International Journal of Gender, Science and Technology

http://genderandset.open.ac.uk

Closing the Gender Gap in Math Confidence: Gender and Race/Ethnic Similarities and Differences in the Effects of Academic Achievements among High Math Achievers

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ABSTRACT

This paper uses data from the U.S.-based Education Longitudinal Study, 2002 (ELS02) to examine gender and race/ethnic similarities and differences in high achieving math students' confidence in their math ability. Previous research indicates that negative cultural beliefs about gender and math ability lead young women to evaluate themselves as less competent at math than young men do, even when their achievements are the same or higher. However, groups who face negative cultural beliefs based on their race/ethnicity do not lack confidence. We examine math confidence across and within gender and race/ethnic groups among students with "As" in their high school math classes. OLS regression results demonstrate that young women of all race/ethnicities have lower math confidence than young men, even when they have the same level of math achievement. Young women who are Asian have less math confidence than all other students. Finally, the math confidence of all young women who have As in their math classes, except for young women who are Asian, converges with young men's math confidence when the effects of standardized tests on math confidence vary for students who are Asian and the effects of math GPAs vary for young women and students who are Asian.

KEYWORDS

gender; confidence; math; STEM; race/ethnicity

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INTRODUCTION

Most students in the United States, except for, perhaps, young men who are White or Asian, assess their math ability in a cultural context that denigrates it (Leslie, Cimpian, Meyer, & Freeland, 2015; Cvencek, Meltzoff, & Greenwald, 2011; Nosek, Smyth, Siriam, Lindner, DeVos, & et al., 2009; Nosek, Banaji, & Greenwald, 2002; Ridgeway, 2009, 2001; Ridgeway & Correll, 2004). The National Science Foundation (NSF) in the U.S. identifies the following gender and race/ethnic groups[1] as underrepresented in science, technology, engineering, and math (STEM) disciplines because their representation in STEM education and/or STEM fields is not equal to their representation in the U.S. population: women who are White, Black, Hispanic, or Native American and men who are Black, Hispanic, or American Indians/Alaska Natives (NSF, 2017). One explanation for this underrepresentation focuses on how individuals respond to hegemonic U.S. cultural beliefs about which groups are believed to have "natural" talent in math (see for review: Xie, Fang, & Shauman, 2015). In support of this explanation, young women, who face negative cultural beliefs about their "innate" math ability, tend to underestimate their math ability; while young men, at least some of whom face positive cultural beliefs about their "innate" math ability, tend to overestimate theirs (Chevalier et al., 2009; Correll, 2001). Further, higher achievements (e.g. good grades) appear to counter the negative effect of negative cultural beliefs on math confidence (Correll, 2001).

In contrast, students who are historically marginalized in the U.S. due to their race/ethnicity (we focus on students who are Black, Hispanic, and Multiracial in this study), who also face negative stereotypes about their intellectual effort and ability (Collins, 1990 & 2004; Devine, 1989; Smith, 1990; Steele & Aronson, 1995; Wingfield, 2007), do *not* have less confidence in their math abilities than students who are White (Catsambis, 1994; Correll, 2001; Riegle-Crumb, Moore, & Ramos-Wada, 2011). However, to our knowledge, no studies, except for one descriptive analysis, examine whether math confidence varies by gender *and* race/ethnicity (Riegle-Crumb & King, 2010). The current research has not yet tested whether 1) the race/ethnic math confidence distribution is the same for young women as it is for young men or whether 2) the gender gap in math confidence is the same across race/ethnic groups. Further, research has not tested whether math achievements, such as good grades and test scores, have the same effect on math confidence among young women across race/ethnic groups or on the gender gap within race/ethnic groups.

The present study fills these gaps by examining the links between 1) U.S. cultural beliefs about gender, race/ethnicity, and math ability; 2) academic math achievements; and 3) gender and race/ethnic gaps in math confidence. We employ data from a U.S. sample of high school graduates with GPAs ranging from 3.5 to 4.0 (hereafter, "As") in their high school math classes to examine whether gender and race/ethnic differences in self-rated confidence in math ability (hereafter "math confidence"), mirrors cultural beliefs about gender, race/ethnicity and math ability even when students' math achievements are the same. In addition, we examine whether gender and race/ethnic differences that reflect cultural beliefs exist in the *effects* of academic math achievements on math confidence.

We focus on students who earned "As" (in the U.S., "As" are the top category of grades students can receive, followed by Bs, Cs, Ds, and Fs, respectively) in their high school math classes for several reasons. First, focusing on this sample of "high math achievers" allows us to examine whether confidence differences exist among students who succeed on the most commonly accepted measures of math skills because they are most likely to persist in and succeed in STEM fields (Adelman, 2006; Maltese & Tai, 2011; Ware & Lee, 1988). Second, focusing on students with As in their math courses enables us to examine a less ambiguous confidence-assessment situation compared to one in which a student receives a B, for example. Receiving an A indicates that a student's work is excellent, whereas a B or lower suggests some degree of error. In situations where achievements are ambiguous or low, students who have been historically marginalized are more likely to rely on external attribution (Resh, 2010). For example, students who receive Bs may wonder if their teachers' assessments were influenced by a cultural bias against their gender and race/ethnic groups' math ability (Foschi, 2000; Gilliam, Maupin, Reyes, Accavitti, & Shic, 2016; Gunderson, Ramirez, Levine, & Beilock, 2012; Reigle-Crumb, 2012; Resh, 2010). In contrast to students who receive all other grades (B through F), students who have a history of earning As in math classes experience the cumulative effects of consistent achievements, and thus do not need to rely on external attribution to explain it. Rather, most have had to overcome bias in order to receive As in their classes (Foschi, 2000; Gilliam et al., 2016; Gunderson et al, 2012; Riegle-Crumb, 2012). Finally, in empirical analyses of our data (available upon request), we find that there are indeed gender and race/ethnic differences in confidence among students who have As, Bs, Cs, Ds, and Fs in their math courses in our sample. In addition, we find that the effect of academic achievements on confidence varies by GPA in math courses in our sample. In summary, we focus on gender and race/ethnic differences in math confidence and the effects of math achievements on math confidence among students with A's in their math classes because even this seemingly narrow focus is extremely complicated and addresses significant gaps in the literature.

Below we summarize the findings from the research literature addressing cultural beliefs about gender and/or race/ethnicity and race/ethnic differences in students' math confidence. Throughout the review, we highlight studies examining confidence across gender *and* race/ethnic groups in the U.S. However, much of this earlier research focused on gender or on race/ethnicity.

BACKGROUND

The Effects of Cultural Beliefs about Gender and Math Ability on Math Confidence

The cultural beliefs about gender perspective argues that dominant beliefs about gender in the U.S. are comprised of three main dimensions (Correll, 2001; Ridgeway, 1997, 2009, 2011). The first dimension is the belief that there are only two sexes/genders (sex and gender are conflated in U.S. culture)- men and women- and they are considered "opposites." The second element is the belief that men, not women, have the most valuable skills in society, such as rationality, math skills, and decisiveness. The final dimension is the belief that men and women's "opposite" skills are innate characteristics (Correll, 2001; Dweck, 2016; Ridgeway, 1997, 2009, 2011). Math skill is currently valued in U.S. society and is assumed to be an innate characteristic of men (Charles & Bradley, 2009; Project Implicit; Miller, Eagly, & Linn, 2014). The widespread belief about men's superior math ability over women's is associated with women's lower math confidence (Correll, 2001). Young women of all race/ethnic groups have been shown to have lower math confidence than young men; however, no studies have allowed the effects of gender on math confidence to vary by race/ethnicity (i.e., no interaction effect was tested) (Correll, 2001).

Applying the logic of the cultural beliefs about gender perspective to students who face negative cultural beliefs due to their race/ethnicity suggests that they too should have lower math confidence. For example, given cultural beliefs about gender and math ability in the U.S., young men who are White and Asian should have the most math confidence, followed by young men who are Black, Hispanic, and perhaps Multiracial, and all young women. However, Correll's (2001) study indicates that negative cultural beliefs about race/ethnicity and ability are not associated with lower math confidence for students who are historically marginalized in the U.S. (Correll, 2001). Rather, students who are White have lower math confidence than students who are Asian, Black, or Hispanic and students who are Black have relatively high math confidence (Correll, 2001). Again, since no study has allowed math confidence to vary by gender *and* race/ethnicity, the math confidence of young women was assumed to be the same as that of young men across race/ethnic groups. To our knowledge, only one study focusing on gender and race/ethnic differences in college majors descriptively examined average math confidence by gender and by race/ethnicity (Riegle-Crumb & King, 2010). In their descriptive analysis, they found that young men who are White had the most math confidence although the math confidence of young men who are Black and Hispanic was very similar and were followed by young women who had lower math confidence than their male peers (Riegle-Crumb & King, 2010). Also, young women who are White and Hispanic had the same math confidence and young women who are Black had the least confidence (Riegle-Crumb & King, 2010).

These studies assumed that the race/ethnic math confidence distribution would be the same among young men and that the gender gap across historically marginalized race/ethnic groups would be the same size. The goal of the present study is to investigate the interaction of gender and race/ethnicity on math confidence to determine whether these assumptions hold. Next, we review scholarship about stereotype content in the U.S. We focus on stereotypes for the gender and race/ethnic groups we can analyze with our data: young women and men who are White, Asian, Black, Hispanic, and Multiracial. We do not mean to imply that these are the only groups that face negative stereotypes, nor do we mean that there is no heterogeneity in the experiences of students within these groups. We return to this point in the conclusion along with a discussion of the challenges of using quantitative techniques to account for multiple locations in social hierarchies.

The Effects of Gendered and Racialized Cultural Beliefs on Math Confidence
Cultural beliefs are both racialized and gendered (Collins, 1990 & 2004; Wingfield, 2007). In the U.S., men who are White are the only gender and race/ethnic group that seems to receive unambiguously positive cultural messages about their math ability (Charles & Bradley, 2009; Project Implicit; Miller, Eagly, & Linn, 2014). In contrast, while men who are Asian also benefit from positive cultural messages about their math ability, they also face negative effects from the "model minority" stereotype (Cheryan & Bodenhausen, 2000; Goyette & Xie, 1999; Oyserman & Sakamoto, 1997). The model minority stereotype in the U.S. is the notion that people who are Asian have overcome a history of discrimination to achieve economic and social success and, as a result, should be touted as a "model" that other historically marginalized groups should follow (Cheryan & Bodenhausen, 2000; Goyette & Xie, 1999). The implication is that the consequences of racism and discrimination can be relegated to the past and forgotten with no lingering or current consequences of that history (Cheryan & Bodenhausen, 2000; Goyette & Xie, 1999). The model minority stereotype is associated with harmful consequences for the mental health and well-being of students who are Asian (Cheryan & Bodenhausen, 2000; Goyette & Xie, 1999; Oyserman & Sakamoto, 1997). For women who are Asian, cultural beliefs about their ability are positive due to their race/ethnicity, but the effects of those positive stereotypes on their math confidence may be countered by the negative effects of the model minority stereotype (Cheryan & Bodenhausen, 2000; Goyette & Xie, 1999; Oyserman & Sakamoto, 1997) and/or by cultural beliefs about their docility, passivity, and/or hypersexuality (Espiritu, 1997). Similarly, women who are White may benefit from positive stereotypes about their race/ethnic groups' math ability even as they confront negative stereotypes due to their gender (Charles & Bradley, 2009; Project Implicit; Miller, Eagly, & Linn, 2014).

Young men who are Black in the U.S. are often depicted in the mass media as hyper-violent, criminals, athletes, and/or effeminate sidekicks for White men (Collins, 1990 & 2004; Wingfield, 2007). Women who are Black confront stereotypes that they are "treacherous, hypersexual, aggressive, and/or ideal for service" jobs (Wingfield, 2007: 199). Women who are Black also face a "modern-day Mammy" stereotype, the belief that they will put their personal lives aside to succeed in White, male dominated businesses (Wingfield, 2007).

Men who are Hispanic or Latino share the criminal stereotype with young men who are Black and are also often depicted as comedic, aggressive, "Latin Lovers," and/or lacking intelligence (Mastro, Behm-Morowitz, & Otriz, 2007). Women who are Hispanic or Latina are often stereotyped as feisty, lazy, aggressive, hypersexual, lacking a good work ethic, and/or motivated only by motherhood (Ghavami & Peplau, 2012; Lozano, Rodriquez, Guido-DiBrito, Torres, & Talbot, 2000; Rivadeneyra, Ward, & Gordon, 2007; Vargas, 2010). Finally, women and men who are Multiracial face stereotypes that they are fragile or damaged due to being caught between the worlds of their multiple race/ethnicities (Streeter, 1996) or touted as examples of assimilation and the end of racism in the U.S. (Mahtani, 2014; Osei-Kofi, 2012).

How might these complicated cultural beliefs about ability in the U.S. affect students' math confidence? Next, we turn to scholarship that suggests several predictions: 1) students who face negative cultural beliefs due to their gender *and* race/ethnicity will have lower math confidence than students who face negative cultural beliefs about either their gender *or* their race/ethnicity; 2) students who face more negative cultural beliefs will have more math confidence than young students who face fewer negative cultural beliefs; and 3) young women will have similar math confidence levels no matter their race/ethnicity.

Negative cultural beliefs and lower math confidence

The logic of the "double burden" is that "two devalued identities interact to influence the individual in a way that is greater than the sum of the independent effects of those identities" (Gonzalez et al., 2002: 659; St. Jean & Feagin, 1998). In this study, if the double burden is relevant, we will find that anyone facing negative stereotypes about their math ability based on their race/ethnicity *and* gender will have lower confidence than individuals that face negative stereotypes based on either their gender *or* their race/ethnicity. If this assumption holds, we would expect men who are White to have the most confidence, followed by men who are Asian (positive beliefs due to their gender and race/ethnicity but some confidence lowering effect of the model minority stereotype), men who are Black, Hispanic, or Multiracial (positive beliefs due to their gender, but negative beliefs about race/ethnicity), women who are White (negative beliefs due to their gender, but positive beliefs about race/ethnicity), and women who are Asian (negative beliefs about their gender and the model minority stereotype, but positive beliefs about race/ethnicity). Young women who are Black, Hispanic, and Multiracial are predicted to have the lowest math confidence (negative beliefs about their gender and race/ethnicity). However, some available scholarship appears to contradict this prediction- students who are White in the U.S. have lower math confidence than students who are Black and Hispanic, but, again, we have not yet tested whether this order holds among young women (Correll, 2001). Even though some evidence contradicts the hypotheses that follow from this perspective, we include them because some evidence suggests that the gender and race/ethnic differences in math confidence are greatest at the highest levels of achievement, at least through eighth grade (Hedges & Novell, 1999; Neal, 2006; Reardon, 2008; Riegle-Crumb & Grodsky, 2010; Robinson & Lubienski, 2011; Wai, Cacchio, Putaliaz, & Makel, 2010).

Hypothesis 1a: Students who face more negative cultural beliefs (i.e., women who are Black, Hispanic, or Multiracial) will have lower math confidence than students who face fewer negative beliefs (i.e., men who are Asian, Black, Hispanic, or Multiracial; women who are White or Asian) or no negative beliefs (i.e., men who are White).

We are also interested in whether the effect of positive academic achievements on young women's math confidence found in prior research also helps individuals who face negative cultural beliefs based on their gender *and* race/ethnicity. Correll's (2001) study found that good grades improved young women's self-assessments of their math aptitude more than they did for young men's and reasoned that since individuals tend to safeguard their self-esteem, they seek out information that allows them to maintain or increase confidence. If individuals who face negative cultural beliefs pay more attention to their math achievements, we would expect:

Hypothesis 1b: Greater academic achievements (i.e., good grades and test scores) will have a larger positive effect on the math confidence of students who face more negative beliefs about their ability (i.e., women who are Asian, Black, Hispanic, or Multiracial) than students who face fewer negative beliefs (i.e., men who are Asian, Black, Hispanic, or Multiracial; women who are White or Asian) or no negative beliefs (i.e., men who are White).

Negative cultural beliefs and higher math confidence
Research on social-psychological skills suggests the opposite- individuals who face more negative cultural beliefs develop skills or receive other supports that help them combat negative cultural beliefs (Anzaldua, 1987; Bettie, 2003; Carbonaro & Covay, 2010; Hanson, 2006, 2009; Resh, 2010; Reyna, 2000; Sandoval, 1998). Students appear to protect their self-esteem in several ways. For example, they may interpret lower grades as evidence of teacher bias or discrimination, rather than evidence that they lack ability (Reyna, 2000). They may believe that investments in education can lead to greater opportunity, despite their own negative experiences with educational institutions and discrimination (Mickelson, 1990). They may not find "bad" grades or test scores credible because they view the educational system as biased (Carbonaro & Covay, 2010; Reyna, 2000). They may be less likely to have implicit biases about gender, race/ethnicity, and STEM (O'Brien, Adams, Blodorn, Garcia, & Hammer, 2015). Finally, community support could counter the influence of negative cultural beliefs on math confidence. Some evidence suggests that Black and Hispanic communities invest more material and emotional resources in young women's development than they invest in young men's because women face less- or less severely consequential- discrimination than men (Anzaldua, 1987; Bettie, 2003; Hanson, 2006; Sandoval, 1998). There is some evidence to support this perspective. First, young women who are Black are less likely to hold implicit biases about men's greater suitability for work in STEM disciplines (Quinn & Cooc, 2015) and tend to be confident about their STEM ability (Hanson, 2006). Correll's (2001) study also finds that students who are Black, Asian, or Hispanic have higher math confidence than students who are White. This research would lead us to predict that students who face more negative beliefs about their gender *and* race/ethnicity may have more confidence than students who face fewer negative beliefs. In addition, our sample of students who have received As in their math courses may not be receiving grades that are "bad" enough for them to discount it by relying on external attributions.

Hypothesis 2a: Students who face more negative beliefs (i.e., women who are Asian, Black, Hispanic, or Multiracial) about their ability will have more math confidence than students who face fewer negative beliefs (i.e., men who are Asian, Black, Hispanic, or Multiracial; women who are White or Asian) or no negative beliefs (i.e., men who are White).

Given our sample of high math achievers, hypotheses about the effects of academic achievements on math confidence based on these perspectives are equivocal. On one hand, students who have developed skills to counter negative beliefs may pay less attention to their academic achievements because they are already confident. Furthermore, they may discount educational institutions as biased. On the other hand, our sample is of high math achievers who have overcome teacher bias to earn good grades, thus they may pay attention to those achievements because they see it as more legitimate. Hypotheses 1b (above) addresses the former and the hypothesis 2b below predicts the latter:

Hypothesis 2b: Increases in academic achievements (i.e., good grades and test scores) will have a smaller positive effect on math confidence among students who face more negative beliefs about their ability (i.e., women who are Asian, Black, Hispanic, or Multiracial) than students who face fewer negative beliefs (i.e., men who are Asian, Black, Hispanic, or Multiracial; women who are White or Asian) or no negative beliefs (i.e., men who are White).

Negative cultural beliefs about gender are difficult to counter

Finally, it is possible that even though the number and content of stereotypes are different depending on an individual's gender *and* race/ethnicity, stereotypes due to race/ethnicity are countered by social-psychological skills and/or community support while stereotypes about gender are more difficult to counter. Correll (2001) argues that due to race segregation in schools, neighborhoods, and marriages, students who are historically marginalized less frequently confront negative stereotypes and are often surrounded by resistance to those ideas. In contrast, there is less gender segregation in schools, families, and neighborhoods. Others argue that cultural beliefs about gender and ability rely more on assumptions about innate skills or traits than do cultural beliefs about race/ethnicity (Bonilla-Silva, 2003; Cech, Blair-Loy, & Rogers, 2018; Charles & Bradley, 2009; DiTomoso, 2013; Messner, 2009). If cultural beliefs about gender are less likely to be countered than race/ethnic beliefs:

Hypothesis 3a: Students who face negative gender beliefs (i.e., women who are White, Asian, Black, Hispanic, or Multiracial) will have less math confidence than students who face negative race/ethnic beliefs (i.e., men who are Asian, Black, Hispanic, or Multiracial) or no negative beliefs (i.e., men who are White).

Hypothesis 3b: Increases in academic achievements (i.e., good grades and test scores) will have a larger positive effect on math confidence among students who face negative gender beliefs about their ability (i.e., women who are Asian, Black, Hispanic, or Multiracial) than students who face negative race/ethnic beliefs about their ability (i.e., men who are Asian, Black, Hispanic, or Multiracial) or no negative beliefs (i.e., men who are White).

DATA AND METHODS

Data

This study uses the Education Longitudinal Study, 2002 (ELS02) to examine whether gender and race/ethnic similarities and differences in math confidence exist even among high math achieving high school students in the U.S. The ELS02 used a two-stage sampling procedure (i.e., stage one is schools with 10th grades in the U.S. and stage two is 10th graders in those schools) and is a nationally representative sample of 10th grade students in 2002 collected by National Center for Education Statistics (NCES,2002; see Ingels et al. 2014 for more detailed sampling information). The ELS02 is well-suited to answer our research questions because it asks students about their math confidence and the restricted dataset includes high school transcript information, allowing us to examine high school math GPAs and math test scores. In addition, the ELS02 is the next student cohort about which the NCES collected data after the cohort studied in a seminal paper on the topic (Correll, 2001) (i.e., NCES's National Educational Longitudinal Study (NELS88). Finally, since gender and race/ethnic equality and equity is in a constant state of flux, information about academic math achievements, gender and race/ethnic gaps in math confidence, and gender and race/ethnic differences and similarities in the effects of achievements on confidence at multiple time points is useful.

The dataset allows us to examine gender and race/ethnicity gaps in math confidence in the early 2000s in the U.S. It is possible that educational reforms in the U.S. since 2002, such as No Child Left Behind and Common Core, have affected students' math confidence, however recent studies indicate that the gender gap in math confidence persists despite these reforms (e.g., Dweck, 2016; Ganley & Lubienski, 2016). Furthermore, cultural beliefs that denigrate women's math ability continue. Sixty percentage of women and men still espouse the explicit belief that women are not as good at science as men (Miller, Eagly, & Linn, 2014) and 70% hold these beliefs implicitly (Project Implicit), indicating that educational reforms have not coincided with changes in beliefs about gender and math/science ability.

Sample

We limited the sample to students who graduated from high school between September 1, 2003 and August 31, 2004, who had A-level GPAs in their high school math coursework and did not have missing information on our key independent variables of race/ethnicity and sex (n=1,710[3]). Although in the U.S. most students graduate high school in May or June, some graduate throughout the calendar year, and this inclusion criteria allowed us to retain those cases. The U.S. has several types of grading systems, but in general, grades are associated with a numerical point value. A-level math GPA means grades in all math courses taken in high school range from a 3.5 or A- to a 4.0 or A+. Mastery of 90 percentage of the material is associated with an A- or 3.5 ranging to mastery of 100 percentage of the material or a 4.0 on the numerical scale. We used the ELS02 restricted transcript data to identify students' math courses. To ensure that math GPAs were comparable across different U.S. grading and credit systems, we used the ELS02 measures that standardize course units and letter grades to the Carnegie system. We followed the ELS documentation to convert standardized letter grades into standardized grade points. We then identified which courses were math classes to create a variable for math GPA (we multiplied the standardized grade point and grade credit measures for math classes, summed math credit hours by person, and divided the former by the latter). We eliminated n=220[3] A-level students from the sample because they did not answer the questions about math confidence, the dependent variable. Our sample size was n=1,500[3] from 512 U.S. high schools. The school with the most students from our sample only had 10 students, all of whom are White, non-Hispanic individuals.

Tests for selection bias (not shown) indicated some race/ethnic and gender differences in the likelihood of students' answering questions about their math ability (i.e., the questions we used to create our measure of math confidence). Regressions of race/ethnicity and gender, math achievement, and control variables on the likelihood of students with As in math classes answering questions about their math confidence showed that young women who are White, and young men who are Asian, Hispanic or Multiracial were less likely to answer these questions than were young men and women who are White or Black. Among Hispanic students, young women were more likely than young men to answer the math confidence questions. In addition, students in precalculus and advanced math classes were more likely to answer questions about their math confidence than were students in calculus or all other math classes. Finally, students who lived in the northeast and urban areas were more likely to answer the questions about their math confidence than students living in all other regions of the U.S. and rural and suburban areas. We address how these differences may affect our results in the conclusion.

Measures

Dependent Variable: Math Confidence

Math confidence was measured using five questions that captured students' perceptions of their math ability. Since factor analysis indicated equal effects of each measure on the latent concept of math confidence, we created an additive scale of students' perceptions based on the following series of questions: "How often do these things apply to you:" 1) "I'm confident that I can do an excellent job in my math tests," 2) "I'm certain I can understand the most difficult material presented in math texts," 3) "I'm confident I can understand the most complex material presented by my math teacher," 4) "I'm confident I can do an excellent job on my math assignments," and 5) "I'm certain I can master the skills being taught in my math class." Response options were: Almost never, Sometimes, Often, and Almost always. The scale ranged from 0-15. Low values indicated that students have low math confidence while high scores indicated high math confidence. The alpha reliability score for our sample was .938.

Focal Independent Variable: Gender and Race/Ethnicity

We used a dichotomous sex category variable (coded 1 for young women). Race/ethnicity was a categorical measure with the following groups: students who are 1) White, non-Hispanic; 2) Asian, non-Hispanic (includes Native Hawaiian and Other Pacific Islander); 3) Black, non-Hispanic (includes African American); 4)

Hispanic (includes Latino); and 5) Multiracial[2]. We also used interaction terms between gender and each race/ethnic group.

Independent Variables (1): Achievement Measures- Math GPA

To measure GPA, we included two measures. Math GPA was calculated as explained in the sample section of this paper. Since our analyses focused on students with As in their math classes, our GPA measure ranged from students with an A- GPA to an A+ GPA in their math classes throughout high school, (i.e., 3.5 to 4.0; mastery of 90 percent or more of the material). For multivariate analyses, we modified the scale of this variable so that the value 0 = 3.5 and .50 = 4.0. We also tested whether the effect of an A GPA on confidence was linear and found that a parabola more accurately reflected the relationship between GPA and confidence. Thus, we also include a GPA^2 term in the models.

Independent Variables (2): Achievement Measures- Math Test Scores

We included two measures of test scores, both of which allowed comparison of a student's math ability to the ability of their peers nationally. ELS02 included a battery of math tests that assessed skill/knowledge, understanding/comprehension, and problem solving with items covering the following areas: arithmetic, algebra, geometry, data/probability, and advanced math topics. To account for differences in the test forms and students whose understanding of math is limited, but guess well, ELS used Item Response Theory (IRT), "which uses patterns of correct, incorrect, and omitted answers" (U.S. Department of Education, 2004, pg. 19). ELS standardized students' math items using IRT theory and rescaled to the national math ability mean of 50 and a standard deviation of 10. The scores ranged from 10-90. For A students in our sample, scores ranged from 26.15 to 86.68 with a mean of 60.52. We centered the variable at the mean for our sample in the multivariate analyses.

We utilized one measure of 5 hierarchical NELS measures computing the probability a student would pass a given math proficiency level. For example, the first level measured simple arithmetic operations on whole numbers and the second level covered simple operations with decimals, fractions, powers, and roots. In sensitivity analyses, we found that the measure distinguishing among the highest achievers in our sample was the highest NELS measure that assessed the probability of proficiency at the most difficult math skills—complex, multi-step word problems and/or advanced mathematics material. The NELS-equated proficiency probabilities were computed using IRT-estimated item parameters calibrated in NELS:88 (NCES 2002). This score ranged from 0 to 1. For A students, the scores ranged from .0 to .996 with a mean of .06. We centered this variable at the sample mean in the multivariate analyses.

Control Variables

We controlled for other factors associated with differences in math confidence: family socioeconomic status; percent of students who are race/ethnic minorities in students' high schools; percent of students eligible for free lunches in students' high schools; urbanicity; and region. Family socioeconomic status is a binary variable coded one if either parent has a college degree or more education and family income in thousands centered at the median value for the sample. Percent of students who are race/ethnic minorities in the school and the percent of students eligible for free lunches are continuous measures. U.S. public schools offer a free lunch program that provides nutritional lunches at a low cost or free for students who cannot afford lunch. We used this as a measure of the socioeconomic status of the school. Urbanicity was measured using two dummy variables. The first was coded one if the respondent lived in an urban area. The second was coded one if the respondent lived in a suburban area. The reference group was students who live in rural areas. Region was measured with three dummy variables: Midwest, West, and Northeast. The reference group was the South.

To capture the highest-level math course students took in high school, we used the NELS measure originally created by Burkham and Lee (2003) and later amended to capture more math classes and pipelines. We created three dummy variables comparing students whose highest math class in high school was calculus, pre-calculus or an advanced math class (e.g., algebra 3, trigonometry, statistics) to the reference group, students whose highest math class was any other math class. We also included a binary variable coded 1 for students who have ever taken an Advanced Placement (AP) math class. AP courses in the U.S. are college-level courses taught in high school. Students can take AP exams to place out of those courses in college.

Analysis
We used OLS regression to answer our research questions: 1) are there gender *and* race/ethnic differences in math confidence among high math achievers ;and 2) are there gender and race/ethnic differences in the *effects* of academic achievements on math confidence? Our data meet the assumptions of OLS regression. To test Hypotheses 1-3a, we regressed math confidence on gender and race/ethnicity and introduced interaction effects between race/ethnicity and gender in successive models (see Table 2, Models 1 and 2). We then introduced controls for math achievement (test scores, and GPA) to determine if the gender *and* race/ethnic differences in math confidence persisted when math achievements were the same (i.e., held constant; see Table 2, model 3). Finally, examining interactions between achievement levels and gender *and* race/ethnic groups allowed us to test Hypotheses 1-3b, (see Table 4), which posited that the effects of achievement levels on math confidence would vary by gender *and* race/ethnicity.

RESULTS
Descriptive Results
Table 1 provides the descriptive statistics for students with A-level math GPAs in high school by race/ethnic and gender groups. In Table 1, we indicate significant differences between young women and men within race/ethnic group next to the means or percentages for each variable in the young men's section of the table (e.g., among high school students who are White, is average math confidence significantly different for young women and men?). We also show statistically significant differences within gender category between race/ethnic group in the last column of the table (e.g., among young men, is average math confidence statistically significantly different across race/ethnic groups?).

Table 1. Descriptive Statistics by Gender and Race/Ethnicity for Students with A GPAs in Math, ELS02, (n=1,490).

	Young Men (n=570)						
	White n=430	Asian n=70	Black n=20	Hispanic n=30	Multi-racial n=20	Average	Race Diff.
Confidence	11.78†††	12.20†††	11.59	10.63	11.86†	11.77	
Math GPA	3.77	3.78	3.73	3.77	3.76	3.77	
Standardized Tests	62.71†††	63.41†	53.78	57.75	61.52	62.22	***
Level 5 Math Proficiency	0.08†††	0.15†	0.00	0.06	0.11†	0.08	*
	Young Women (n=910)						
	White n=660	Asian n=130	Black n=30	Hispanic n=70	Multi-racial n=20	Average	Race Diff.
Confidence	10.57	9.27	10.56	10.40	10.04	10.36	**
Math GPA	3.78	3.77	3.70	3.76	3.80	3.78	
Standardized Tests	59.26	60.25	52.11	55.75	57.12	58.81	***
Level 5 Math Proficiency	0.02	0.08	0.02	0.02	0.00	0.03	***

* p<.05; ** p<.01;*** p<.001, race/ethnic differences within gender

† p<.05; †† p<.01;††† p<.001, gender differences within race/ethnicity

NOTE: The National Center for Education Statistics requires that all sample size numbers be rounded to the nearest 10 when using restricted data.

Average math confidence is higher for some groups who face positive cultural beliefs about their math abilities than for those who face negative beliefs. Young men who are White and Asian had higher math confidence scores than young women in their same race/ethnic group (11.78 vs.10.57; 12.20 vs. 9.27). However, young men who face negative cultural beliefs about their math ability do not have lower math confidence than young men who are White. Among young men, there was no statistically significant difference in average math confidence across race/ethnic groups (final column). Young men who are Asian, Black, Hispanic, or Multiracial with As in their math classes in high school do not have lower math confidence than young men who face supportive cultural beliefs about their ability (i.e., White men). In contrast, young women did have significantly different math confidence across race/ethnicity. Young women who are Asian had the lowest math confidence score of all the gender and race/ethnic groups in our sample, 9.27 out of 15. All young women's confidence scores were lower than all young men's, but only young women who are White, Asian or Multiracial had average scores that were statistically significantly lower than their male peers who share a race/ethnicity.

There were several similarities in level of math achievement across gender and race/ethnic groups. First, math GPAs did not vary by gender or race/ethnicity among students with As in the math classes. Stated differently, young men and women who are White, Asian, Black, Hispanic or Multiracial all had the same GPAs in their math classes, on average. Second, there was no statistically significant difference between the average standardized test scores of young men and women who are Black, Hispanic, or Multiracial nor any statistically significant differences in the percentage of students with the highest math proficiency between young men and women who are Black or Hispanic.

The differences in average math achievements were mostly between young women and men who are White and Asian. Young men who are White or Asian have standardized test scores that were statistically significantly higher than their female counterparts in the same race/ethnic category (62.71 vs. 59.26 and 63.41 vs. 60.26, respectively). More young men who are White and Asian had proficiency in the highest math skill level (.08 vs. .02 and .15 vs. .08, respectively) than young women who are White and Asian. More young men who are Multiracial had proficiency in the highest math skill level than their female counterparts (.11 vs. .00). The same pattern existed in young women's average standardized test scores as young men's-young women and men who are White, Asian, or Multiracial had the highest standardized test scores, on average.

Two additional findings merit emphasis. First, young women who are Asian had the lowest math confidence of all the students, but the highest test scores among the young women. In fact, their probability of advanced math skills was equal to that of the average overall score for the young men (.08). Second, 73 percent of our sample were students who are White. Students who are Asian and Hispanic make up 14 and 7 percent of the sample, respectively. Finally, students who identify as Black or Multiracial each make up 3 percent. While this mirrors prior research on race/ethnic differences in math achievements, we cautiously interpret our results for groups with fewer respondents, a point we return to in the discussion. Appendix A reports the results of the control variables by gender and race/ethnicity.

Multivariate Results- Gender and Race/Ethnicity, and Math Confidence
Table 2 shows the results of three OLS regression models testing Hypotheses 1a through 3a. The models presented in Table 2 progressively added gender and race/ethnicity interactions (Model 2) and math achievements, as measured by math GPAs and test scores (Model 3) to an initial model that included measures of gender and race/ethnicity as well as control variables (Model 1).

We found the most support for hypothesis 3a- students who face negative cultural gender beliefs (i.e., women who are White, Asian, Black, Hispanic, or Multiracial) will have less math confidence than students who face negative race/ethnic beliefs (i.e., men who are Asian, Black, Hispanic, or Multiracial) or no negative beliefs (i.e., men who are White). In model 2, since none of the main effects for race/ethnicity were significant, the results indicated that there were no significant differences in young men's math confidence, no matter their race/ethnicity (see Model 3). The significant and negative coefficient for females across models 2 and 3 and the non-significant gender *and* race/ethnic interactions show that all young women had lower math confidence than young men, by about one point.

Appendix A. Descriptive Statistics for Control Variables by Gender and Race/Ethnicity for Students with A GPAs in Math, ELS02, (n=1,490).

	Young Men (n=570)						
	White n=430	Asian n=70	Black n=20	Hispanic n=30	Multi-racial n=20	Average	Race Diff.
Advanced Math	13%††	7%	35%	9%	0%	12%	***
Precalculus	24%††	19%	12%	53%	29%	25%	***
Calculus	53%††	71%	47%	25%	62%	54%	***
AP Math Class	43%†††	67%	41%†	22%†	52%	45%	***
College Educated Parents	68%†††	77%†	53%	47%	67%	68%	*
Family Income	$90,597	$82,014	$44,765	$70,000	$84,452	$86,817	*
Single Mother	9%	11%	41%	16%	24%	12%	***
Percent minority in school	13%	41%†	53%	37%	34%	20%	***
Percent free lunch at schoo	12%	16%	29%	22%	14%	14%†	***
Midwest	38%	13%	5%	25%	29%	33%	***
West	12%	49%	12%	44%	38%	19%	***
Northeast	18%	20%	24%	3%	5%	17%	***
Urban Area	29%	34%	41%	44%	19%	30%	
Suburban Area	50%	57%	41%	44%	71%	51%	
	Young Women (n=910)						
	White n=660	Asian n=130	Black n=30	Hispanic n=70	Multi-racial n=20	Average	Race Diff.
Advanced Math	17%	8%	24%	10%	9%	15%	*
Precalculus	30%	26%	18%	33%	13%	29%	***
Calculus	42%	60%	29%	44%	65%	45%	***
AP Math Class	30%	61%	15%	46%	61%	36%	***
College Educated Parents	58%	63%	56%	43%	43%	57%	*
Family Income	$88,019	$67,008	$62,456	$59,479	$78,370	$81,621	***
Single Mother	9%	13%	44%	13%	17%	12%	***
Percent minority in school	13%	52%	53%	51%	17%	23%	***
Percent free lunch at schoo	13%	20%	27%	28%	12%	16%	***
Midwest	36%	11%	26%	9%	22%	29%	***
West	11%	56%	3%	49%	26%	21%	***
Northeast	15%	15%	15%	7%	9%	14%	***
Urban Area	27%	41%	29%	54%	30%	31%	***
Suburban Area	53%	52%	53%	37%	70%	52%	***

* p<.05; ** p<.01;*** p<.001, race/ethnic differences within gender

† p<.05; †† p<.01;††† p<.001, gender differences within race/ethnicity

NOTE: The National Center for Education Statistics requires that all sample size numbers be rounded to the ne

when using restricted data.

Table 2. Gender and Race/Ethnic Differences in Perception of Math Ability Among Students Graduating from High School between 2003-2004 with A level GPAs in Math, ELS02, (n=1,490).

	Model 1		Model 2		Model 3	
Female	-1.308	***	-1.123	***	-1.034	***
Asian	-.773	**	.295		.253	
Black	.157		-.041		.733	
Hispanic	-.274		-.864		-.808	
Multiracial	-.246		.127		.311	
Female*Asian			-1.701	***	-1.592	**
Female*Black			.247		.110	
Female*Hispanic			.789		.992	
Female*Multiracial			-.707		-.752	
Achievements						
Math GPA					.797	
Math GPA^2					8.575	*
Standardized Test, Peers (cntrd)					.055	***
Math Proficiency, Level 5 (cntrd)					1.677	**
Control Variables						
Calculus	.416		.395		-.605	*
Precalculus	.341		.351		-.164	
Advanced Math	.502		.493		.100	
AP Math	.297		.315		.048	
College Educated Parents	.460	**	.451	*	.263	†
Family Income (cntrd)	.000		.000		.000	
Single Mother	-.609	*	-.609	*	-.617	*
Percent minority in school	.005		.006		.004	
Percent free lunch at school	-.012		-.013		-.011	
Midwest	-.230		-.216		-.425	*
West	-.566	*	-.550	*	-.484	*
Northeast	.236		-.233		-.247	
Urban Area	.400		.410		.564	*
Suburban Area	.360		.353		.390	
Intercept	11.126		11.018		10.681	
Adjusted R-squared	.055		.060		.162	
F Change in R-Squared	***		*		***	

* p<.05; ** p<.01;*** p<.001, one-tailed

NOTE: GPA rescaled 0=3.5; Math Proficiency centered at mean=.05; Standardized test centered at mean=60.52

NOTE: The National Center for Education Statistics requires that all sample size numbers be rounded to the nearest 10 when using restricted data.

Table 3. Math Confidence Expected Values by Gender, Race/Ethnicity, and Achievement Level for Students at Mean and Modal Categories for Overall Sample and for their Gender and Race/Ethnic Group[1], ELS02, (n=1,490).

	Gender & Race/Ethnic Group's Statistics[2]	Gender & Race/Ethnic Group's Statistics[2] & 4.0 GPA	Gender & Race/Ethnic Group's Statistics[2] & Young Men Who are Asian's Mean Test Score[3]	Gender & Race/Ethnic Group's Statistics[2] & Young Men Who are Asian's Mean Proficiency Score[4]	Gender & Race/Ethnic Group's Statistics[2] & 4.0 GPA, & Young Men Who are Asian's Mean Test[3] & Proficiency Scores[4]
Young Men					
White	11.23	12.93	11.27	11.34	13.08
Asian	11.75	13.39			13.39
Black	11.70	13.61	12.23	11.95	14.39
Hispanic	10.39	12.09	10.7	10.54	12.56
Multiracial	11.52	13.28	11.62	11.59	13.45
Young Women					
White	10.37	12.02	10.6	10.59	12.46
Asian	8.78	10.48	8.95	8.9	10.77
Black	10.43	12.47	11.06	10.65	13.61
Hispanic	9.67	11.42	10.09	9.89	11.89
Multiracial	9.71	13.21	10.05	9.96	11.84

1. Expected values calculated using the coefficients from Table 2, Model 4.
2. Gender and race/ethnic group specific means and modal categories for all independent and control variables
3. Highest group's standardized test score is young men who are Asian, 63.41.
4. Highest groups probability of proficiency in level 5 math is young men who are Asian, 60.15.

NOTE: The National Center for Education Statistics requires that all sample size numbers be rounded to the nearest 10 when using restricted data.

The only exception were young women who are Asian, who had the lowest math confidence of all high school students with As in their math classes in the U.S. At first pass, this finding appears to most closely fit the hypothesis following the logic of the double burden- that students who face more negative beliefs about their ability will have more math confidence than students who face fewer negative beliefs or no negative beliefs. However, it only holds for students who are Asian, not students who are White, Black, Hispanic, or Multiracial.

It is remarkable that in no case did math achievement measures eliminate the gap in math confidence between young men and women. Even when young women had the same math GPAs in the A-range and the same math test scores, they were still less confident than young men. Young women who are Asian had even lower math confidence than all other young women. Please note, however, that the numbers of high school students who are Black or Multiracial in our sample are small; thus, we interpret their effects cautiously.

To further emphasize these findings, Table 3 presents expected math confidence values for each gender and race/ethnic group calculated using the regression results from Table 2. The first column in Table 3 used the coefficients from Table 2, Model 3 and the gender and race/ethnic group-specific means and modal categories for all independent and control variables. The remaining columns show the predicted effects of each math achievement on math confidence by gender and race/ethnicity We calculated math confidence in four different scenarios substituting the race/ethnic and gender group's average 1) GPA for a 4.0 GPA, 2) standardized test score compared to peers to the race/ethnic group with the highest standardized test scores (i.e., young men who are Asian), 3) probability of being proficient at level 5 math problems to the race/ethnic group with the highest probability (i.e., young men who are Asian), 4) and then one that combines the highest GPA, highest standardized test score (young men who are Asian), and highest level 5 probability (young men who are Asian). Even when young women who are Asian have all the highest achievements (final column), their confidence score is a 10.77, out of 15, compared to young men whose scores ranged from 12.56 to 13.45 and all young women with scores of 11.84 to 13.61.

Multivariate Results- Gender and Race/Ethnic Differences in the Effects of Math Achievements on Math Confidence

Our analyses in Table 4 address hypotheses 1b through 3b testing whether academic achievements in math have a larger or smaller effect on groups who face more negative cultural beliefs about their ability than those who face fewer or no negative beliefs (i.e., 1b and 2b) and whether positive academic achievements have a larger effect on young women's math confidence than all other groups (i.e., 3b). We report the results of our final model; however, in analyses not shown, we tested whether the effect of math GPAs and standardized tests on math confidence was larger, smaller, or the same for young women and men across all race/ethnic groups using two-way and three-way interactions between gender, race, and math achievements. Table 4 shows the final model that focuses on the gender and race/ethnic groups whose math confidence was differentially affected by math achievements.

Taken together, our results indicate that the effect of test scores on students' math confidence is the same whether they face positive or negative beliefs. However, the "model minority" stereotype that students who are Asian face seems to modify the relationship between achievements and math confidence. We do find some support for hypothesis 3b- cultural gender beliefs are difficult to overcome. Standardized test scores had the same effect on math confidence for most women and men, except young women and men who are Asian. The higher the standardized math test scores, the higher the math confidence of young men and women who are White, Black, Hispanic, or Multiracial. Although the math confidence of students who are Asian increases as their standardized test scores increase, the positive effect is smaller than for all other groups. Our results also show that the effect of math proficiency in higher level math was the same and positive for all students, regardless of their gender and race/ethnicity. Math confidence increased for all young men and women as their probability of proficiency at higher level math increased.

The effect of math GPAs in the A-range on math confidence was more complicated by gender *and* race/ethnicity than was suggested by hypotheses based on double burdens, social-psychological skills, or the particular power of beliefs about gender. In line with hypothesis 3b- that negative beliefs about gender are particularly powerful- the main effects of Math GPA and Math GPA^2 show that young men who are White, Black, Hispanic, or Multiracial all experienced increases in their math confidence at low levels of math GPAs in the A-range, but that increase in confidence begins to flatten out at higher levels of math GPAs. The female*math GPA and female*math GPA^2 terms show that women who are White, Black, Hispanic, or Multiracial all experienced increases in their math confidence at higher levels of math GPAs but those with lower math GPAs in the A-range, have lower math confidence.

In contrast to all predictions, Math GPAs have a different effect on math confidence for young men and women who are Asian. The effects of math GPA and math GPA^2 on confidence were different for young men who are Asian compared to young men of all other race/ethnic groups but had a pattern similar to most young women. For young men who are Asian, math GPAs lower in the A-range had a negative effect on their confidence but GPAs higher in the A-range had a positive effect on math confidence. Thus, similar to young women, young men who are Asian appear to need higher GPAs in the A-range in order to boost their math confidence. The effect of math GPA and math GPA^2 on math confidence show a similar pattern for young women who are Asian and young men who are White, Black, Hispanic, or Multiracial (see main effects for math GPA and math GPA^2 and female*Asian*mathGPA and female*Asian*mathGPA^2). However, the decrease in the effect of math GPA squared when math GPAs are higher in the A-range is not statistically significant.

Table 4. Gender Differences in the Effects of Achievements on Perception of Math Ability, High School Graduates, 2003-2004 with A level GPAs in Math, ELS02, (n=1,490).

	Final Model	
Female	-.504	
Asian	2.540	*
Black	.808	
Hispanic	-.127	
Multiracial	-.143	
Female*Asian	-4.914	*
Achievements		
Standardized Test, Peer (cntrd)	.068	***
Asian*Standardized Test (cntrd)	-.070	*
Math Proficiency, Level 5 (cntrd)	1.909	**
Math GPA	6.286	*
Math GPA^2	-3.527	*
Female*Math GPA	-8.426	**
Female*Math GPA^2	17.898	*
Asian*Math GPA	-20.038	*
Asian*Math GPA^2	32.554	*
Female*Asian*Math GPA	23.538	*
Female*Asian*Math GPA^2	-32.643	
Control Variables		
Calculus	-.635	*
Precalculus	-.262	
Advanced Math	.094	
AP Math	.038	
College Educated Parents	.246	
Family Income (cntrd)	.000	
Single Mother	-.561	*
Percent minority in school	.005	
Percent free lunch at school	-.011	
Midwest	-.448	*
West	-.462	*
Northeast	-.245	
Urban Area	.549	*
Suburban Area	.424	*
Intercept	10.408	
Adjusted R-squared	.187	
F Change in R-Squared	***	

† p<.10; * p<.05; ** p<.01;*** p<.001, one-tailed

NOTE: GPA rescaled 0=3.5; Math Proficiency at mean=.05; Standardized test at mean=60.52

NOTE: The National Center for Education Statistics requires that all sample size numbers be rounded to the nearest 10 when using restricted data.

To illustrate these findings, Table 5 presents expected math confidence values for each race/ethnic and gender group calculated based on the regression results in Table 4, Model 10. The first six columns show the effect of different GPA values on the math confidence of each race/ethnic and gender group calculated using the means and modal values for their race/ethnic and gender group. The final column shows math confidence values for the gender and race/ethnic group at the average GPA for the overall sample (3.77) also calculated using the gender and race/ethnic group specific means and modal values on all other variables.

Table 5. Math Confidence Expected Values by Gender and Race/Ethnicity for Students for their Gender and Race/Ethnic Group across A Level Math GPAs (n=1,490).*

	GPA= 3.5	GPA= 3.6	GPA= 3.7	GPA= 3.8	GPA= 3.9	GPA= 4	Average GPA, overall sample GPA= 3.77
Young Men							
White	10.12	10.72	11.24	11.69	12.08	12.39	11.33
Asian	12.97	11.88	11.38	11.45	12.11	13.35	11.39
Black	10.76	11.35	11.88	12.33	12.71	13.02	11.97
Hispanic	9.87	10.46	10.99	11.44	11.82	12.13	11.08
Mutiracial	10.07	10.66	11.18	11.63	12.02	12.33	11.27
Young Women							
White	9.71	9.64	9.86	10.36	11.15	12.23	9.96
Asian	7.21	7.49	8.05	8.90	10.04	11.46	8.22
Black	10.08	10.01	10.22	10.73	11.52	12.60	10.32
Hispanic	8.79	8.71	8.93	9.44	10.23	11.31	9.03
Mutiracial	9.21	9.13	9.35	9.86	10.65	11.73	9.45

* Expected values are calculated using the race/ethnic and gender group specific averages for all independent variables

NOTE: The National Center for Education Statistics requires that all sample size numbers be rounded to the nearest 10 when using restricted data.

For young men who are White, Black, Hispanic, or Multiracial, higher math GPAs are associated with higher math confidence. The math confidence of young women who are White, Black, Hispanic, or Multiracial dipped between a 3.5 and 3.6 math GPA. Then, math confidence steadily increased for young women who are White, Black, Hispanic, or Multiracial with GPAs ranging from 3.7 to 4.0.

Young men who are Asian have a dip in math confidence at a 3.6 math GPA and then math confidence gradually begins to recover when their GPA reaches 3.80 but does not surpass math confidence at 3.5 GPA until the GPA is a 4.0. In contrast, the effect of math GPA on math confidence for young women who are Asian followed a similar pattern to that of most young men. Young women who are Asian experienced a steady increase in math confidence as their math GPAs increased, but, again, their confidence was still lower than most other groups until their GPA reached 4.0.

In sum, the findings offered some support for the notion that negative cultural beliefs about gender and the model minority stereotype may have particularly challenging effects on math confidence among US high school students with As in the math courses.

CONCLUSION AND DISCUSSION

The domination of STEM disciplines by men who are White and Asian in the U.S. is attributed to factors ranging from institutional discrimination, to "chilly climates," to cultural beliefs about men's naturally superior math skills (Correll, 2001, 2004; Xie & Shauman, 2003). Our study extends the results of prior research on cultural beliefs about gender which finds that 1) cultural beliefs about math ability are associated with women's lesser math confidence compared to men's and 2) academic achievements such as good grades appear to help counter those messages (Correll, 2001). We tested whether among high math achieving students, groups who face negative cultural beliefs based on their gender, race/ethnicity, or both their gender *and* race/ethnicity have lower or higher math confidence. We also examined whether groups who face negative beliefs need higher levels of achievement to feel confident than those who face positive beliefs about their ability.

Our results lend support to the scholarship suggesting that the effects of negative cultural beliefs about gender on students' math confidence may be more difficult to overcome than negative cultural beliefs about race/ethnicity or gender *and* race/ethnicity (Bonilla-Silva, 2003; Cech, Blair-Loy, & Rogers, 2018; Charles & Bradley, 2009; Correll, 2001; DiTomoso, 2013; Messner, 2009). Prior research has offered several explanations for why this may be the case, such as social-psychological and material resources developed in the face of long-term discrimination and the "essentialized" logic of beliefs about gender. While we were unable to determine the mechanism(s) in our study, all young men with A GPAs in their high school math classes, whether they face positive or negative cultural beliefs about their math ability, had higher confidence in their math ability than all young women. Young women, whether they faced negative beliefs based on their gender or gender *and* race/ethnicity, have lower math confidence than young men. Young men, whether they face negative beliefs about their ability or not, have similar levels of math confidence.

When we examined whether the effects of math achievements on confidence vary by gender *and* race/ethnicity, we found more evidence that cultural beliefs about gender may be particularly challenging to overcome. Young women needed higher grades than men in order to experience a boost to their confidence. Most young women who faced negative beliefs about their ability due to their gender *and* race/ethnicity (i.e., Black, Hispanic, and Multiracial) did not need higher- or lower-achievements than students who face negative beliefs based on "only" their gender to increase their confidence (i.e., young women who are White). However, this is only the case for achievements that come in the form of math GPAs. Standardized test scores and math proficiency scores had the same positive effect on math confidence among young women and men of most race/ethnic groups, indicating that the effects of negative cultural beliefs about gender, race/ethnicity, and ability is decreased by certain kinds of academic achievements.

Our results also affirm the importance of disentangling the content of gendered and racialized cultural beliefs when considering their effects on math confidence and on the relationship between achievement and math confidence. Cultural beliefs about the "model minority" seem to matter for high achieving math students who are Asian. We find that young women who are Asian have lower math confidence than all other groups, even when they have the same or better math achievements. In addition, young men who are Asian and young women who are Asian benefit less from better standardized tests scores than every other group in our sample. And, finally, young men and women who are Asian are also affected differently by higher math GPAs than each other and everyone else in our sample.

Our findings also suggest that the "double burden" is affecting the math confidence of young women who are Asian who have As in their high school math classes in ways that are not affecting young women who are Black, Hispanic, or Multiracial. There are several possible reasons suggested by prior research for why this may be the case. Students who believe that knowledge is learned rather than innate tend to be less discouraged by lower achievements (Dweck, 2016). If the model minority stereotype reinforces the idea that ability is "innate" and cannot be learned, then young women who are Asian who also face the stereotype that they are not good at math due to their gender may be less confident because they are more likely than other students to believe that they cannot develop the skill. It is also possible that our sample consists of recent immigrants from societies that emphasize humility, especially for women. In our sample of students who have As in their math classes and are Asian, we find that most students are of Chinese descent (40%[3]), followed by South East Asian (20%[3]), and South Asian (20%[3]). In addition, most of the students who are Asian (70%[3]) report that English is not their native language. Finally, sociology of education research finds that students in more challenging classes tend to have lower assessments of their abilities because they are "small fish in big ponds" (Davis, 1966; Marsh, Trautwein, Ludtke, & Koller, 2008; Thijs, Verkuyten, & Helmond, 2010). Conversely, students who are surrounded by peers with lower levels of academic abilities often have higher assessments of their own abilities (i.e., "big fish in small ponds"). However, students who are Asian in our sample had more advanced math coursework compared to all other gender and race/ethnic groups (except young women who are Multiracial; see Appendix A), with a larger percentage of young men who are Asian taking more advanced coursework than young women who are Asian. Compared to young men who are Asian, the young women who are Asian went to schools with a higher percent minority composition and a higher percent with free lunches. Thus, you might expect that they would feel like big fish in small ponds, but they do not appear to. We would expect that the young men who are Asian in our sample might feel like small fish in a big pond since they appear to go to "better" schools, but they do not appear to either.

Limitations and Future Research

Our study contributes to the literature on inequality in students' math confidence: however, it nonetheless has several limitations, which we discuss below and include suggestions for future research that may address our limitations.

First, examining the intersections of gender *and* race/ethnicity using quantitative analyses is limiting for two main reasons. First, because students who have been historically marginalized due to their race/ethnicity are underrepresented in math classes, we needed to combine students into race/ethnic categories without the ability to examine the nuances in stereotypes and cultural groups within that category. For example, students who are Asian in our sample were Chinese (40%[3]), Southeast Asian (20%[3]), South Asian (20%[3]), Korean (10%[3]), Japanese (10%[3]), or Filipino (5%[3]). Although stereotypes do not tend to be nuanced, how groups respond to stereotypes based on their cultural background likely is nuanced. Unfortunately, the small number of students who are Asian, Black, Hispanic, and Multiracial did not allow us to delve further into this issue. In addition, many secondary datasets, including NELS, do not ask students about their gender identity, so we are left reifying the sex/gender binary.

Another challenge of using quantitative analyses is the difficulty of examining more than two social statuses at a time. In our study, we tested three-way interactions in order to address the intersection of gender and race/ethnicity. Taking into account disadvantaged social statuses, such as socioeconomic statuses, gender identities, sexuality, and able-bodiedness, and their interconnectedness is important for understanding cultural beliefs and their effects on math confidence. However, it will be difficult to study how gender, race/ethnicity, socioeconomic status, and other social statuses work together to affect perceptions of ability because processes pushing students out of STEM pipeline courses begin early in educational systems, leaving few students to study. Furthermore, to assess widespread patterns that take into account these important intersecting statuses using quantitative methods would require testing more than the three-way interactions we used here, which was already extremely complicated. Thus, we were unable to challenge overly-simplistic notions of stereotypes including, but not limited to, the idea that all men who are White benefit from positive cultural beliefs about their math ability.

A second limitation of this study is our focus only on high achievers, which does not allow us to test these relationships among students with Bs or lower in their math classes. Although we consider this specific focus appropriately narrow and fruitful for the present paper, we suggest that future research should also explore the results of more "ambiguous" academic achievements, such as B-level and C-level math GPAs. If students who face negative beliefs but achieve good grades and test scores have a difficult time feeling confident about their skills, what happens to students with B and C GPAs? Understanding the effects of "ambiguous" academic achievements in math is important because historically underrepresented groups with B-level and C-level GPAs may be better at math than their GPAs reflect due to teacher bias (Entwisle, Alexander, & Olson, 2007; Lavy & Sand, 2015; Leonard & Jiang, 1999). Furthermore, students with Bs and Cs in college math courses go on to successful careers in STEM disciplines, a fact of which historically underrepresented groups may not be aware because they are not as likely to be mentored and have access to informal information networks as young men who are White (Carrell, Page, & West, 2010; O'Brien, Biga, Kesslery, & Allen, 2008).

A third limitation of this study is that we focus specifically on the differential effects of gender and race/ethnicity on math confidence, but we are unable to test the process or mechanisms underlying our findings. We do not have measures of students' knowledge of and interpretation of cultural beliefs about gender, race/ethnicity, and ability. Furthermore, we did not have questions about how students experience academic achievements such as good grades. Future research could consider why measures of test scores have similar effects for most race/ethnic and gender groups with As in their high school math classes. It is possible that students view test scores as "objective" and therefore not open to interpretation. The opposite is also possible-students may think tests are measures of ability that can be outsmarted by taking test preparation courses. The test scores that we use are estimates of ability based on a battery of tests that the ELS gave respondents. Perhaps measures of students' actual test scores would lead to different effects on math confidence. Thus, understanding how students process cultural beliefs about gender, race/ethnicity and ability as well as academic achievements are an important area that we did not address in this paper.

Another limitation of our study, as mentioned in our data section, is that the gender and race/ethnicity of A-level math students who comprised our final sample were somewhat different from A-level math students who we had to exclude because they did not answer questions about the perceptions of their math ability, the dependent variable. Young women who are White or Asian and young men who are Asian, Hispanic, or Multiracial were less likely to answer the questions about their math confidence than were young men who are White and young men and women who are Black. Young women who are Hispanic were more likely than young men in their race/ethnic group to answer the questions. If these students did not answer questions about their math confidence because they lack confidence in the first place, then our analyses are under-estimates of the math confidence among A students. We would then expect that there may be even more gender and race/ethnic differences in confidence than we were able to ascertain in our models. Conversely, if those same students did not answer the math confidence questions because they were extremely confident, then we are likely overestimating the differences between young women who are Asian and everyone else. Unfortunately, we cannot be sure why the students did not answer the questions about math confidence, so we do not know if we are under- or over-estimating gender and race/ethnic differences in math confidence among students with As in their high school math courses.

Finally, the data from our study is over a decade old and recent educational reforms may have had an equalizing effect on the math confidence of recent cohorts. To our knowledge, scholars, especially those who study math confidence in the U.S., report that the gender gaps in math confidence persists (e.g., Dweck, 2016; Ganley & Lubienski, 2016) as do cultural beliefs that denigrate the math ability of groups historically marginalized based on their gender and/or race/ethnicity (Charles & Bradley, 2009; Miller, Eagly, & Linn, 2014; Project Implicit). Many of these findings are based on longitudinal datasets, similar to the one we use in our study, and tend to be based on earlier cohorts of middle and high school students. Our understanding of these relationships would benefit from the inclusion of math achievement and math confidence-related questions in large-scale, nationally representative datasets, such as the General Social Survey (GSS) in the U.S.

Implications

While confidence is not enough to overcome the complex puzzle of processes leading to gender and race/ethnic segregation in STEM fields, jobs, and career paths, examining gender and race/ethnic differences in young people's math confidence as well as what types of achievements increase and decrease math confidence is important. Several researchers point to the link between math skills and career-relevant experiences (Baird, 2012; Correll, 2001; Riegle-Crumb & Grodsky, 2010; Riegle-Crumb & King, 2010). If even young women who are high math achievers fall prey to negative cultural beliefs about their own ability when assessing their achievements, then we are losing valuable talent. Our results lend further support to the difficulty of overcoming negative cultural beliefs about one's ability- particularly cultural beliefs about gender and the "model minority."

To change cultural beliefs, policies, procedures, and best practices compiled through projects like the U.S.'s National Science Foundation (NSF) ADVANCE grants need to be implemented and enforced at pre-college and college levels as well as in workplaces. Dweck's (2016) research finds that emphasizing math and science ability as a learnable skill rather than as an innate, unchangeable trait positively affects a wide variety of math and science career-relevant outcomes. There is also some evidence that pre-college programs that provide hands-on learning opportunities, role models, mentoring, and internships increases math self-confidence (Clewell & Campbell, 2002; Campbell & Steinbrueck, 1996; Clewell, et al., 2000). In general, it appears that a constellation of supports across entities, such as parents, teachers, guidance counselors, and after-school programs is needed to overcome negative cultural beliefs about math ability (NRC, 2015). In addition, collecting data at one's educational institution or workplace, holding leaders accountable to increasing the inclusion of historically underrepresented groups, and developing and implementing policies and practices that mitigate the effects of cultural beliefs on educational and work outcomes are all important steps to take (see for review: Baird, 2018). By focusing on students who are achieving in their math classes, our study highlights the valuable talent we may lose to rigid and inaccurate cultural beliefs about the inferior math skill of historically marginalized groups.

ENDNOTES

1. We use the term "race/ethnicity" throughout the paper because cultural beliefs about gender, race/ethnicity, and ability in the U.S. conflate skin color and shared cultural experiences and behavior. We also use "historically underrepresented", and "historically marginalized groups" to reduce repetition for the reader, but we are referring to the NSF definition of groups who are underrepresented in STEM in the U.S.- women who are White, Black, and Hispanic, and Native American and men who are Black and Hispanic. NSF also includes men and women who are Native American, but all students in our sample who are Native American are Multiracial, see endnote 2.
2. Our dummy variable for students who are Asian and not Hispanic include students who are Chinese (40%[3]), Southeast Asian (20%[3]), South Asian (20%[3]), Korean (10%[3]), Japanese (10%[3]), and Filipino (5%[3]). The dummy variable for students who are Black includes students who are African American or Black or not Hispanic. Students who are in the Hispanic category could have either specified a race or not. In analyses not shown, we determined there were no significant differences between the experiences of students who are Hispanic and specified a race and students who are Hispanic and did not specify a race in terms of math confidence or any of the covariates, so we combined the category in line with prior research. This dummy variable includes students who are Mexican or Mexican-American (80%[3]), Central American (10%[3]), Puerto Rican (10%[3]), South American (10%[3]), Cuban (10%[3]), and Dominican (<10%[3]). Finally, the dummy variable for students who are Multiracial include students who are White and Asian (50%[3]); White and Native American (30%[3]); White, Asian, and Pacific Islander (10%[3]); Asian and Pacific Islander (10%[3]); Black and Asian (<10%[3]); Black and Native American (<10%[3]); and White, Asian, and Native American (<10%[3]).
3. The National Center for Education Statistics requires that all sample size numbers be rounded to the nearest 10 when using restricted data. To be extra cautious percentages of race/ethnic groups have also been rounded to the nearest 10.

ACKNOWLEDGEMENTS
The authors would like to thank Anastasia Prokos and the anonymous reviewers for their helpful comments on previous drafts of this paper.

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