemininity feel particularly similar to a feminine role model, the role model's success should also seem more attainable.

In this study we will utilize the SC-IAT to determine if women hold stronger implicit associations between STEM and unfemininity or STEM and femininity. If a stronger implicit association exists between STEM and unfemininity women will find it easier to pair unfeminine stimuli with math/science words rather than feminine stimuli, and they will therefore display quicker reaction times on those pairs. We also aim to see if women hold explicit stereotypes linking STEM with unfemininity, which we will measure through self-report items. On the one hand, our research will look to discover a correlation between implicit and explicit associations. However, if explicitly stating that women in STEM are more unfeminine seems taboo, even though one may still feel that way implicitly, we may not discover a strong relationship between explicit and implicit attitudes (Nosek et al. 2002, Rudman et al., 1999).

Next, we will compare the effect of feminine and gender-neutral STEM and humanities role models on women's STEM aspirations. This research will examine a theoretical mediation model to determine the strength and direction of these effects. As seen in Figure 1, we expect that stereotype will interact with role model condition and predict future aspirations, interest in STEM, and importance of STEM in one's life. That is, women with stronger implicit unfeminine-STEM stereotypes should respond most positively to the feminine STEM role model. We then will determine look to see if the overall rating of the role model as positively, similar to oneself, and attainably successful mediates this effect. In order to determine if a mediator exists, the role model by stereotype interaction must first adequately predict STEM aspirations and then predict the role model rating. Finally, in a third model, the role model rating must predict STEM aspirations, while reducing the role model by stereotype interaction to nonsignificance.

Method

Participants

We recruited 161 University of Michigan female students using the Introductory to Psychology Subject Pool as well as campus flyers and engineering student lists emails advertising the study for paid participants. 71 paid subjects received $12 in return for their participation, and 90 received one hour of credit towards their course requirement. Participants ranged in age from 17 to 39 (M=19.48, SD = 2.142). There were 60 first year, 43 second year, 33 third year, 20 fourth year, and 3 fifth year or above students. We also had a variety of ethnicities: 5.6% African-American, 22.4% Asian American, 62.1% Caucasian, 4.3% Latino, 2.5% International Asian, and 3.1% mixed race. This sample included 54 STEM majors (i.e. chemistry, biology, etc.) and 107 non-STEM majors (i.e. psychology, English, etc.). Using random assignment, there were 30 participants in the feminine role model-STEM condition, 31 in the gender-neutral role model-STEM condition, 32 in the feminine role model-Humanities condition, 35 in the gender-neutral role model-Humanities condition, and 32 in a no role model control condition. Computer error prevented us from collecting IAT data on 4 participants; however, we did not exclude these cases from the sample, as we were able to collect all other measures from them.

Materials

Prescreening. Participants had the option of filling out prescreening questionnaires when they signed up to participate in the study. One hundred twenty-four agreed to complete them. All items on the prescreening questionnaire were measured on a 7-point Likert Scale (*1 – strongly disagree, 7 – strongly agree*).

All of the prescreening questions addressed explicit stereotypes or beliefs about femininity ($\alpha = .68$). They were also broken down into subscales. Three questions addressed prescriptive ideals for women, specifically how women ought to appear in terms of femininity (e.g. *Women should look feminine,* $\alpha = .79$). Two focused on the adherence to feminine norms of appearance in everyday life (adapted from Mahalik et al. 2005; e.g. *I regularly wear makeup;* $r(124) = .40$, $p < .001$).

Three items were based on the Social Physique Anxiety scale (Hart, Leary, & Rejeski, 1989; e.g. *I am comfortable with how my body appears to others;* $\alpha = .80$). This scale focuses on a person's own body distortions that mostly are centralized around weight and appearance. It measures perceived social pressures and evaluations of others that may bring about a person's anxiety of their own appearance.

The final two questions asked about participants' overt beliefs that STEM pairs well with unfemininity (e. g. *Most people think that women in science, technology, engineering, and math (STEM) look less feminine than women in more traditional fields (e.g., education, nursing*)). These questions were also paired with two similar explicit questions that participants completed during the experimental session right after the IAT (e.g. *I believe that natural science and being feminine go together* and *I believe that math and being feminine go together*) to create a four-item "go together" composite ($\alpha = .68$).

Single Category Implicit Association Test. All versions of the IAT and SC-IAT ask participants to categorize words, pictures, or a combination of the two. There are no differences or benefits to using one type of stimuli over another, as long as the stimulus used is easily recognized and categorized with the least amount of ambiguity (Karpinski & Steinman, 2006; Dasgupta, McGhee, Greenwald, & Banaji, 2000). For this study, it was most logical to use words to describe STEM fields of study and pictures to represent feminine and unfeminine appearance.

Through pilot testing, we chose to use six objects that were rated as feminine (pink sweater, pink coat, high heel shoe, pink watch, necklace, and purse) and six similar objects that were rated as unfeminine (brown turtleneck, black coat, black sandal, black watch, lanyard, and backpack). We also chose six words that are associated with STEM majors (engineering, physics, biology, technology, mathematics, and chemistry). See Results for details on pilot testing, and see Appendix A for pictures.

To complete the SC-IAT, participants saw one word or picture at a time in the middle of a computer screen and were asked to assign it to one of the categories on the computer screen. The IAT program randomizes the order in which the participants see the categories and the side of the computer that the categories are placed so that this does not have an effect on the reaction times. For example, one participant may first see the category label "feminine" on the right side of the computer and the paired category labels "unfeminine/STEM" on the left side, whereas another participant may see it the other way around. This controls for any order effects or bias that may occur from a particular sequence. If the picture/word fit into the category on the left side of the computer screen they pressed the "Z" key; and if the picture/word fit into the category on the right side of the computer screen they pressed the "M" key.

Participants completed the SC-IAT in four rounds, including two practice rounds and two rounds that were analyzed for results. In every round, participants saw a green circle for a correct selection, a red x for an incorrect selection, or the phrase "Please respond more quickly" if the selection took more than 1600 milliseconds. The first practice round did not count for our analyses and only included 24 trials so that the participants could become familiar with the program and could learn to distinguish feminine pictures from unfeminine pictures. The next round used the same grouping but over 72 trials; these responses provided part of the participant's data. Then the pairing was switched, so if they first saw feminine-STEM and unfeminine only, they now saw feminine only and unfeminine-STEM. See Figure 2 for a schematic of what participants saw while completing the SC-IAT. Research shows that a fewer number of trials than what we used here lowers the internal consistency of the SC-IAT. There also was no beneficial effect of lengthening the response window time passed 1500 milliseconds (Karpinski & Steinman, 2006).

Implicit associations were analyzed through calculations of reaction time. A quicker reaction time to one pair versus another shows an easier association between the two. An easier association infers a stronger implicit stereotype reflecting that grouping.

Role Models. The participants then read magazine articles depicting fictional interviews with two female University of Michigan graduates. These women successfully built upon their undergraduate degrees towards their current career. These successful graduates were meant to serve as relevant role models to the participant. See Appendix B for examples of the feminine STEM and unfeminine humanities articles.

The same female models were used in every condition, but we manipulated their appearance and their major. In the feminine conditions, the role models wore make up, jewelry, accessories and clothing with either a feminine color (i.e. pink) or pattern (i.e. floral). All of these features were exaggerated so that the participants obviously recognized the role model as feminine. In the gender-neutral condition, the role model lacked these additions, meaning that they did not wear any make up, jewelry or accessories. The gender-neutral role models also wore clothing that were not form-fitting, such as a boxy t-shirt, with a black sweater or jacket over top. In both the feminine and the gender-neutral condition, the role models wore glasses to maintain an equal perception of intelligence. In addition to manipulating the pictures, the feminine condition included purple-pink headline and border, whereas the headline and border were gray in gender-neutral condition. See results for details of piloting testing.

In the STEM conditions, one role model was a biochemistry major and the other was in aerospace engineering, whereas in the humanities condition one role model was an English major and the other was in art history. All interviews followed the same format, including a memory of a previous class, overcoming difficulties in the major, non-school related hobbies, and current success in her career. Maintaining the same format for each interview allows for less bias and easier interpretation.

Measures and Assessments

Role Model Ratings. Participants were asked to provide responses to various questions about the magazine articles that they had just read. Based on the research of Lockwood and Kunda (1997), the first set of questions discussed the participants' perception of the role models. They used 7-point Likert scales (*1 = not at all, 7 =very much so*) to rate certain traits of the role model. They rated how smart, hardworking, organized, likable, friendly, outgoing, and successful the role model appeared. These traits collapsed into one positivity measure ($\alpha = .87$). They used a similar scale to answer one item on how similar they felt to the role model. Next, participants were asked to rate the attainability of the role models success. Participants used a 7-point scale *(1 – Not at all, 7 – Very much so)* to rate the attainability of the role models' academic success, femininity, and combination of both for a total of 6 questions (e.g., *How likely is it that you could be as academically successful as these students one year after graduation*). The items comprising three different ratings (i.e. positivity items, similarity item, and "attainability of both" item) of the role models were combined into one overall rating of the role model ($\alpha = .83$).

Femininity Manipulation Check. In addition, participants were asked to rate one item how feminine-looking the role models were. This was to ensure that noticeable difference existed between the feminine role model conditions and the gender-neutral role model conditions.

STEM/Math/English Aspirations. In addition to participant's attitudes about the role model, we wanted to know their intentions towards taking STEM classes at the university. We first asked them to identify the first class that came to mind in each of five categories (Natural Science, Social Science, Humanities, Mathematics, and Creative Expression). These selected classes will then serve as the basis for the proceeding questions. The following questions were categorized into four different overall outcomes in terms of future plans, academic self-concept, interest, and importance (Simpkins et al., 2006). Future plans outcomes included two questions. The first asked if the participant would consider taking classes in each category if they had to fulfill graduation credits. The second either asked if the participant was looking forward to classes in that required category (e.g. natural science) or if the participant would choose to take classes in the optional category (e.g. mathematics) in upcoming semesters. Both were answered on 7-point scales ($r_{ns} = .82, p < .001, r_{math} = .78, p < .001, r_{hu} = .76, p < .001$).

Next, participants used 7-point scales to answer eleven items each about natural science, math, and English. Five of those items asked about their current self-concept in each subject (including self-rated ability and success expectancies e.g., "How good at _____ are you?" $\alpha_{ns} = .93$; $\alpha_{math} = .95$; $\alpha_{eng} = .93$), three items measured interest (e.g., "Do you find working on _____ assignments (boring/interesting)?" $\alpha_{ns} = .89$; $\alpha_{math} = .92$; $\alpha_{eng} = .88$), and three items measured the perceived importance of each subject (e.g., "In general, how useful is what you learn in _____?" Simpkins et al., 2006; $\alpha_{ns} = .85$; $\alpha_{math} = .86$; $\alpha_{eng} = .84$).

Demographics. Participants were also asked to fill out basic demographic information. These questions determined gender, race, age, and year in school. Participants were also asked to fill out information about their choice of major or intended major as well as identify current class enrollment. Based on participants' answers, they were categorized into a dichotomous variable denoting whether they majored in STEM (n = 54) or a non-STEM field (n = 107).

Procedure

Participants first completed a ten-item pretest questionnaire. Subject pool students completed the survey as part of a larger battery of questions in a mass testing session. Paid participants completed the survey online at least one day before they came to the lab to complete the experiment.

In the experiment, participants first completed a Single-Category Implicit Association Test (SC-IAT), assessing associations of feminine and unfeminine images with STEM words.

After completing the SC-IAT, participants read a magazine article featuring two interviews. Participants were randomly assigned to one of four magazine conditions based on the role models' appearance and domain of success; feminine-STEM, feminine-humanities, gender neutral-STEM, and gender neutral-humanities.

Following the magazine interviews, the participants completed several online questionnaires that focused on the participants' perceptions of the role models, as well as the participants' perceptions of themselves. They ended with a demographic questionnaire.

In order to provide a baseline on our outcome measures, a fifth control condition was included. Participants selected for this condition answered the questionnaires before reading about the role models; thus, the specific magazine article selected should not have an effect on the participants' responses.

After finishing the entire study, the participants received a *New York Times* article during debriefing that depicted the life of true successful women in a STEM fields. The participants were given this to counteract any negative effects on future plans that may occur during this study (Betz & Sekaquaptewa, 2012).

Results

Pilot Testing of Experimental Materials

Role Model Pictures. To create role model stimuli, the goal was to select one photo for each of two different women to represent two role models who were either feminine or gender-neutral and either successful in STEM or humanities. Feminine and gender-neutral role models had to seem differently feminine, but all role models had to seem equal in perceived intelligence.

To achieve this, we took photos of two women (one African American, one White) wearing three different kinds of outfits: a feminine outfit, a feminine outfit with glasses (in case glasses were necessary to convey intelligence), and a neutral outfit (always with glasses). The photos were manipulated in Photoshop to yield either a STEM background (e.g., equations written on blackboard) or a neutral academic blackboard (e.g., blank blackboard). This yielded a 3 (outfit) x 2 (domain) factorial model. Seventy-three pilot participants were assigned to one of these six conditions. Participants viewed four photos: each of the two women was presented in two poses each (e.g., reading a book or taking a book off a library shelf). The photos featured the women in whatever outfit and domain was appropriate to the participant's condition. Participants used two seven-point Likert scales to rate how feminine and intelligent the woman in each photo appeared to be (1 = very un___, 7 = very ___).

A 3x2 factorial ANOVA tested the impact of outfit, domain, and their interaction on the perceived femininity of the woman in each photo pose. Because each participant saw four photos, the factorial ANOVA was conducted four times, once on each photo type. The same four factorial ANOVAs tested the impact of outfit, domain, and their interaction on the perceived intelligence of the woman in each photo pose. The final photos were chosen because they met our criteria of different femininity yet equivalent intelligence, as supported by the analyses described below.

For the chosen African American role model photo, a main effect of outfit emerged ($F(2,67) = 11.22$, $p < .001$) on perceived femininity. A Tukey's post-hoc test revealed that both the feminine outfit and feminine outfit with glasses conditions seemed more feminine than the neutral outfit condition (both *p*s < .001). Outfit marginally significantly interacted with domain ($F(2,67) = 2.70$, $p = .08$). A MANOVA analysis suggested that the neutral humanities role model seemed less feminine than the neutral STEM role model ($F(1,69) = 9.39$, $p < .01$). When the same factorial ANOVA was run on perceived intelligence, no significant effect of outfit ($F(2,68) = .23$, $p = .80$), domain ($F(1,68) = .02$, $p = .90$), or their interaction emerged ($F(2,68) = 2.29$, $p = .11$). This suggested that the Black role model seemed equally intelligent regardless of the femininity of her outfit or her domain of success.

For the chosen White role model photo, a main effect of outfit emerged ($F(2, 68) = 12.60$, $p < .001$). A Tukey's post-hoc test revealed that both the feminine outfit and feminine outfit with glasses conditions seemed more feminine than the neutral outfit condition (both *p*s < .001). Outfit did not interact with domain for the White role model ($F(2,68) = 1.15$, $p = .32$), suggesting that the feminine outfit pictures seemed more feminine than the neutral outfit pictures regardless of domain. When the same factorial ANOVA was run on perceived intelligence, no significant effect of outfit ($F(2,68) = .30$, $p = .74$), domain ($F(1,68) = .07$, $p = .79$), or their interaction emerged ($F(2,68) = 1.30$, $p = .28$). This suggested that the White role model seemed equally intelligent regardless of the femininity of her outfit or her domain of success.

Thus, both photos satisfied our role model photo criteria. Unfortunately, the African American role model's femininity differed marginally depending on domain. However, we hoped that this would not matter for the present study's results since participants would view the Black role model together with the White role model, whose perceived femininity did not depend on domain. Finally, we chose the feminine outfit with glasses photos to represent the feminine role models in the present study because they did not differ from the feminine outfit photos in perceived femininity or intelligence, and because this allowed us to keep the presence of glasses constant between feminine and neutral role model conditions.

IAT Pictures. The pictures chosen for the SC-IAT were matched on type of item between the feminine and unfeminine categories. To determine which objects were most easily recognized as feminine and unfeminine, the pictures had to be significantly different from their counter-picture and significantly different than the middle of the scale (4 – *Neither feminine nor unfeminine*). We decided on 6 final pairs of pictures (watch, coat, sweater, shoe, bag, and necklace). As a whole the pictures were rated as either significantly more feminine than the midpoint, $t(31) = 50.66$, $p < .001$, ($M = 6.78$, $SD = 0.31$) or either significantly less feminine than the midpoint, $t(31) = -9.59$, $p < .001$, ($M = 2.82$, $SD = 0.69$).

Manipulation Check

A factorial ANOVA tested whether feminine role models seemed more feminine than gender-neutral role models, regardless of domain of success. A 2 (role model femininity) x 2 (role model domain) ANOVA on the one-item "feminine-looking" item revealed a significant effect of role model femininity ($F(1,157) = 39.0$, $p < .001$, such that role models in the feminine conditions looked more feminine (*M* = 6.07, *SD* = .99) than role models in the gender-neutral conditions (*M* = 4.86, *SD* = 1.43). Neither domain (*p* = .41) nor domain by femininity (*p* = .83) was a significant predictor.

Implicit and Explicit Stereotype Descriptives

Implicit Stereotyping. Participants' individual SC-IAT scores were determined through a series of calculations on reaction times, as described by Karpinski and Steinman (2006). First, all trials less than 350ms or greater than or equal to 1400ms were excluded from analysis. Next, the mean reaction time for each block was calculated for only correct responses. Incorrect responses were scored as the reaction time of that trial plus a 400ms penalty for the incorrect response. Then a new mean reaction time was calculated for each block including all correct trials and the penalty valued incorrect trials. Finally to calculate an over SC-IAT score per participant, the mean reaction time for stereotypic block pairing is subtracted from counter-stereotypic pairing. Intuitively this makes sense because counter-stereotypic reactions should take a longer time, therefore more positive scores are considered more stereotypic. Lastly, that final score was divided by the standard deviation of all correct response times (Karpinski & Steinman, 2006).

Overall, a one-sample t-test revealed that the mean score on the SC-IAT (*M* = 0.29, *SD* = 0.33) was significantly different than zero ($t(156) = 11.162$, $p < .001$). The average score was positive indicating a stronger association between unfemininity and STEM than femininity and STEM. This is evidence that an implicit association exists and STEM fields are viewed as more stereotypically unfeminine.

Explicit Stereotyping. Participants did not display strong overall explicit attitudes in either a stereotypical or non-stereotypical direction, as their average score hovered around the midpoint of the scales (*M* = 4.01, *SD* = .82). However, one-sample t-tests were run on each subscale of the explicit questions. Compared to the midpoints of the scales, participants had more significant stereotypical attitudes about feminine appearance (*M* = 4.52, *SD* = 1.61, *t*(123) = 3.63, *p* < .001) and prescriptive feminine norms (*M* = 4.63, *SD* = 1.19, *t*(123) = 5.90, *p* < .001), felt comfortable with their appearance (*M* = 3.37, *SD* = 1.46, *t*(123) = -4.75, *p* < .001) and saw STEM and femininity as "going together" significantly more (*M* = 3.53, *SD* = 1.36, *t*(123) = -3.85, *p* < .001).

Here we see that women believe it is important for them to appear feminine and that women in general should be feminine. At the same time, these women are displaying a strong sense of comfort in their body and appearance. Furthermore, counter to the SC-IAT results, women explicitly disagreed that an unfeminine-STEM stereotype exists.

Correlations between explicit and implicit stereotypes. Implicit associations were not correlated with explicit associations (*r*(120) = .05, *p* = .57). The lack of correlation between implicit and explicit associations is consistent with the hypothesis that participants may not be consciously aware of the stereotypes that they hold. This was also true for explicit scale sub-categories, except the items concerned with whether STEM and unfemininity go together (*r*(157) = .18, *p* = .03). Two of these questions were answered after the SC-IAT so that may have an effect on why they correlated so much more than the rest of the explicit questions. For all other implicit-explicit stereotype correlations, see Table 1.

Mediation Analyses

Hierarchical linear regression analyses were used to test our hypotheses concerning the effects of different types of role models. First, this research aimed to explore the effects of counterstereotypic feminine STEM role models on STEM aspirations, as compared to other kinds of role models or no role model control condition. We achieved this by dummy coding role model conditions, which produced four predictors that independently compared the effect of the neutral STEM role model, the feminine humanities role model, the neutral humanities role model , and the no role model control condition to the effect of the feminine STEM role model. In addition to seeking main effects of type role model, we tested whether, pre-existing implicit or explicit stereotypes would interact with the type of role model a participant saw to determine the role model's impact on academic aspirations. Finally we also aimed to discover if perceived attainability, similarity, or positivity of the role model acted as a mediator for the interactive effect of role model and stereotypes on STEM aspiration outcomes. To test all of these main, interactive, and mediational effects, multiple regression analyses were conducted.

First, a regression model tested whether the feminine STEM role model affected future plans, self-concept, interest, and importance in natural science, math, and English (twelve separate outcome measures), relative to each other role model condition, controlling for students' major and class year. In addition, the regression models test if any of the role model by stereotype interactions were significant predictors for these twelve outcomes. These twelve regression models were conducted twice. The first set of models tested the main and interactive effects of implicit stereotypes, and the second set of models tested the main and interactive effects of explicit stereotypes. In reporting the dependent variables, we only focus on the natural science and English aspiration outcomes because the mathematics aspiration outcomes did not appear to have any relationship with the participants' stereotypes. This makes sense, given that five of the six math/science IAT words were actually science words (see Appendix A). IAT scores may thus better reflect an unfeminine science stereotype than an unfeminine math stereotype.

Implicit Stereotypes. Looking first at implicit stereotypes and their interactions with role model condition, a hierarchical linear regression model was fit. The first step included two control variables: participant's class year and a dichotomous variable indicating whether they were STEM (0) or non-STEM majors (1). The second step included our main effect variables: centered SC-IAT score and four dummy coded condition variables (comparing feminine STEM role model's effects to each of the other four role model condition: neutral STEM, feminine humanities, neutral humanities, and no role model condition). Finally, the third step included four variables interacting with SC-IAT scores with each of the dummy coded role model variables.

The model fit significantly well for natural science future plans ($F(11, 143) = 1.99$, $p = .03$). The interaction between the implicit stereotypes and the feminine humanities condition was a significant predictor ($B = -3.25$, $p = .05$). The model was also significant when predicting natural science self-concept ($F(11, 143) = 2.13$, $p = .02$), with the interaction of implicit stereotypes and the feminine humanities role model as a significant predictor ($B = -2.24$, $p = .03$). The interaction between the control condition and implicit stereotypes was also significant ($B = -2.07$, $p = .04$) However, the model fit was marginal for interest ($F(11,143) = 1.65$, $p = .09$) and perceived importance ($F(11,143) = 1.82$, $p = .06$) in natural science. However, the interaction of implicit stereotypes and the feminine humanities role model was significant for natural science importance ($B = -2.66$, $p = .03$). These significant interactions suggest that as implicit unfeminine-STEM stereotypes increase, the feminine STEM role model negatively impacts future plans, self-concept, and perceived importance in natural science relative to the feminine STEM role model. Further, the feminine STEM role model improves natural science self-concept relative to control, as implicit stereotypes increase. Additionally, being a non-STEM major compared to a STEM major negatively predicted all natural science outcomes.

Tests regarding future plans in English showed that the model was marginal ($F(11,143) = 1.81$, $p = .06$), but no significant interactions emerged. However, with all other English aspiration outcomes, these models did not fit significantly well. Within these nonsignificant models, being a non-STEM major compared to a STEM major positively predicted all English outcomes. See the model statistics and betas associated with each of the eight dependent variables in Table 2.1.

Explicit Stereotypes. Similarly, the same hierarchical linear regression model was run, replacing implicit stereotypes with the centered overall explicit stereotype and its interaction with dummy-coded role model condition variables. We found that this model was much more predictive of all the aspiration outcomes in natural science (compare R^2 statistics in Tables 2.1 and 2.2), but not of the outcomes involving English. This regression model fit well for future plans ($F(11,110) = 2.54$, $p = .007$), self-concept ($F(11,110) = 2.75$, $p = .003$), interest in ($F(11,110) = 2.44$, $p = .009$), and perceived importance ($F(11,110) = 2.34$, $p = .01$) of natural science; however none of the interactions were significant predictors of these outcomes.

The regression model with English future plans as the dependent variable was significant ($F(11,110) = 1.95$, $p = .04$). However, none of the interactions between explicit stereotypes and role model condition were significant predictors. All other models for English outcomes did not provide a statistically significant fit. See the betas associated with each dependent variable in Table 2.2.

Mediators. Having determined that SC-IAT significantly interacted with either the feminine humanities role model (compared to feminine-STEM) or the control condition (compared to feminine-STEM) to predict natural science outcomes, we next tested whether the participants' ratings of the role model (i.e. positivity, similarity, and attainability) mediated these effects. For a meditational model to be significant, the same predictor used for the outcome variables must significantly predict the mediator as well. To test this, the same hierarchical linear model, including implicit stereotyping and its interactions was regressed upon the overall role model rating. The model significantly predicted overall role model rating ($F(11,143) = 2.63$, $p = .004$); however none of the interactive variables were significant predictors. See all betas associated with this model in Table 2.3.

This suggests that the role model by implicit stereotype interactions are not driving the significance of the model predicting role model ratings. Rather in the second step of the model (before interactions were added), the implicit stereotype negatively predicted participants' rating of the role model ($B_{implicit} = -.55$, $p = .002$). That is, the stronger the participants' implicit stereotypes, the less positive, similar, and attainable they saw the role models to be (but this did not depend on the type of role model the participant saw). Therefore, due to the fact that the role model by implicit stereotype interaction was not significant for role model rating, the overall rating of the role models is not mediating the interaction's effect on natural science outcomes. Thus, the results did not support our theorized model (Figure 1).

Although role model and explicit stereotypes did not significantly predict our natural science outcomes, we also regressed them upon the overall role model rating to see if they would predict perceived positivity, similarity, and attainability of the role model. Similarly, the model with the main and interactive effects of explicit stereotypes and role model condition was statistically significant ($F(11,143) = 2.04$, $p = .03$), but none of the interaction variables were significant predictors. However, unlike with the implicit stereotype model, explicit stereotype did not significantly predict the overall role model ratings in any step of the model ($B_{explicit}$ = -.11, *p* = .17). See all betas associated with this model in Table 2.4.

Another interesting result is that all the dummy-coded role model condition variables are negative compared to the Feminine role model STEM condition in both the implicit (B_{NS} = -.52, *p* = .007, B_{FH}=-.73, *p* < .001, B_{NH} = -.60, *p* = .001, $B_{control}$ = -.46, *p* = .02) and explicit (B_{NS} = -.49, *p* = .03, B_{FH} = -.85, *p* < .001, B_{NH} = -.65, *p* = .002, $B_{control}$ = -.74, *p* = .001) stereotype models. This suggests that the participants rated the feminine STEM role model as more positive, similar, and attainable compared to all other role models.

Correlations among role model ratings. Perceived similarity to the role model was highly correlated with positivity scores (*r*(161) = .47, *p* < .001). The more positively the role model was rated, the more similar participants felt towards that role model. Similarity was also positively correlated with perceived attainability of the role model's femininity (*r*(161)=.23, *p* < .01) and perceived attainability of both academic and feminine success (*r*(161) = .27, *p* < .01). Overall positivity ratings of the role model were also marginally correlated with perceived attainability of the role model's femininity (*r*(161) = .14, *p* < .10). This suggests that the more similar participants felt towards the role model and the more positively they rated the role model, the more attainable the role models' success was perceived in both academic and feminine success. These correlations can be found in Table 3.

Stereotypes' Correlations with STEM Aspiration Outcomes

Finally, a series of correlation analyses examined the relationship between implicit and explicit stereotypes (including subscales) and future plans, self-concept, interests in, and perceived importance of natural science, mathematics, and English. Overall, the stronger the stereotype that STEM is unfeminine, both implicit and explicit, the lower the participant scored on the outcome variables.

Natural Science. The most consistently significant correlations were in relation to outcomes concerning natural science. The stronger participants' implicit unfeminine-STEM stereotype was, the less they wanted to pursue natural science classes in the future ($r(157) = -.17$, $p = .04$). Future plans in natural science were also negatively significantly correlated with explicit stereotypes ($r(124) = -.23$, $p = .01$). Similarly, higher explicit stereotypes were significantly correlated with lower natural science self-concept ($r(124) = -.27$, $p = .003$). Implicit stereotypes only marginally showed this same correlation with natural science self-concept ($r(157) = -.126$, $p = .115$). In addition, participants showed significantly lower interest and importance in natural science as stereotypes increased. When breaking down explicit questions even further, these outcomes were either significantly or marginally significant with stereotypes about feminine appearance and body comfort. See correlations in Table 4.1.

Mathematics. Outcomes related to math were not significantly correlated with stereotypes, both implicitly and explicitly. There was one exception; participants who held strong stereotypes about feminine appearance also felt less desire to pursue mathematics classes in the future ($r(124) = -.185$, $p = .04$). Feminine appearance stereotypes were also marginally correlated with a lower interest in mathematics. All other relationships were not significant. See correlations in Table 4.2 in Appendix B.

English. Similar to the math outcomes, aspirations about English were largely uncorrelated with stereotypes. Surprisingly, the more stereotypically participants believed women should look feminine, the less participants wanted to pursue English in the future ($r(124) = -.17$, $p = .07$). Similarly, the more participants believed STEM and unfeminine go together, the less they wanted to pursue English (*r*(161) = -.16, *p* = .04). A lower English self-concept was marginally correlated with stronger overall explicit stereotypes (*r*(124) = -.16, *p* = .08) and significantly correlated with explicit body comfort stereotypes (*r*(124) = -.17, *p* = .07). See all correlations in Table 4.3.

Discussion

This research yielded multiple insights into the implicit associations between STEM and unfemininity. First and foremost, women hold a significant implicit stereotype between STEM and unfemininity. In support of our hypothesis and previous research, women more easily associate STEM with unfemininity rather than femininity. Through using a Single-Category Implicit Association Test, rather than a traditional IAT, we can conclude that regardless of attitudes towards another field such as English, students feel that STEM is more unfeminine than feminine.

Explicitly, students displayed very different stereotypes than the SC-IAT suggests. Through the self-report items, women did not indicate strong feelings in either direction about the STEM-unfeminine stereotype, perhaps because respondents are hesitant to answer in extremes (Hodge & Gillespie, 2003). Yet, when broken down in subscales, participants expressed more disagreement than indifference with the belief that STEM and unfemininity do not go together. This finding is expected because women may be unwilling to say that women in STEM fields are unfeminine, as it is socially unacceptable to explicitly state many social stereotypes. However, participants strongly felt it was important for them to look feminine and believed that women in general should look feminine. These discrepancies coincide with the nature of explicit questionnaires about sensitive topics.

As anticipated, there were no significant correlations between explicit associations and implicit associations. The two types of measures often do not correlate or predict each other because participants are often unaware of how strong their implicit associations are, especially towards sensitive or stereotypic topics (Paulhus & Trapnell, 2008). Implicit associations were more strongly correlated with the explicit items that discussed appearance. Due to our definition of unfemininity being a lack of effort towards appearance, it makes sense that these items were the most correlated.

Through the series of regression and mediation analyses, we found that our proposed mediation model was not supported. When first looking at how the interaction of stereotypes and role model condition affects STEM aspirations, we found that depending on the type of the role model, STEM aspirations were affected in different manners. The super-stereotypic feminine-humanities role model was much less motivating than the feminine-STEM role model towards increasing STEM aspirations, but only as implicit unfeminine-STEM stereotypes grew stronger. The feminine STEM role model also seemed to improve natural science self-concept compared to the no role model control condition, as implicit unfeminine-STEM stereotype increased. This gives light to the fact that a relationship exists between the role model by stereotype interaction and natural science plans and self-concept.

However, that same interaction did not predict the overall ratings of the role models. In order for these ratings to be the mediator, that same interaction must also significantly predict these ratings. This then suggests that stereotypes did not moderate how highly the participants rated the roles models, and thus that the role model by stereotype interaction on role model ratings was not driving the significant effect of the interaction on science aspirations. Therefore, there may be some other variable to be explored in future research driving this effect on future plans, self-concept, and importance in natural science.

Although role model ratings did not drive their effect on outcomes, the regression analyses revealed that the feminine-STEM role model condition was rated more positively, similar to oneself, and attainable than all other conditions. This supports our hypothesis that the feminine STEM role model, by countering socially undesirable stereotypes about unfemininity, would be viewed positively. Further, this occurred even though all four types of role models were rated equally on intelligence in pilot testing. These significant differences give light to the possibility that the feminine-STEM role model counters the typical STEM stereotype enough so that women feel more positive towards STEM fields and women in STEM. In future research, a version of this counterstereotype may by able to elicit changes in participants' desire to pursue these concentrations.

Although not a significant mediator, the different dimensions of the role model ratings positively correlated with one another. Women who believed the role models to be very similar to them and more positive overall also perceived the role models to be more attainable both in terms of their academic success and femininity. Past research is consistent with this finding; if a role model is similar and relevant then people will hold more positive attitudes towards to role model and their success (Lockwood & Kunda, 1997, McIntyre et al., 2001, Stout et al., 2010). Overall, participants rated all the different role models very positively in terms of personality traits. Participants who rated the role models very positively, in turn believed the role models to be more similar to themselves. Finally, feeling similar predicted feeling more able to attain the role model's femininity or combined feminine STEM success. People, in general, tend to view themselves in a more positive light than others (Taylor & Brown, 1988); therefore, it makes sense that women would feel very similar to and able to match a positively rated role model.

Another goal of this research was to understand how stereotypes on their own correlate to students' STEM aspirations. In fact, there were significant correlations between both explicit and implicit stereotypes and the participants' perceptions towards their future plans and self in relation to STEM. In all cases, as predicted, stronger stereotypes negatively influenced these perceptions. Women were deterred from wanting to pursue natural science (and to a less extent mathematics) in the future if they held a strong stereotypic association between STEM and unfemininity. Women's self-concepts also negatively correlated with their stereotypic associations. Strong stereotypes between STEM and unfemininity lowered the students' perception of their self in relation to natural science. This is consistent with past findings that stereotypes about STEM weaken female self-concepts (Hanover & Kessels, 2004, Simpkins et al., 2006). Similarly, heightened stereotypes correlated with lower interest in and perceived importance of natural science.

Interestingly, future and self-perceptions towards humanities were negatively influenced as well. Our questions regarding these STEM aspirations only focused on future class choices, not necessarily career paths; therefore, women could feel a lack of interest in school and classes in general, rather than a lack of interest in STEM or humanities. The relationship these perceptions appear to have with a STEM-unfeminine stereotype could just be an illusory correlation.

Consistent with the regression results, we see that although these correlations between implicit stereotypes and natural science aspirations exist, the stereotype alone is not predictive of the natural science outcomes, but rather is dependent on the role model condition. In order to increase interest and self-perception towards natural science this stereotype must be eliminated. Our feminine STEM role models achieved these positive outcomes, as compared to a super stereotypic role model (a feminine women in humanities) and on one outcome, as compared to no role model at all, illustrated by our regression analyses.

Limitations

The explicit items in this research may have been too broad and too few to truly determine if women hold an explicit STEM-unfeminine stereotype. Explicit items were asked prior to experimentation period in an uncontrolled environment, so many external factors might have influenced responses. Adding more questions, either before or during the experimentation period, may help better determine the strength of any relevant relationships with explicit stereotypes.

Similarly, many of the explicit items discussed social anxiety. This type of anxiety stems from others' evaluations of appearance or even worse perceptions of other's evaluations of appearance, regardless of whether they are true (Hart, Lear, & Rejeski, 1989). Women's body esteem is multidimensional, most associated with sexual attractiveness and weight (Franzoi & Shields, 1984). Today's westernized culture has placed a large emphasis on the sexual objectification of women, leading to self-objectification. Self-objectification leads to an overemphasis of appearance and lower self-esteem. The emphasis on self-objectification and appearance may negatively affect competence (Strelan & Hargreaves, 2005). Participants may have been shown feelings of social pressure towards societal norms more so than unfeminine-STEM stereotype.

Our methods for measuring overall role model ratings may have been too limiting as well. Our results displayed overall ratings as a poor mediator, which was not expected.

Perceptions of the role models could be a function of skewed self-perception. For instance, if women's perception of their ability does not match their actual ability, they may feel less similar to an accomplished STEM role model or feel that she cannot attain success. Our research did not measure actual ability. In order to correctly gauge actual versus perceived ability, this research should have looked into past grades in classes, GPA, or SAT scores.

Lastly, there were informal reports from participants that role models may not have been as realistic as we would have like. There were issues with the language in interviews; some participants said it was too elementary for a college student, which raised questions about realism. Others did not feel as though students in STEM would have time for extra-curricular activities or that students in humanities could not possibly be that successful after college. Perhaps creating more believable role models would strengthen our promising results.

Future Directions

Looking to future directions, research that dives deeper into the relationships of explicit and implicit stereotypes of women in STEM could yield more insight on preconceived attitudes about femininity. Future research should also explore the differences between perceived ability and actual ability in STEM fields. A lower perceived ability in math or science may negatively affect women's STEM self-concept or interest. However, if a person's actual ability is higher than what she believes to be true, narrowing that misconception may create a more positive attitude towards STEM. Especially if women want to be as successful as role model, but don't believe they can attain it, matching actual ability to perceived ability may further encourage participation in STEM. Similarly, defining attainability in different ways, not just as general academic success, might be useful for understanding what specifically isn't attainable about the role models. Splitting attainability into subparts, such as success in specific courses or success in a specific job position, may help to discover differences between what exactly about the role models is attainable and what is not.

Moving forward, we have some evidence that for women with a strong stereotype, a feminine-STEM role model may improve natural science aspirations. This occurs even though they do not uniquely see her as more positive, similar, and attainable. Research could explore different possible mediators that may positively drive these STEM aspirations. One possibility may be the extent of social anxiety that women possess. Women often are inhibited by social anxiety to the point where they avoid participation in social activities, especially ones showcasing body physique (i.e. going to the gym). If women already have concerns about a feminine attractive appearance, the presence of role models can either heighten these feelings of distress and anxiety or counteract them depending on the characteristics of the role model (Lockwood & Kunda, 1997). Perhaps the feminine-STEM role model reduces social anxiety in women with strong stereotypes, which then makes her feel freer to pursue “unfeminine” pursuits.

So far, research has only looked into the presence of a role model and personality traits as motivators for women. Further exploring research on appearance of role models and reducing stereotypes will hopefully lead to interventions that create a larger interest for women in science and engineering fields.

Conclusion

This research discovered that women do hold implicit stereotypes that STEM is unfeminine, though these stereotypes are not necessarily expressed explicitly. A stronger stereotype indicated less desire to pursue natural science in the future as well as a lower self-concept and interest in natural science. However, a feminine STEM role model did not counter this stereotype or mediate the effects. In the future, research should look to see what else might be driving strong stereotypes to lessen STEM aspirations as well as explore why this stereotype exists and how to counter it.

References

Andre, T., Whigham, M., Hendrickson, A., & Chambers, S. (1999). Compentency beliefs, positive affect, and gender stereotypes of elementary students and their parents about science versus other school subjects. *Journal of Research in Science Teaching, 36(6)*, 719-747.

Bem, S. L. (1974). The measurement of psychological androgyny. *Journal of Consulting and Clinical Psychology, 42(2)*, 155-162.

Betz, D. E., & Sekaquaptewa, D. (in press). My fair physicist? Feminine math and science role models demotivate young girls. *Social Psychological and Personality Science.*

Buck, G. A., Clark, V. L. P, Leslie-Pelecky, D., Lu, Y. & Cerda-Lizarraga, P. (2007). Processes used by adolescent girls and women scientists in identifying science role models: a feminist approach. *Wiley InterScience*.

Cheryan, S., Plaut, V. C., Davies, P. G. & Steele, C. M. (2009). Ambient belonging: how stereotypical cues impact gender participation in computer science. *Journal of Personality and Social Psychology, 97(6)*, 1045-1060.

Cheryan, S., Siy, J. O., Vichayapai, M., Drury, B. J., & Kim, S. (2011). Do female and male role models who embody STEM stereotypes hinder women's anticipated success in STEM? *Social Psychology and Personality Science,* 1-9.

Cole, E. R., & Zucker, A. N. (2007). Black and White women's perspectives on femininity. *Cultural Diversity and Ethnic Minority Psychology, 13,* 1-9.

Dasgupta, N., McGhee, D. E., Greenwald, A. G., & Banaji, M. R. (2000). Automatic preference for white Americans: eliminating the familiarity explanation. *Journal of Experimental Social Psychology*, *36(3)*, 316-328.

Hart, E. A., Leary, M. R., & Rejeski, W. J. (1989). The measurement of social physique anxiety. *Journal of Sport & Exercise Psychology, 11*, 94-104.

Hannover, B., & Kessels, U. (2004). Self-to-prototype matching academic choices. Why high school students do not like math and science. *Learning and Instruction, 14,* 51-67.

Hodge, D. R. & Gillespie, D. (2003). Phrase completions: An alternative to Likert scales. *Social Work Research, 27(1)*, 45-55.

Paulhus, D. L. & Trapnell, P. D. (2008). Self-Presentation of Personality. In O.P. John, R.W. Robins, & L.A. Pervin (Eds.), *Handbook of personality psychology* (pp.492-517). New York: Guilford.

Kahneman, D., & Tversky, A. (1972). Subjective probability: A judgment of representativeness. *Cognitive Psychology, 3*, 430-454.

Karpinski, A., & Steinman, R. B. (2006). The single category implicit association test as a measure of implicit social cognition. *Journal of Personality and Social Psychology, 91(1)*, 16-32.

Kessels, U. (2005). Fitting into the stereotype: how gender-stereotyped perceptions of prototypic peers relate to liking for school subjects. *European Journal of Psychology of Education, 20(3)*, 309-323.

Komori, M. Kawamura, S., & Ishihara, S. (2011). Multiple mechanisms in the perception of face gender: effect of sex-irrelevant features. *Journal of Experimental Psychology, 37(3)*, 626-633.

Lockwood, P. & Kunda, Z. (1997). Superstars and me: predicting the impact of role models on the self. *Journal of Personality and Social Psychology, 73(1)*, 91-103.

Mahalik, J. R., Morray, E. B., Coonerty-Femiano, A., Ludlow, L. H., Slattery, S. M., & Smiler, A. (2005). Development of the Conformity to Feminine Norms Inventory. *Sex Roles, 52,* 417-435.

Marx, D. M. & Roman, J. S. (2002). Female role models: protecting women's math test performance. *Personality and Social Psychology Bulletin, 28*, 1183-1193.

McIntyre, R. B., Paulson, R. M., Taylor, C. A., Morin, A. L., & Lord, C. G. (2011). Effects of role model deservingness on overcoming performance deficits induces by stereotype threat. *European Journal of Social Psychology, 41*, 301-311.

National Science Foundation. (2011). Science and engineering indicators 2011. Retrieved February 1, 2011, from http://www.nsf.gov/statistics/htm.

Nosek, B. A., Banaji, M. R., & Greenwald, A. G. (2002). Math = me, me = female, therefore me ≠ math. *Journal of Personality and Social Psychology, 83(1)*, 44-59.

Oyserman, D., Gant, L., & Ager, J. (1995). A socially contextualized model of African American possible selves and school persistence. *Journal of Personality and Social Psychology, 69 (6)*, 1216-1232.

Payne, B. K., Burkley, M. A., & Stokes, M. B. (2008). Why do implicit and explicit attitude tests diverge? The role of structural fit. *Journal of Personality and Social Psychology, 94(1)*, 16-31.

Rudman, L. A., Greenwald, A. G., Mellott, D. S. & Schwartz, J. L. K. (1999). Measuring the automatic components of prejudice: flexibility and generality of the implicit association test. *Social Cognition, 17(4)*, 437-465.

Salisbury, J. & Passer, M. W. (1982). Gender-role attitudes and participation in competitive activities of varying stereotypic femininity. *Personality and Social Psychology Bulletin, 8*, 486-493.

Simpkins, S. D., Davis-Kean, P. E., & Eccles, J. S. (2006). Math and science motivation: a longitudinal examination of the links between choices and beliefs. *Developmental Psychology, 42(1),* 70-83.

Stout, J. G., Dasgupta, N., Hunsinger, M., & McManus, M. A. (2011). STEMing the tide: using ingroup experts to inoculate women's self-concept in science, technology, engineering, and mathematics. *Journal of Personality and Social Psychology, 100(2)*, 255-270.

Taylor, S. E., & Brown, J. D. (1988). Illusion and well-being: a social psychological perspective on mental health. *Psychological Bulletin, 103(2)*, 193-210.

Yoder, J. D., & Schleicher, T. L. (1996). Undergraduates regard deviation from occupational gender stereotypes as costly for women. *Sex Roles, 43(3)*, 171-188.

Table 1

Implicit vs. Explicit Stereotype Correlations

	1.	2.	3.	4.	5.	6.
1. SC-IAT Score	--					
2. Explicit Score (Overall)	.05	--				
3. Appearance	.12	.57***	--			
4. Comfort	-.03	.57***	-.01	--		
5. Prescriptive	.01	.64***	.31***	.001	--	
6. Go Together	.18**	.41***	.10	.08	.15*	--

Note. *p ≤ .10; **p ≤ .05 *** p ≤ .01

Table 2.1

Model statistics for regression analyses testing effects of implicit stereotypes, role model, and interactions on science and English outcomes.

	DV: Science future plans	DV: Science self-concept	DV: Science interest	DV: Science importance	DV: English future plans	DV: English self-concept	DV: English interest	DV: English importance
Model	$F(11, 143) = 1.99$, $p = .03$	$F(11, 143) = 2.13$, $p = .02$	$F(11, 143) = 1.65$, $p = .09$	$F(11, 143) = 1.82$, $p = .056$	$F(11, 143) = 1.81$, $p = .057$	$F(11, 143) = 1.49$, $p = .14$	$F(11, 143) = 1.11$, $p = .36$	$F(11, 143) = 1.27$, $p = .25$
R^2	.13	.14	.11	.12	.12	.10	.08	.09
Constant	5.00***	4.98***	4.11***	5.44***	4.75***	4.36***	2.84***	4.10***
Major	-.95***	-.57***	-.58**	-.66**	.93***	.72***	.54*	.63**
Year	-.08	.08	.16	.02	-.06	.04	.15	.22**
Neutral STEM RM	.51	.33	.37	.22	-.69	.08	.17	.40
Feminine Humanities RM	.61	.27	.49	.20	-.62	-.05	.80*	.60*
Neutral Humanities RM	.30	.18	.40	.03	-.43	.06	.66	.13
Control	.34	-.07	.15	-.08	-.01	.26	.62	.25
Implicit Stereotype	.29	1.12	.37	.72	-1.06	-.66	-.48	-.30
NSRM*IAT	-.92	-1.33	-.75	-.77	.02	.30	.86	.73
FHRM*IAT	-3.25**	-2.24**	-1.98	-2.66**	1.51	1.05	-.19	.50
NHRM*IAT	-1.20	-1.63*	-1.75	-.98	.49	2.24**	1.59	.91
Control*IAT	-.66	-2.07**	-1.17	-2.10*	1.82	.81	.90	.26

Note. *p ≤ .10; **p ≤ .05 *** p ≤ .01

Table 2.2

Model statistics for regression analyses testing effects of explicit stereotypes, role model, and interactions on science and English outcomes.

	DV: Science future plans	DV: Science self-concept	DV: Science interest	DV: Science importance	DV: English future plans	DV: English self-concept	DV: English interest	DV: English importance
Model	$F(11, 110) = 2.54$, $p = .007$	$F(11, 110) = 2.75$, $p = .003$	$F(11, 110) = 2.44$, $p = .009$	$F(11, 110) = 2.34$, $p = .01$	$F(11, 110) = 1.95$, $p = .04$	$F(11, 110) = 1.14$, $p = .34$	$F(11, 110) = 1.14$, $p = .34$	$F(11, 110) = 1.07$, $p = .40$
R^2	.20	.22	.20	.19	.16	.10	.10	.10
Constant	4.87***	5.20***	4.30***	5.70***	5.32***	4.86***	3.24***	4.58***
Major	-1.00***	-.56**	-.73**	-.78***	.71**	.66**	.44	.40
Year	-.03	.09	.15	.02	-.14	-.01	.12	.16
Neutral STEM RM	.87	.24	.44	.16	-1.12**	-.46	-.36	.01
Feminine Humanities RM	.48	-.08	.26	.09	-.65	-.30	.52	.21
Neutral Humanities RM	.05	-.18	.16	-.23	-.82*	-.47	.42	-.14
Control	.02	-.73**	-.39	-.65	-.18	-.28	.08	-.19
Explicit Stereotype	-.75	-.45	-.39	-.50	-.83*	-.40	-.35	-.34
NSRM*Exp	.73	.18	.42	.26	.17	.14	-.06	-.36
FHRM*Exp	.54	.10	.03	-.17	.72	.03	.42	.64
NHRM*Exp	-.26	-.002	-.61	-.11	.21	.15	.16	-.08
Control*Exp	-.50	-.25	-.67	-.17	1.50**	.18	-.31	.20

Note: *$p \le .10$; **$p \le .05$ *** $p \le .01$

Table 2.3

Model statistics for regression analyses testing effects of implicit stereotypes, role model, and interactions on role model rating.

	Step 1	*Step 2*	*Step 3*
Model	*F*(2, 152) =.03, *p* = .97	*F*(7, 147) =3.91, *p* = .001	*F*(11, 143) =2.63, *p* < .01
R^2	.00	.16	.17
Constant	5.86***	6.36***	6.36***
Major	.01	0.0	-.01
Year	-.01	-.01	-.02
Neutral STEM RM		-.52***	-.52***
Feminine Humanities RM		-.74***	-.73***
Neutral Humanities RM		-.60***	-.60***
Control		-.47**	-.46**
Implicit Stereotype		-.55***	-.05
NSRM*IAT			-.48
FHRM*IAT			-.50
NHRM*IAT			-.88
Control*IAT			-.56

Note. *p ≤ .10; **p ≤ .05 *** p ≤ .01

Table 2.4

Model statistics for regression analyses testing effects of explicit stereotypes, role model, and interactions on role model rating.

	Step 1	*Step 2*	*Step 3*
Model	$F(2, 119) = 2.04$, $p = .03$	$F(7, 114) = 2.04$, $p = .03$	$F(11, 110) = 2.04$, $p = .03$
R^2	.00	.16	.17
Constant	5.94***	6.48***	6.50***
Major	-.06	-.08	-.07
Year	-.02	-.01	-.01
Neutral STEM RM		-.47**	-.49**
Feminine Humanities RM		-.82***	-.85***
Neutral Humanities RM		-.61***	-.65***
Control		-.73***	-.74***
Explicit Stereotype		-.11	-.21
NSRM*Exp			.18
FHRM*Exp			.16
NHRM*Exp			-.01
Control*Exp			.16

Note: *p ≤ .10; **p ≤ .05 *** p ≤ .01

Table 3

Correlations between Attainability, Similarity, and Positivity of Role Model

	1.	2.	3.	4.	5.
1. Academic Attainability	--				
2. Feminine Attainability	.27***	--			
3. Attainability Both	.70***	.61***	--		
4. Similarity	.09	.23***	.27***	--	
5. Positivity	.06	.13	.14*	.46***	--

Note. *$p \leq .10$; **$p \leq .05$ *** $p \leq .01$

Table 4.1

Correlations of Natural Science Outcome with Stereotypic Associations

	1.	2.	3.	4.	5.	6.	7.	8.
1. SC-IAT score	--							
2. Explicit score	.05	--						
3. Appearance	.12	.57***	--					
4. Comfort	-.03	.57***	-.01	--				
5. Future Plans	-.17**	-.23**	-.20**	-.17*	--			
6. Self-Concept	-.13	-.27***	-.16*	-.23***	-.17*	--		
7. Interest	-.17**	-.26***	-.20**	-.22**	.77***	.79***	--	
8. Importance	-.15*	-.26***	-.15*	-.28***	.66***	.77***	.74***	--

Note. *$p \leq .10$; **$p \leq .05$ *** $p \leq .01$

Table 4.2

Correlations of Math Outcome with Stereotypic Associations

	1.	2.	3.	4.	5.	6.	7.	8.
1. SC-IAT score	--							
2. Explicit score	.05	--						
3. Appearance	.12	.57***	--					
4. Comfort	-.03	.57***	-.01	--				
5. Future Plans	-.05	-.13	-.19**	-.08	--			
6. Self-Concept	.01	.03	-.12	.03	.67***	--		
7. Interest	-.05	-.07	-.16*	-.08	.73***	.76***	--	
8. Importance	.02	.08	-.10	.05	.58***	.66***	.63***	--

Note. *$p \leq .10$; **$p \leq .05$ *** $p \leq .01$

Table 4.3

Correlations of English/Humanities Outcome with Stereotypic Associations

	1.	2.	3.	4.	5.	6.	7.	8.	9.
1. SC-IAT score	--								
2. Explicit score	.05	--							
3. Comfort	-.03	.57***	--						
4. Prescriptive	.01	.64***	.00	--					
5. Go Together	.18**	.41***	.08	.15*	--				
6. Future Plans	-.05	-.14	-.09	-.17*	-.16**	--			
7. Self-Concept	.05	-.15*	-.16*	-.12	-.13*	.56***	--		
8. Interest	.04	-.12	-.19**	-.03	-.01	.50***	.63***	--	
9. Importance	.05	-.12	-.10	-.02	-.08	.29***	.37***	.53***	--

Note. *p ≤ .10; **p ≤ .05 *** p ≤ .01

Figure 1

Proposed Theoretical Mediation Model.

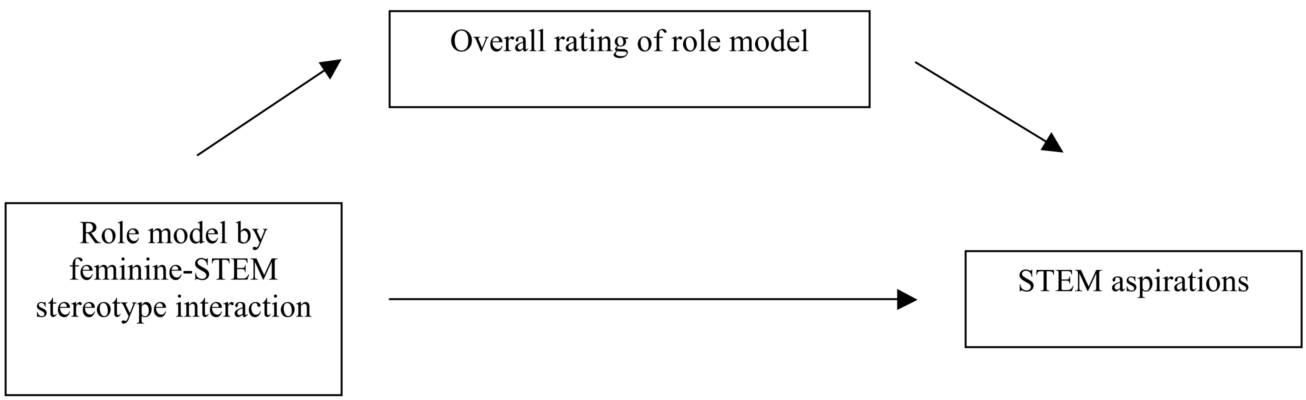
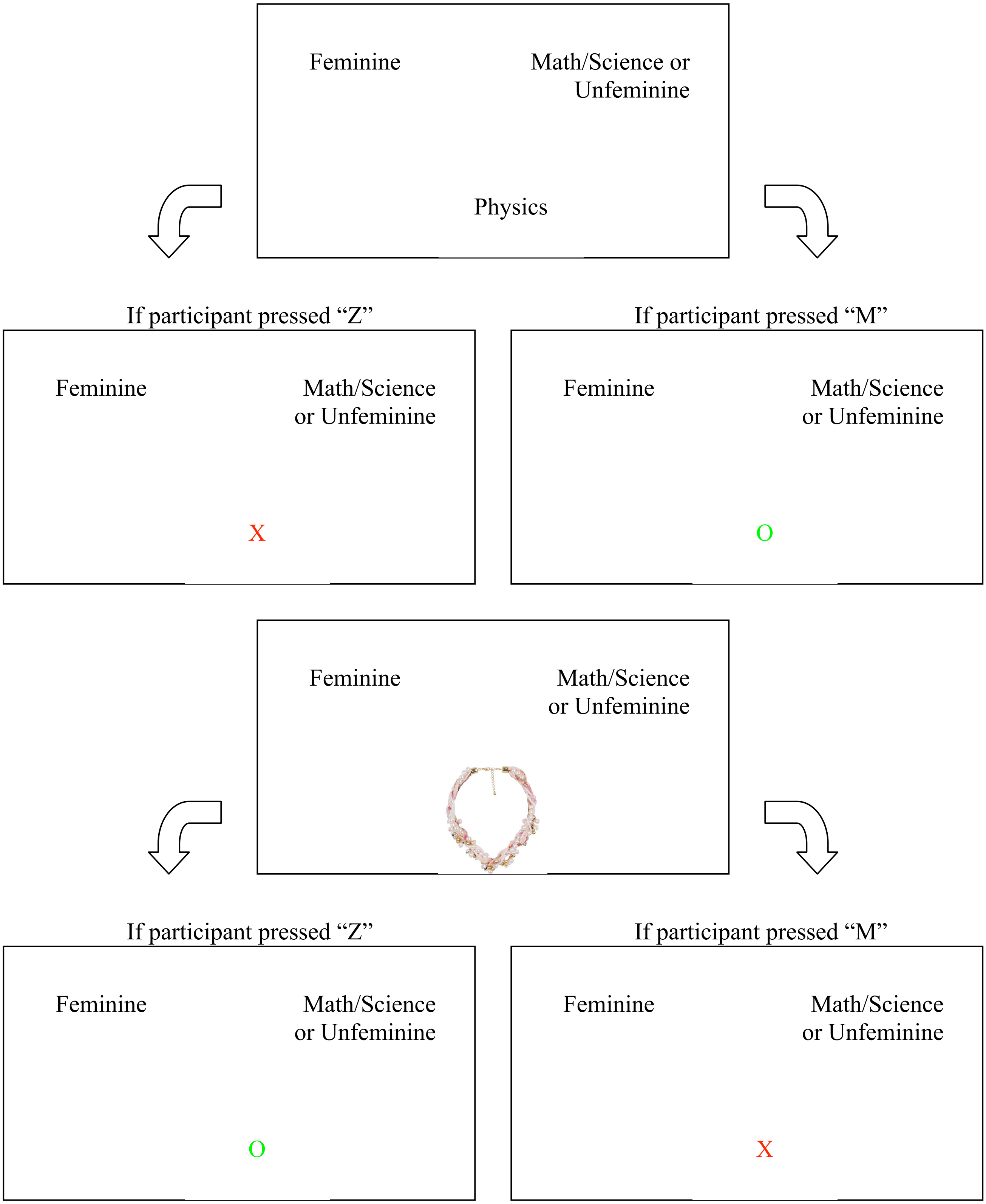


Figure 2

Schematic of Computer Screen



Appendix A

Feminine IAT Pictures

Unfeminine IAT Pictures

Math/Science IAT words

mathematics

engineering

technology

biology

chemistry

physics

Appendix B: Role Model Interviews

We shine our "Alumni Spotlight" on recent Chemistry graduate Jennifer Simon.

Professor Smith of Chemistry, Jennifer's honors thesis advisor, predicted "great success in the field of chemistry" for Jen. Jennifer takes us through her favorite UM memories and updates us on what she's been up to since her May graduation.

Jennifer fondly remembered her first **chemistry lab** here at the University of Michigan. She got to work with real lab equipment for the first time, and she loved learning how to work with volatile chemicals, and how to increase her chemistry knowledge.

Jennifer credits that chemistry lab with helping her improve in what would become not just her favorite subject but also her major. Concentrating in **chemistry**, she took tons of science classes. She remembers having to study a lot, "especially for the killer classes like Organic Chem," but she found that she loved the material.

When studying was done, Jennifer would read, unwind at the gym, hang out with friends, and go to the movies. "The Michigan Theater is so beautiful," she says.

She keeps up with those hobbies even as she pursues her **PhD in Chemistry and Biomedical Engineering** at UC Berkeley. She relies on molecular theory and simulation to understand how various surfaces react to changes in their environment. Jennifer is doing great, and she credits the **chemistry program** at Michigan with helping her pursue inspiring work.

We shine our next Spotlight on recent Engineering graduate Stacey Moore.

Stacey earned a reputation as a hard-working student at UM, and has maintained it since beginning her job in New York.

Stacey looked back over the great memories of her **introduction to engineering class** here at the University of Michigan. She was able to design products, work with others on robotics projects, and expand her engineering skills

This class made Stacey feel confident about her decision to pursue **Aerospace Engineering** as her concentration. With this major, Stacey had to take many different engineering courses. She remembers having to work very hard on her senior design class because she had to research and design a plane that would fly according to a computer program. Looking back, Stacey thought, “It was a lot of work, but a lot of fun to see the end result”.

Outside of the classroom, Stacey loved to go on bike rides and to concerts. On campus, she loved working with the Michigan Solar Car group. Stacey and the group designed solar cars to compete against other schools. Her sophomore year the team placed third, “but hanging out with all my friends and meeting people with similar interests was the best part.”

Currently, Stacey is working in New York City with **Parsons Engineering Design Firm,** which specializes in sustainable and environmentally friendly project design. She uses her knowledge from her engineering classes to work on transportation projects within the company. Stacey is thoroughly enjoying her work in New York and thanks **the engineering department** at the University of Michigan for all of their help and guidance.

We shine our “Alumni Spotlight” on recent English graduate Jennifer Simon.

Professor Smith of English, Jennifer’s honors thesis advisor, predicted “great success in the field of literature” for Jen. Jennifer takes us through her favorite UM memories and updates us on what she’s been up to since her May graduation.

Jennifer fondly remembered her **first-year writing requirement** here at the University of Michigan. She got to read ancient Greek texts for the first time, and she loved learning how to analyze the difficult poetry and prose, and how to improve her writing.

Jennifer credits that writing requirement with helping her improve what would become not only her favorite subject but also her major. Concentrating in **English**, she took tons of **literature and writing classes**. She remembers having to study a lot, “especially for the killer classes like my English 450 advanced seminar,” but she found that she loved the material.

When studying was done, Jennifer would read, unwind at the gym, hang out with friends, and go to the movies. “The Michigan Theater is so beautiful,” she says.

She keeps up with those hobbies even as she pursues her **PhD in English Language and Literature** at UC Berkeley. She relies on literary theory and historicism to understand how narrative styles were affected by changes in Victorian society. Jennifer is doing great, and she credits the **English program** at Michigan with helping her pursue inspiring work.

We shine our next Spotlight on recent Art History graduate Stacey Moore.

Stacey earned a reputation as a hard-working student at UM, and has maintained it since beginning her job in New York.

Stacey looked back over the great memories of her **introduction to art history class** here at the University of Michigan. She was able to study different artists' techniques, visit museums and see wonderful art first hand, and expand her knowledge of artistic details.

This class made Stacey feel confident about her decision to pursue **art history** as her concentration. With this major, Stacey had to take many different art history courses. She remembers having to work very hard on her senior thesis class because she had to research different techniques and artists to make conclusions about a specific era of art. Looking back, Stacey thought, "It was a lot of work, but a lot of fun to see the end result".

Outside of the classroom, Stacey loved to go on bike rides and to concerts. On campus, she loved to participate in Helicon, the University of Michigan's History of Art Student Organization. Stacey and the group promoted the arts through museum visits and other art history related events on campus. Her sophomore year the group planned a trip to the different museums in Detroit; "but hanging out with all my friends and meeting people with similar interests was the best part".

Currently, Stacey is working in New York City with the **Metropolitan Museum of Art** as an expert for Renaissance period pieces. She uses her knowledge from her art history classes to guide restoration of historic pieces and give presentations on the art to local universities. Stacey is thoroughly enjoying her work in New York and thanks **the art history department** at the University of Michigan for all of their help and guidance.

Appendix C

PARTICIPATION CONSENT FORM

Psychology Pool Research Participant Consent Form: Science Beliefs

Principal Investigator: Diana Betz **email**: dibetz@umich.edu **phone:** (201)4018323
Co-Investigator: Kelsey Martin **email:** kmmart@umich.edu **phone:** (610)613 0499
Faculty Advisor: Denise Sekaquaptewa **email:** dsekaqua@umich.edu **phone:** (734)647 9685

In this research study, we are interested in how people's beliefs about science affect their responses to a magazine article. If you want to participate, here is what you will have to do: 1.) Complete a computerized sorting task that asks you to match pictures with words. 2.) Read some magazine interviews. 3.) Answer some questions about the interviews and yourself (including about your skills and interests in different academic subjects).

To account for the role of preexisting attitudes/beliefs, your responses today will be linked to responses that you gave in the prescreening survey that you may have completed at the beginning of the semester.

This study involves several parts, which take a total of approximately 1 hour.

Please note that you must be at least 18 years of age to participate, or you must have submitted a parental permission slip via the U of M Intro Psych Subject Pool. Your participation is voluntary, anonymous, completely confidential, and you may withdraw at any time without reprisal. As well, you may leave any questions blank. There are no risks and no direct benefits to participating in this survey, although your participation may help future students. U of M Psychology students will receive **one hour credit** towards their Introductory Psychology course requirement. Credit will be provided in full to participants who elect to withdraw from the study before the end of the study, and responses given up to that point will be included in the dataset unless participants request that they be withdrawn.

You may request a copy of this consent form to keep.

If you have any questions or concerns about this study, please ask now so that you understand what you are being asked to do. You may also contact the co-principal investigators and/or the faculty advisor (using the information above) in the future. Should you have questions regarding your rights as a participant in research, please contact: Institutional Review Board 540 East Liberty Street, Suite 202 Ann Arbor, MI 48104-2210 734-936-0933 email: irbhsbs@umich.edu.

<u>Consent of the subject</u>. By signing this document, you are agreeing to the following statement: "I have read [or been informed] of the information given above. The experimenter has offered to answer any questions I may have concerning the study. I hereby consent to participate in the study."

____

Printed Name Consenting Signature Date

PARTICIPATION CONSENT FORM

Paid Participant Consent Form: Science Beliefs

Principal Investigator: Diana Betz **email**: dibetz@umich.edu **phone:** (201)4018323
Co-Investigator: Kelsey Martin **email:** kmmart@umich.edu **phone:** (610)613 0499
Faculty Advisor: Denise Sekaquaptewa **email:** dsekaqua@umich.edu **phone:** (734)647 9685

In this research study, we are interested in how people's beliefs about science affect their responses to a magazine article. If you want to participate, here is what you will have to do: 1.) Complete a computerized sorting task that asks you to match pictures with words. 2.) Read some magazine interviews. 3.) Answer some questions about the interviews and yourself (including about your skills and interests in different academic subjects).

This study involves several parts, which take a total of approximately1 hour.

Please note that you must be at least 18 years of age to participate. Your participation is voluntary, anonymous, completely confidential, and you may withdraw at any time without reprisal. As well, you may leave any questions blank. There are no risks and no direct benefits to participating in this survey, although your participation may help future students. You will receive $12 in Virtual Visa bucks in return for your participation. Payment will be sent via email within one week of participation. Payment will be provided in full to participants who elect to withdraw from the study before the end of the study, and responses given up to that point will be included in the dataset unless participants request that they be withdrawn.

You may request a copy of this consent form to keep.

If you have any questions or concerns about this study, please ask now so that you understand what you are being asked to do. You may also contact the co-principal investigators and/or the faculty advisor (using the information above) in the future. Should you have questions regarding your rights as a participant in research, please contact: Institutional Review Board 540 East Liberty Street, Suite 202 Ann Arbor, MI 48104-2210 734-936-0933 email: irbhsbs@umich.edu.

Consent of the subject. By signing this document, you are agreeing to the following statement: "I have read [or been informed] of the information given above. The experimenter has offered to answer any questions I may have concerning the study. I hereby consent to participate in the study."

____

Printed Name Consenting Signature Date

DEBRIEFING FORM: HUM00053162

Thank you for participating! This research study was presented as a look at how beliefs about science predict responses to a sample magazine. More specifically, we were interested in beliefs about whether math and science fields are feminine or unfeminine. We will analyze your responses to the computerized categorization task to assess whether you have stronger unconscious associations between STEM and femininity or unfemininity. Specifically, if you paired feminine photos with STEM words more quickly and easily than you paired unfeminine photos with STEM words, you likely nonconsciously associate STEM with femininity more strongly than with unfemininity.

This study is also interested in whether reading about successful women in math and science can help get more women and girls into the top levels of science and math. We are interested in whether women in science or English who are either more or less “feminine” in appearance will boost interest in those fields, depending on readers’ beliefs about whether math and science are more or less feminine.

Finally, we wanted to see how your own identities, attitudes about whether femininity and “STEM” go together, and cognitive preferences predict how you respond to these different types of role models. We will see how your answers today relate to answers you gave to prescreening questions assessing these concepts. All identifying information will be removed from the dataset, and your privacy will be protected with the utmost caution.

If you have any questions about the experiment, or anything you did in this study, please call, email, or write to me, Kelsey Martin (kmmart@umich.edu; phone: 610 613 0399) or Diana Betz (dibetz@umich.edu; phone: 201 401 8323), or my advisor, Denise Sekaquaptewa (dsekaqua@umich.edu). You may also request a copy of the final report of this project.

If you are interested in reading more about real women in science, enjoy the attached New York Times article!

For further reading:

Marx, D. M., & Roman, J. S. (2002) Female role models: Protecting women’s math test performance. *Personality and Social Psychology Bulletin, 28*, 1183-1193.

Pronin, E., Steele, C.M., & Ross, L. (2004). Identity bifurcation in response to stereotype threat: Women and mathematics. *Journal of Experimental Social Psychology, 40*, 152-168.

If you have questions regarding your rights as a participant in research, please contact the Institutional Review Board, 540 East Liberty Street, Suite 202, Ann Arbor, MI 48104-2210, 734-936-0933, email: irbhsbs@umich.edu.

June 6, 2011

Women Atop Their Fields Dissect the Scientific Life

By GINA KOLATA

Elena Aprile, Joy Hirsch, Mary-Claire King and Tal Rabin are members of a rare breed — women scientists at the top of their fields.

Dr. Aprile, a professor of physics at Columbia University, is searching for dark matter. Dr. Hirsch, a professor of neuroscience at Columbia University, maps brain processes. Dr. King, a professor of medical genetics at the University of Washington, studies the genetic basis of common complex medical conditions like breast cancer and mental illness. And Dr. Rabin is a cryptography researcher at I.B.M. All four were in New York for the World Science Festival, and were invited to a 30-minute round-table discussion at The New York Times on Wednesday. They talked about their lives as scientists, the joys and struggles of research, and the specific challenges women in science face.

What follows is a condensed and edited transcript of one part of the discussion.

GINA KOLATA: I once wrote about the life of a senior scientist who traveled from meeting to meeting promoting himself and his work. A woman scientist I interviewed said it was really hard for her to travel that much, and she felt that her career had suffered because of that. I was wondering if this is still a problem. And if it is, how do you handle it?

MARY-CLAIRE KING: We are very well established. It may be more of a problem with younger women who can't travel because their children are small or travel far less compared to their younger male counterparts — although it is also true that young men are much more involved nowadays taking care of the small children, and it may be more of an equalizer.

ELENA APRILE: You have to do what the guys do, and it does not matter what it takes. It is important to be out there, and so it comes with the territory. You have to find a way around to solve the practical problems. You have to.

TAL RABIN: Even when we do make it to the conferences, I think that there is still something different about the way that we promote ourselves.
I remember standing next to one of my co-authors, and he was talking to some other guy, and he was telling him, "I have this amazing result. I just did this, I just did that." And I was sitting and thinking there, what result is he talking about? Until he got to the punch line. It was a joint result. It was a result of mine

also. I would have never spoken about my result in the superlatives that the guy was speaking about it.

MS. KOLATA: What would you have done?

DR. RABIN: I would have said, you know, "I have this very interesting result, and we achieved very nice things." But not "This is the best thing since we invented the wheel, and here it is."

DR. APRILE: I think I wouldn't do it as nicely as you.

DR. KING: But women can help each other out a lot in this way because we know this about our younger women colleagues. We can introduce them to our colleagues. We can say: "Diane has a fabulous result. She needs to tell you what it is, and don't move until she has told you."

JOY HIRSCH: There is one very important component here that is worth raising, and I think that is the need for institutional procedure and commitment to bring women on board. When I was at Yale, I was the chairman of the Status of Women Committee for a long period of time. During that time Yale as an institution had a major commitment to raise the visibility and the numbers of women, and we did exactly as you described without a compromise at all in quality. It is not that we just teach our women to be self- promoting and to be excellent. We must also, I think, take the responsibility of teaching our institutions to be receptive and proactive and even aggressive in this manner.

DR. APRILE: And it is not just the top. It should also be the colleagues and the ones closest to you. You have to have women involved in search committees.

MS. KOLATA: So what you are describing, as I understand it, is getting a lot of people into the beginning positions. But then how do you keep them?

DR. KING: I think the choke point is going from a postdoc to an assistant professorship to a tenure-track position. In my experience the largest remaining obstacle is how to integrate family life with the life of a scientist.

MS. KOLATA: And you have advice for women?

DR. KING: At institutions where there is child care on site, where it is subsidized, where there are enough places for assistant professors to have their children, women do well. And at institutions where it is assumed that you will make your own arrangements, women do less well. There is good data on this. We need institutional commitment.

DR. APRILE: It is by example that young women see that you can be both a successful scientist, the best, but also the best mother and the lover, and the wife. You can do everything, so I think you need to have more examples of those. those.

DR. HIRSCH: I think it is important to develop a style in the laboratory where these issues are open and can be talked about. And what happens is that men become involved too.
MS. KOLATA: It must be exciting for your children to grow up with a mother who has such passion for what she does.

DR. APRILE: It depends on the child. The second of my daughters used to say, "Mommy, why can't we have dinner at 6 p.m. like everybody else?" They finally accepted these crazy hours that I had to live with.

DR. RABIN: I am a child of a working mother. My mother was a very high-ranking lawyer in the Israeli Department of Justice, and I think she is the best mother in the world. And what I can say about her is that although she worked long hours, she was always available to me when I needed her. So somehow I think it is easier for me, because I can go and work without the guilt, because I know you can be a great mother. Whether I am or not is a different question.

DR. HIRSCH: The great discovery for me was the middle of the night. It's all done, and everybody has gone to bed. You can go to your computer and sit down and work. The middle of the night has been what saved my life as a scientist.

DR. RABIN: What I do feel as a mother is that sometimes I hear these young women graduate students talking. They are saying, "Yes, the baby is going to be born, I am going to be back doing research within a week," and so on. And I think that one important thing to remember is that these children are going to grow. And if you miss out on their babyhood and then childhood and so on, these times are gone. You should think how to balance these things and get the research done but not forsake these things that are never coming back. The research is going to be there two years down the road, three years down the road, but there are things that are very precious that should not be missed out on.

MS. KOLATA: Would you encourage your daughter to be a scientist?

DR. KING: My daughter is now 36. Both her parents are scientists — her father is an ecologist and I am a geneticist — and she said that she was not going to be a scientist, that the life was just too tough or too grueling. She went to Brown, and she did linguistics. Loved it. Now she works for the Berkeley Humane Society and organizes huge projects for them — writes grants, organizes large groups of people doing work. So in many ways, there is not that much difference between her daily life and my daily life.

DR. HIRSCH: I think the judgment about whether someone should be a scientist or not is a very serious one, because the life of a scientist, whether you are a woman or you are a man, is very difficult. It is a nonstandard life. It is a life with constraints and obligations that don't come with other types of professions. If my daughter has to ask "Should I be a scientist?" the answer is no. But if my daughter says to me, "I was born to be a scientist. I can't be anything else. This is my life," then you say, "You go, girl."

DR. APRILE: I couldn't have said it better.

DR. RABIN: The truth is that I feel differently. I think that the life of a scientist is a fantastic life. I think it is exciting because every day there is something new that you can go and think of. There are challenges, no doubt, and the times when you can't solve things. So I think it is all a wonderful life. And not to mention even things like time flexibility, traveling around the world, meeting a lot of exciting people. I think that these are fantastic jobs.
I did not grow up with this feeling that, yes, I am going to be a scientist. In fact, in Israel you have to register, you have to apply to a specific school that is not liberal arts. I was good at math. I said, O.K., computer science. And things evolved with time until I knew that this was the path that I wanted to take, and it was also a little bit dependent on the successes that I had that kept me going.
So sometimes I think at the onset it is not 100 percent sure, but it evolves.

DR. APRILE: I kind of disagree, honestly, at least in my field, in my life. You have to be very tough, and this is a very hard life and you are always exposed. You have to be extremely strong. You have to face the competition. If one of my daughters were really dying for being a scientist, there would be no question I would support them. But if I have to encourage them, to push them in that direction, there is no way.

DR. HIRSCH: I think it is important to look at this from the point of view of the field of science. It is very important that diversity be represented in the field of science. And so from the point of view of the science — not our daughters — then I think it is necessary to have women and a woman's point of view. Her ability to collaborate, her ability to think differently, is important for the trajectory of the field. But I really agree with you, Elena. You have to be tough. You have to be made of steel.

DR. APRILE: Titanium is better.

DR. HIRSCH: Yes, thank you. I hope it is not everybody's experience, but it has been mine, and I say that from the point of view of a very successful woman. I have been made of steel, and thank heavens, because I wouldn't be here if I wasn't.

DR. RABIN: But this is something that I feel has developed in me. I do not think that I was this warrior that I am today when I started out in the field. I am like that today, but I wasn't like that when I was 20.

DR. APRILE: Even if they are not scientists, these daughters of ours, they have had the best example in their life, and they will carry that example and that passion that they see in us, in me and you, with them. And so you never know what will develop along the way. And if they don't practice science directly, they are going to change the world in other ways. Just because they have had the examples they have.
have had the examples they have.

DR. KING: They will change the world. They don't have to do it our way.

Appendix D

Questionnaire B

Now that you have read the magazine,
please answer the following questions

	Not at all						**Very much**
	1	2	3	4	5	6	7

How much did you enjoy reading this magazine article?

How would you rate the woman featured in the article on the following traits?

Smart

Hardworking

Organized

Likable

Friendly

Outgoing

Similar to Me

Feminine-Looking

Successful

How likely is it that you could be as academically successful as these students one year after graduation?

How likely is it that you could look as feminine as these students one year after graduation?

How likely is it that you could be as academically successful and look as feminine as these students one year after graduation?

To what extent do you want to be as academically successful as these students one year after graduation?

To what extent do you want to look as feminine as these students one year after graduation?

To what extent do you want to be as academically successful and look as feminine as these students one year after graduation?

Enter your subject number!
Subject #: ____________

C

This questionnaire has 8 pages. We are first interested in how students plan to meet the University of Michigan's course requirements for graduation.

LS&A students are required to take three courses in each of the following categories.

- **Natural science**
- **Social science**
- **Humanities**

LS&A students must fill additional credits from some combination of the following categories.

- **Mathematics and symbolic analysis**
- **Creative expression**

What class or classes FIRST come to mind when you think about each of these categories?

Natural Science:	
Social Science:	
Humanities:	
Mathematics…:	
Creative Exp.:	

Keep these classes in mind when answering the questions on the following pages.
Answer each question by marking the circle that corresponds to your answer choice.

Please answer the following questions about each category by marking the corresponding circle.

I am looking forward to taking course(s) in this required category:

	Disagree strongly	Disagree moderately	Disagree slightly	Neutral	Agree slightly	Agree moderately	Agree Strongly	OR	None left to take
Natural Science	o	o	o	o	o	o	o		o
Social Science	o	o	o	o	o	o	o		o
Humanities	o	o	o	o	o	o	o		o

I will likely choose to take course(s) from this optional category:

	Disagree strongly	Disagree moderately	Disagree slightly	Neutral	Agree slightly	Agree moderately	Agree Strongly	OR	No optionals left to take
Mathematics…	o	o	o	o	o	o	o		o
Creative Exp.	o	o	o	o	o	o	o		o

I enjoyed the course(s) I <u>have</u> already taken or <u>am</u> already taking in this category:

	Disagree strongly	Disagree moderately	Disagree slightly	Neutral	Agree slightly	Agree moderately	Agree Strongly	OR	Have not taken any
Natural Science	o	o	o	o	o	o	o		o
Social Science	o	o	o	o	o	o	o		o
Humanities	o	o	o	o	o	o	o		o
Mathematic	o	o	o	o	o	o	o		o

s…									
Creative Exp.	O	O	O	O	O	O	O		O

If I had to take more classes for graduation, I would consider course(s) in this category:

	Disagree strongly	Disagree moderately	Disagree slightly	Neutral	Agree slightly	Agree moderately	Agree Strongly
Natural Science	O	O	O	O	O	O	O
Social Science	O	O	O	O	O	O	O
Humanities	O	O	O	O	O	O	O
Mathematics…	O	O	O	O	O	O	O
Creative Exp.	O	O	O	O	O	O	O

If I were to take a course in this category, I would likely receive this grade:

	A	B	C	D	E
Natural Science	O	O	O	O	O
Social Science	O	O	O	O	O
Humanities	O	O	O	O	O
Mathematics…	O	O	O	O	O
Creative Exp.	O	O	O	O	O

Please answer the following questions on the 1-7 scales provided:

How good are you at:

	1 not at all good	2	3	4	5	6	7 very good
Math	o	o	o	o	o	o	o
Natural Science	o	o	o	o	o	o	o
English	o	o	o	o	o	o	o

If you were to rank all the students in your most recent _________ class from the worst to the best, where would you put yourself?

	1 the worst	2	3	4	5	6	7 the best
Math	o	o	o	o	o	o	o
Natural Science	o	o	o	o	o	o	o
English	o	o	o	o	o	o	o

Compared to most of your other subjects, how good are you at:

	1 much worse	2	3	4	5	6	7 much better
Math	o	o	o	o	o	o	o
Natural Science	o	o	o	o	o	o	o
English	o	o	o	o	o	o	o

How well do you expect to do in _________ this semester or the next semester that you take this course?

	1 not at all well	2	3	4	5	6	7 very well	n/a
Math	o	o	o	o	o	o	o	o
Natural Science	o	o	o	o	o	o	o	o
English	o	o	o	o	o	o	o	o

How good would you be at learning something new in:

	1 not at all good	2	3	4	5	6	7 very good
Math	o	o	o	o	o	o	o

Natural Science	O	O	O	O	O	O	O
English	O	O	O	O	O	O	O

How successful do you think you'd be in a career that required ability in:

	1 not very successful	2	3	4	5	6	7 very successful
Math	O	O	O	O	O	O	O
Natural Science	O	O	O	O	O	O	O
English	O	O	O	O	O	O	O

Compared to most of your other activities, how much do you like:

	1 not as much	2	3	4	5	6	7 a lot more
Math	O	O	O	O	O	O	O
Natural Science	O	O	O	O	O	O	O
English	O	O	O	O	O	O	O

In general, do you find working on _________ assignments:

	1 very boring	2	3	4	5	6	7 very interesting
Math	O	O	O	O	O	O	O
Natural Science	O	O	O	O	O	O	O
English	O	O	O	O	O	O	O

How much do you like studying:

	1 a little	2	3	4	5	6	7 a lot
Math	O	O	O	O	O	O	O
Natural Science	O	O	O	O	O	O	O
English	O	O	O	O	O	O	O

In general, how useful is what you learn in:

	1 not at all useful	2	3	4	5	6	7 very useful
Math	O	O	O	O	O	O	O
Natural Science	O	O	O	O	O	O	O
English	O	O	O	O	O	O	O

For me being good at _________ is:

	1 not at all important	2	3	4	5	6	7 very important
Math	O	O	O	O	O	O	O
Natural Science	O	O	O	O	O	O	O
English	O	O	O	O	O	O	O

Compared to most of your other activities, how important is it to you to be good at:

	1 not as important	2	3	4	5	6	7 a lot more important
Math	O	O	O	O	O	O	O
Natural Science	O	O	O	O	O	O	O
English	O	O	O	O	O	O	O