Gender and Racial Stereotype Endorsement and Implications for STEM Outcomes among High-Achieving Underrepresented Adolescent Females

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Purpose and Objectives

A multitude of studies have illustrated the underrepresentation of women and people of color entering and persisting in STEM (Science, Technology, Engineering, and Mathematics) fields of study and careers (NSF, 2010; Perna et al., 2009; U.S. Department of Commerce, 2011). Research demonstrates that the lack of same-gender or same-race role models (Price, 2010; Stout et al., 2011), perceived negative treatment and hostile climates in gatekeeper courses (Chang, et al., 2009), and psychological reactions including decreased achievement or disengagement (Steele & Aronson, 1995) are associated with STEM involvement and persistence.

Given pervasive societal stereotypes about racial and gender ability within math and science (Bobo, 2001; Nosek, Banaji, & Greenwald, 2002) and research indicating that psychological responses to stigma and stereotypes negatively impact women and people of color (Major & O'Brien, 2005), it is imperative to examine the endorsement and impact of stereotypes among female students of color in STEM. Several studies have examined the endorsement of racial and gender stereotypes, finding that negative racial stereotypes are associated with decreased self-concept (Okeke et al., 2009) and decreased self-esteem (Schmader, Johns, & Barquissau, 2004. Yet, the intersectionality of race and gender, which places female students of color within a unique "double-bind" combining two marginalized identities (Malcom, Hall, & Brown, 1976) has been examined with much less frequency, especially with a specific focus on the pursuit of STEM fields of study. Thus, this study utilizes a sample of high-achieving, adolescent female students of color to examine the endorsement of racial and gender stereotypes (and salience of race versus gender) among female students of color who are highly-identified with mathematics and science, and explores the impact that negative racial and gender stereotype endorsement have on STEM outcomes.

Theoretical Framework

This study examines racial and gender stereotype endorsement within a framework of stigmatization and social identity theory. Stigmatization, a term used to describe an attribute, behavior, or reputation which conveys an identity that is devalued or undesirable in a social context, can impact the psychological, educational, and social outcomes of group members through direct interactions and coping mechanisms including: (a) Negative treatment and direct

discrimination, (b) Expectancy confirmation processes, (c) Automatic stereotype activation, and (d) Stigma as identity threat (Major & O'Brien, 2005). Specifically within mathematics and science, research demonstrates that negatively stigmatized groups (women, people of color) may confirm negative stereotypes associated with group membership through internalizing negative messages (Jones, 2000) and through decreased performance associated with fear of confirming a negative stereotype (Brown & Day, 2006; Steele & Aronson, 1995; Schmader & Johns, 2003). In addition, in response to being a member of a negatively stereotyped group, individuals may disengage or disidentify with the target domain in order to protect one's identity and self-concept, leading to decreased valuing of mathematics and decreased intention to pursue STEM fields of study (Shapiro & Williams, 2012). Given the "double-bind" facing female students of color, social identity theory suggests that certain identities can be hierarchically ordered and more salient to individual outcomes than others (Sellers, Chavous, & Cooke, 1998). While existing theory and research suggests that endorsing negative stereotypes about one's group will negatively affect outcomes, we do not yet know if there exists a hierarchical order among female students of color with regards to salience and impact of race versus gender stereotypes. In addition, among students who are highly-identified with STEM and have "broken the mold" (as opposed to those who exhibit disidentification and disengagement), this study will examine whether stereotypes are as readily endorsed and whether they impact interest in STEM. Finally, emerging work on interventions to reduce stereotype threat demonstrate that providing role models and examples to counteract negative stereotypes can effectively reduce the effects of stereotype threat (Blanton, Crocker, & Miller, 2000; McIntyre et al., 2005) and further research is needed to examine effective interventions for alleviating the individual endorsement of negative stereotypes among high school girls of color.

Thus, drawing from theories on social identity and coping with stigmatization, this study examines the following research questions: (1) To what extent do participants endorse negative racial and gender stereotypes about ability in STEM fields? (2) Are negative stereotypes about race and gender endorsed with the same frequency? (3) What impact does endorsing negative stereotypes about one's own racial or gender group have on attitudes towards math and science, self-efficacy and future STEM aspirations? and (4) Does participation in a 5-week summer STEM program focused on students of color reduce negative racial and gender stereotype endorsement?

Methodology and Data Sources

Participants

Seventy-five female students participating in a five-week summer math and science enrichment program in the San Francisco Bay Area participated in this study. This summer program includes rigorous math, science, and STEM elective coursework, college preparation and success courses, and exposure to diverse STEM role models and networks of peer support to nurture

interest and engagement in pursuing STEM fields of study. dcskljafThis study is part of a larger research study examining experiences and outcomes of 152 male and female students of color participating in extracurricular STEM enrichment programs. Students were invited to participate in this research study through a verbal invitation during program orientation and a consent form containing information about the study. Ninety-five percent of all students recruited agreed to participate. Given the focus on the double-bind facing female students of color, male students were excluded from the present study. Students were selected for the summer program based on merit criteria including grades, performance in math and science courses and assessments, essays, and teacher recommendations. All students were members of ethnic groups underrepresented in STEM fields, including Latino (n=35; 47%), African American (n=16; 21%) and Vietnamese (n=5; 7%) students, with other Southeast Asian and multiracial students comprising the remaining 20%. There were slightly more tenth graders in the sample (n=28; 37%) than 11th (n=24; 32%) and 12th (n=23; 30%) graders. The mean age was 16 and the vast majority of students were low-income (n=53; 71%) and first-generation college-bound (n=50; 67%). Ninety-three percent of students (n=70) attended public or charter schools, and "6" was the mean API score for students' school of attendance.

Data Collection and Analysis

Quantitative and qualitative data were collected through surveys and focus groups. Descriptive analyses were used to assess the frequency with which girls of color reported ascribing to negative racial and gender stereotypes and a paired-samples t-test was conducted to examine mean score differences between the STEM Racial and Gender Stereotypes scales. Multivariate analyses were conducted to determine whether negative gender and racial stereotypes were significantly associated with outcome variables including STEM aspirations, self-concept, and attitudes towards math and science. Focus groups were videotaped and transcribed utilizing qualitative analysis software and qualitative data was triangulated with quantitative data in order to synthesize findings.

Study Instruments

Study instruments consisted of a comprehensive survey and a focus group protocol. All participants completed a pre- and post-program survey as part of participation in the larger study. The survey contained 25 scales, including the seven scales examined within this project: (1) STEM Racial Stereotypes, (2) STEM Gender Stereotypes, (3) Attitudes towards Math, (4) Attitudes towards Science, and (5) Self-Efficacy in Math, (6) Self-Efficacy in Science, and (7) STEM Career Aspirations.

STEM Racial and Gender Stereotypes Scales. The STEM Racial Stereotypes scale (α=.82) and the STEM Gender Stereotypes scale (α=.63) each consist of three items assessing the extent to

which students explicitly endorse negative stereotypes about African Americans and Latinos (Racial Stereotypes) and women (Gender Stereotypes) within science and mathematics. These scales were developed in consultation with existing literature attempting to measure beliefs about academic abilities (e.g., Rowley et al., 2007) and stereotypes within the sciences (e.g, Wyers et al., 2010; Smith & Krajkovich, 1979) and were adapted for use with an adolescent population. The STEM Racial and Gender Stereotypes scale items were measured on a 5-point Likert scale, with higher values indicative of less explicit endorsement of negative racial stereotypes. Sample items include, "When I think of people who are very good at science and math, I am…much more likely/slightly more likely to think of Asians and Whites/equally likely to think of Asians, Whites, African Americans and Latinos/slightly more likely/much more likely to think of African Americans and Latinos," and, "When I think of people who are very good at science and math, I am…much more likely/slightly more likely to think of men than women/equally likely to think of men and women/slightly more likely/much more likely to think of women than men."

Attitudes towards Math and Science. The Attitudes towards Math scale (α=.69) consisted of four items assessing student attitudes about perceived importance and interest in mathematics, including, "How important is math to you?" The Attitudes towards Science scale (α=.80) consisted of four items assessing student attitudes about the perceived importance and interest in science, including, "How much do you like or dislike science?" For both scales, each of the items were scored on a 5-point Likert scale, with higher values indicative of more positive attitudes towards math and science (1=Not at all, 5=Very much).

Self-Efficacy in Math and Science. The Self-concept in Math (α=.65) and Self-concept in Science (α=.84) scales consisted of four items each, assessing student perceptions of their skills and abilities in both math and science. Sample items from the Self-Concept in Math and Science scales include, "My science skills are:" and "If you were to take a math/science test right now, how would you expect to do?" All four items on each scale were scored on a five-point Likert scale (1=Very poor, 5=Very good), with higher values indicative of higher self-concept in math and science.

STEM Career Aspirations. The STEM career aspirations scale (α=.91) consisted of 2 items assessing students' intentions to pursue careers within STEM fields. Items include, "I want to get a job in STEM when I grow up," and "I can imagine myself working in the field of Science, Technology, Engineering or Mathematics." Both items were scored on a 5-point Likert scale (1=Strongly disagree, 5=Strongly agree).

Focus Group Protocol. The focus group protocol consisted of questions examining perceptions of gender and racial/ethnic differences in science and math ability, including, "Do you think there are gender differences in math and science ability? Why or why not?" and "Do you think there are racial differences in math and science ability? Why or why not?" As part of the focus

group, students also were asked to write their opinions to the following prompts: "Do you agree or disagree with the following statements, 'Men are better than women in math and science' and 'Asian and White students are better than African Americans and Latinos in math and science. Why or why not?" Focus group data consisted of both verbal and written responses to prompts.

Findings

Endorsement of Negative Racial and Gender Stereotypes about STEM Ability

On average, the participants within this sample reported moderate levels of endorsement of negative racial/ethnic and gender stereotypes about STEM aptitude. As reported in Table 1, each of the three racial/ethnic stereotypes was endorsed more frequently than the corresponding gender stereotypes. Nearly half of the participants (41%) indicated the belief that Asians and Whites have a greater aptitude for math and science than their African American and Latino counterparts. By contrast, only 13% of the sample believed that men had a greater aptitude than women in math and science. In addition, nearly twice as many students reported thinking of Asians and Whites as those who are "very good" at math and science (in comparison to African Americans and Latinos; 63%), than those who reported thinking of men as those who are "very good" in comparison to women (39%). There was not a large difference between the percentage of students who reported that they were more likely to think of Asians and Whites as mathematicians and scientists (65%), and the 59% of participants who reported they were more likely to think of men versus women as mathematicians and scientists (Table 1).

Table 1. Endorsement of Gender and Racial Stereotypes, by Item

	Variable Items	**% Strongly Agree/Agree**
Gender Stereotypes (α=.63)	When I think of people who are very good at math and science, I am more likely to think of *men* than *women*.	36%
	When I think of people who are scientists/mathematicians, I am more likely to think of *men* than *women*.	59%
	When it comes to math and science, I believe that on average, *men* are better at math and science than *women*.	13%
Racial/Ethnic Stereotypes (α=.82)	When I think of people who are very good at math and science, I am more likely to think of *Asians and Whites* (than *African American and Latinos*).	63%
	When I think of people who are scientists/mathematicians, I am more likely to think of *Asians and Whites* (than *African American and Latinos*).	65%
	When it comes to math and science, I believe that on average, *Asians and Whites* are better at math and science (than *African American and Latinos).*	41%

A paired-samples t-test was conducted to determine whether significant differences existed between mean scores for STEM racial/ethnic stereotypes and STEM gender stereotypes. Respondents demonstrated higher mean scores for STEM gender stereotypes (M=2.65, SD=.59) than STEM racial stereotypes (M=2.24, SD=.67), with higher mean scores indicative of less

endorsement of negative stereotypes. This difference was statistically significant, t (74)=5.76, p<.01.

Qualitative responses from students within focus groups also revealed complex ideas about racial and gender stereotypes within STEM fields of study. Participants strongly asserted the belief that women and men are equal in STEM ability, sharing statements such as, "people joke that 'girls can't do math' and 'girls can't do science', but it is totally not true," and "everyone has the same capability. In contrast, while students were emphatic that there were no gender differences in ability, they were much more hesitant in discussing beliefs about racial/ethnic differences in math and science aptitude. In response to questions about racial differences in STEM ability, student responses included, "I don't think it is an absolute fact, but in the environment I've been in, that statement has been true in many cases," and "I sort of agree, sort of disagree." These quotes are indicative of responses given by several students who were hesitant to ascribe to the negative racial stereotypes or to deny them. Table 2 further summarizes the qualitative differences in sample student responses to the following prompts about gender versus racial stereotypes about STEM ability: "Men are smarter than women in math and science" and "Asian and White students are more successful in math and science." In each instance, gender was strongly dismissed as a factor in STEM ability level. However, students' responses on race were more uncertain and at times negative racial stereotypes about ability were subtly or overtly accepted and endorsed.

Table 2. Focus Group Responses to Questions about Racial and Gender Stereotypes in STEM

Prompt: Men are better at math and science than women. Do you agree or disagree?	**Prompt: Asian and White students are better at math and science than African American and Latino students.**
This may have been true 20 years ago but now everyone is equal.	It depends on the area/school where you live. Also what students believe/want can affects this statement. But I think anyone can be successful in math and science.
Everyone has the same capability.	It may seem that way, but everyone has the ability to accomplish what they want to study.
No, we are all humans.	I don't think it is an absolute fact, but in the environment I've been in, that statement has been true in many cases. Seeing a White person do better than a Black person may cause both races to think about the statement with that in their mind and they may promote the stereotype by personally believing they can or can't do better.
No they are not, I have never seen this to be true.	Maybe percentage-wise, but when it comes down to the individual it is totally false.
No, men are just more represented in things like this.	I sort of agree, sort of disagree.
This is not true, both genders can achieve their goals in STEM.	Some Asians could have more experience depending on what their parents are teaching them.
Not true (of course) but there is a greater percentage of men than women in STEM.	I think everyone can be successful but internalized oppression can stop this from happening.

A One-Way Analysis of Variance (ANOVA; Table 3) was used to stratify participants and determine if significant differences existed between participants' endorsement of racial/ethnic and gender stereotypes by demographic characteristics. Results revealed that there were no

significant differences in endorsement of racial/ethnic stereotypes or in gender stereotypes between racial/ethnic groups (African American, Latino, and Other—Filipino, Southeast Asian, etc.), nor were there significant differences between students who were eligible for Free/Reduced Price Lunch and those who were not. There were also no significant differences in endorsement of racial and gender stereotypes by high school grade (10th, 11th, and 12th), nor by first-in-family status.

Table 3. ANOVA: Endorsement of Racial/Ethnic and Gender Stereotypes by Demographic Variables

	Racial/Ethnic Stereotypes			**Gender Stereotypes**		
Independent Variable	*F*	*Sig.*	*Partial* η^2	*F*	*Sig.*	*Partial* η^2
Race/Ethnicity	1.13	.33	.03	.27	.77	.01
Free/Reduced Price Lunch Eligibility	.37	.55	.01	.20	.66	.003
First-in-Family to Complete College	3.25	.08	.04	.02	.89	.00
H.S. Grade	1.58	.21	.04	.97	.39	.03

*p<.05, **p<.00

Negative Racial and Gender Stereotypes and the Impact on STEM Attitudes and Aspirations

This study also sought to determine what impact endorsing negative views about one's racial and gender group has on STEM attitudes and aspirations. Regression analyses indicated that endorsing negative racial stereotypes about math and science ability were not significantly related to students' attitudes towards math ($F(1,73)=.31$, $p>.05$), attitudes towards science ($F(1,73)=.04$, $p>.05$), self-efficacy in math ($F(1,73)=.31$, $p>.05$), and self-efficacy in science ($F(1,73)=1.89$, $p>.05$; Table 3). In addition, there were no significant relationships seen between endorsement of gender stereotypes and attitudes towards math ($F(1,73)=.20$, $p>.05$), attitudes towards science ($F(1,73)=.03$, $p>.05$), self-efficacy in math ($F(1,73)=.26$, $p>.05$), self-efficacy in science ($F(1,73)=.11$, $p>.05$; Table 3).

When examining the impact on STEM career aspirations, results revealed that endorsing negative racial stereotypes about math and science ability were significantly, negatively related to STEM career aspirations ($F(1,73)=1.89$, $p<.05$), while endorsing gender stereotypes was not related to STEM career aspirations ($F(1,73)=.70$, $p>.05$; Table 4). Thus, in addition to indicating that students endorsed racial stereotypes significantly more than gender stereotypes, findings also reveal that endorsing racial stereotypes has a significant, negative impact on interest in pursuing STEM careers among this population, while gender stereotypes do not.

Table 4. Hierarchical Linear Regression Analyses: Negative Racial and Gender Stereotypes as Predictors of STEM Outcomes

Criterion Variable: Attitudes towards Math	R^2	***B***	***SE***	***F***	***t***
Racial/Ethnic Stereotypes	.07	-.05	.09	.31	-.56
Gender Stereotypes	.05	-.05	.11	.20	-.45

Criterion Variable: Attitudes towards Science					
Racial/Ethnic Stereotypes	.02	.02	.08	.04	.20
Gender Stereotypes	.02	-.02	.10	.03	-.17
Criterion Variable: Self-Efficacy Math					
Racial/Ethnic Stereotypes	.07	-.17	.31	.31	-.56
Gender Stereotypes	.06	.19	.36	.26	.51
Criterion Variable: Self-Efficacy Science					
Racial/Ethnic Stereotypes	.16	.57	.41	1.89	1.37
Gender Stereotypes	.04	.16	.48	.11	.37
Criterion Variable: STEM Career Aspirations					
Racial/Ethnic Stereotypes	.26	.64	.28	5.34	2.31**
Gender Stereotypes	.10	.28	.33	.70	.84

*p<.05, **p<.05

Examining the Impact of a STEM-focused Summer Program for Students of Color: Can Negative Racial and Gender Stereotypes Be Reduced?

Given the moderate endorsement of both racial (M=2.24, SD=.67) and gender (*M*=2.65, *SD*=.59) stereotypes about STEM ability, and the propensity for students to endorse gender stereotypes more frequently than racial stereotypes, further analyses were conducted to determine whether participation in a summer STEM program for students of color (which included access to diverse STEM role models of color, networks of high-achieving girls and students of color, and social justice-focused activities) would reduce the endorsement of negative stereotypes. A repeated-measures ANOVA was used to examine whether differences in STEM racial stereotype endorsement or gender endorsement decreased from time 1 (prior to the start of the program) to time 2 (at the completion of the program). Results revealed that there was a significant decrease in both racial and gender stereotype endorsement over the duration of the STEM program (F(1,74)=7.24, p=.09; F(1,74)=14.38, p=.00). While both findings were significant, the reduction of gender stereotypes from time 1 to time 2 had a larger effect size (partial η^2 =.16, compared to partial η^2 =.09), suggesting that the program had a larger effect on reducing gender stereotypes (Table 5). No significant interactions were found between time and race, SES, or first-generation status on differences in endorsing negative racial and gender stereotypes from time 1 to time 2.

Table 5. Repeated-Measures ANOVA: Racial/ethnic and Gender Stereotypes during Time 1 and Time 2

	Racial/Ethnic Stereotypes					**Gender Stereotypes**				
Independent Variable	*M*	*SD*	*F*	*Sig.*	*Partial η²*	*M*	*SD*	*F*	*Sig.*	*Partial η²*
Time 1	2.04	.08				2.44	.53			
Time 2	2.24	.08				2.65	.59			
Time1-Time 2	-0.20		7.24	.09*	.09	-0.21		14.38	.00**	.16

Note: Based on item coding, higher mean values are indicative of lower levels of endorsement of negative stereotypes; *p<.05, **p<.01.

Conclusions and Implications

The findings of this study add depth to literature on STEM underrepresentation by examining race and gender intersectionality and demonstrating that among a sample of adolescent female students of color, racial stereotypes are more frequently endorsed than gender stereotypes. This finding suggests that among female students of color facing a "double-bind" in pursuing STEM fields of study, racial stereotypes are both more salient and more difficult to resist than gender stereotypes. Further, by demonstrating that the endorsement of negative racial and gender stereotypes do not affect self-efficacy or attitudes towards math and science, this study finds that within this sample of girls of color, protective factors appear to be at play which allow for the endorsement of negative stereotypes about one's group without impacting individual beliefs. The fact that endorsing stereotypes do not significantly impact self-concept is consistent with findings suggesting marginalized groups employ a variety of techniques to protect their self-concept (Major et al., 1998). However, the endorsement of negative racial stereotypes was shown to have a significant impact on STEM aspirations, where the endorsement of negative gender stereotypes is not observed to have such an effect, suggesting more of a long-term impact than immediate (e.g., self-efficacy). An additional promising finding within this study revealed that a 5-week STEM program focused on students of color can significantly decrease the endorsement of negative racial and gender stereotypes, suggesting that interventions have potential to alleviate these barriers.

While these findings provide insight into the beliefs about STEM ability by race and gender among high-achieving girls of color, there are several limitations and suggestions for future research. Extending this work by creating a more robust scale assessing racial and gender stereotypes (with in-depth items assessing stereotypes specific to gender and race) could provide additional information about specific ideas and which are more heavily endorsed than others. Focusing on specific subject areas within STEM (e.g, computer science, engineering) would allow for more nuanced understanding of psychological barriers facing girls of color. Additionally, conducting a similar study with a larger sample of girls of color would allow for further disaggregation by race and socioeconomic status to determine if there are differences in endorsement of stereotypes along demographic lines. Finally, additional research examining the impact of specific interventions to decrease the endorsement of negative stereotypes would provide important information with implications for wide-reaching interventions targeted at female student of color. This research contributes to understanding of the salience of race among individuals with multiple marginalized identities, and adds to literature examining low rates of entry and persistence in STEM in college and career among this population. Ultimately this work informs programming and discussion on increasing access and opportunity for females of color in STEM.

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