

The Development of Math–Race Stereotypes: “They Say Chinese People Are the Best at Math”

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Sixty elementary-school children (9–10 years old) and 82 adolescents (12–13 years old) completed explicit and implicit measures of racial stereotypes about math. 60 Asian, 42 Latino, 21 White, 15 Black, and four multiracial students participated (42% boys). On the explicit measure, children as early as fifth grade reported being aware of the stereotype that *Asians = math*, but only adolescents personally endorsed this stereotype. On the implicit measure, there was significant evidence for racial stereotypes about math among adolescents. Across both ages, individual students' explicit awareness of the stereotype was significantly correlated with their implicit stereotypes. Early adolescence is a key developmental window for discussing stereotypes before they become endorsed as personal beliefs.

Racial stereotypes are prevalent in the United States (Bobo, 2001). Racial stereotypes about intelligence and academics are particularly important to investigate, because they can have detrimental effects on students from stereotyped groups (Steele, 1997). Stereotype threat research has shown that when children are reminded of a negatively stereotyped identity, members of the stereotyped group perform worse on achievement tests than they do when the stereotypes are not activated (Schmader, Johns, & Forbes, 2008).

Children are sensitive to academic stereotypes as early as second grade (Cvencek, Meltzoff, & Greenwald, 2011), but their awareness of stereotypes increases by early adolescence (McKown & Strambler, 2009). Some of the most studied academic stereotypes in childhood and adolescence pertain to African Americans and Latinos, who are stereotypically portrayed as “caring less about school” or as being “less intelligent” (Okeke, Howard, Kurtz-Costes, & Rowley, 2009) than their White and Asian counterparts. The range of pernicious racial

stereotypes that have been documented runs from openly negative characterizations to more unintentional biases (Sue et al., 2007), which nevertheless may constrict children's aspirations and shape future academic goals and identities (Spencer & Markstrom-Adams, 1990; Way, Hernández, Rogers, & Hughes, 2013).

In addition to negative stereotypes about social groups, there are also “positive stereotypes.” For example, one pervasive American stereotype is that Asians are a “model minority” (Petersen, 1966)—diligent, hardworking, and excellent in school, particularly math. Even such seemingly positive stereotypes can have deleterious effects (Ng, Lee, & Pak, 2007). In an ethnographic study of Asian American highschool students, Lee (1994) found that the model minority stereotype led to shame and negative self-image among some students who felt they did not live up to the stereotypes. Moreover, because the positive stereotypes about Asians are often interpreted to be relational, many students take them to imply that other groups, such as African Americans, are *not* good at math (Nasir & Shah, 2011). Racial stereotypes about mathematics are particularly relevant in contemporary American society because the United States ranks poorly on the international tests of math proficiency (Organisation for Economic Co-operation &

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Development, 2011) and societal stereotypes may, in part, contribute to this poor performance (Nosek et al., 2009).

Developmental studies have highlighted early adolescence as a time when racial stereotypes become increasingly more salient and personally meaningful for students (Black-Gutman & Hickson, 1996). This may be due to cognitive changes as well as heightened social sensitivity to issues of identity and “belonging” (Aboud, 2003; Master, Cheryan, & Meltzoff, forthcoming). During early adolescence, children increasingly focus on multiple identities relating to the social groups to which they belong (e.g., racial, ethnic, social class; Nesdale, 2001). Although we know that adolescents are knowledgeable about racial stereotypes in general, there is a gap in the literature about the changes in children’s racial stereotypes concerning specific academic domains, such as mathematics as they transition into adolescence. What are children’s beliefs about “who does math”?

Stereotype Awareness Versus Stereotype Endorsement

A distinction can be made between students’ *awareness* (or knowledge) of cultural stereotypes and their *endorsement* (or personal beliefs) (Devine, 1989). Do children first become aware of the stereotypes shared by the culture and subsequently internalize and endorse them as their own personal beliefs? Or do children first develop personal beliefs about different racial groups based on their own encounters with classmates, and only then become aware that these stereotypes are widely shared cultural beliefs? In the current research, we sought to test for the age differences in awareness and endorsement of math–race stereotypes by taking measures of both in the same children.

Explicit Versus Implicit Stereotypes

Psychological research often distinguishes between controlled and conscious processes and more automatic and unconscious processes (Jacoby, 1991), and social psychologists have designed both *explicit* and *implicit* measures to tap people’s beliefs and attitudes toward social groups (e.g., Greenwald & Banaji, 1995). In explicit measures, the participant is asked to provide deliberate reflections and verbal self-reports about what is being assessed; in implicit measures, the participant is often not informed about what is being assessed,

and no verbal report, justification, or purposive introspection is called for. For sensitive social beliefs, such as racial stereotypes, implicit measures have sometimes been shown to be *more* predictive of actual behavior than explicit measures (e.g., Greenwald, Poehlman, Uhlmann, & Banaji, 2009). For gender stereotypes about math, implicit measures have been shown to add predictive power beyond explicit measures for behaviors such as students’ math grades and math-class enrollment (Steffens, Jelenec, & Noack, 2010). Building on these findings, we reasoned that a multimethod approach using both explicit and implicit measures could help capture nuanced aspects of race stereotypes about mathematical ability. Toward this end, we measured beliefs that are conscious and available to introspection (*explicit* measures of awareness and endorsement gathered through questionnaires) and also took a third measure, this one of beliefs that are unconscious and less available to introspection (*implicit* measure). In principle, these constructs are differentiable, and it is of interest how they may relate to one another and how each changes with development.

Study Aims

The current study focuses on whether or not elementary and middle school students hold *racial stereotypes about who can be good at math*, particularly the *Asian = math* stereotype. The current study adds to existing research in three ways. First, we measure math–race stereotypes using *both* implicit and explicit stereotype measures with the *same* children. Second, we examine whether elementary and middle school students are explicitly aware of the particular academic race stereotype that Asians are good at math and compare that to their personal endorsement of these particular racial stereotypes. Third, we test for age differences: To what degree are there differences in the awareness and personal endorsement of the math–race stereotype between middle school adolescents and elementary school children?

METHOD

Participants

Participants were recruited by researchers who visited two participating schools (one elementary school and one middle school serving Grades 6–8). All students were told about the study and given consent forms for signature by parents or guard-

ians. At the elementary school, 93 students were given consent forms, 64 consented, nine students declined participation, and 20 students did not return any forms. Of the 64 consented students, four were absent on the testing days. At the middle school, 116 students were given consent forms, 89 students consented, 15 declined, and 12 students did not return any forms. Of the 89 consented students, seven were absent on the testing days.

The study took place in two school sites in the same neighborhood in a mid-sized city in northern California. Sixty elementary-school students (fourth and fifth grade students) and 82 adolescents (seventh and eighth grade students) participated during their math class. The sample sizes, gender, and race breakdown for the test sample are presented in Table 1. The mean ages, in years, for children attending each of the four school grades were as follows: Grade 4, $M = 9.58$ years ($SD = 0.50$); Grade 5, $M = 10.65$ years ($SD = 0.49$); Grade 7, $M = 12.39$ years ($SD = 0.49$); and Grade 8, $M = 13.41$ years ($SD = 0.50$).

TABLE 1
Participant's Grade, Race, and Sex

Participant's Race	Participant's Grade				Total
	Grade 4	Grade 5	Grade 7	Grade 8	
Asian					
Participant's sex					
Girl	7	7	6	10	30
Boy	11	6	7	6	30
Total	18	13	13	16	60
Latino					
Participant's sex					
Girl	9	6	14	1	30
Boy	3	1	7	1	12
Total	12	7	21	2	42
White					
Participant's sex					
Girl	1	0	9	1	11
Boy	0	2	7	1	10
Total	1	2	16	2	21
Black					
Participant's sex					
Girl	3	0	5	2	10
Boy	0	2	1	2	5
Total	3	2	6	4	15
Multiracial					
Participant's sex					
Girl	1	0	1	0	2
Boy	1	0	1	0	2
Total	2	0	2	0	4
Total					142

Procedures for Questionnaire Measures (Explicit Measures)

Questionnaires were administered during students' math classes. Students were told that their answers would be confidential and that they could skip questions they did not wish to answer. The questionnaire took approximately 20–30 min to complete.

To measure students' awareness and endorsement of cultural stereotypes about race and math, we used Augoustinos and Rosewarne's (2001) procedure to help students differentiate between their perception of others' opinions and their own personally endorsed opinion. The awareness and endorsement measures consisted of two items each about math. For the awareness measure, the two items included in the analyses were: "I think most people in America believe that most Asian people are ____" and "I think most people in America believe that most White people are ____." For the endorsement measure, the two items included in the analyses were: "In my opinion, most Asian people are ____" and "In my opinion, most White people are ____." Students were instructed to circle the number corresponding to their answer, using a 5-point Likert scale that ranged from *very bad at math* to *very good at math*.

Procedures for Implicit Association Test (Implicit Measure)

For the implicit measure of math–race stereotypes, we adapted a social psychology instrument used with adults, the Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998). Our adaptation was closely modeled after the Child IAT procedures previously reported by Cvencek et al. (2011).

The IAT is based on the principle that it is easier to give the same response to items that are associated than if they are not. Children with the math stereotype (i.e., *Asians = math*) should find it easier to respond when *Asian* faces and *math* words are paired together (i.e., *stereotype congruent* task) than when *White* faces and *math* words are paired together (i.e., *stereotype incongruent* task). The IAT procedure also requires a contrast case, and in this study children classified the faces representing *Asian* and *White* races and words representing both *math* (e.g., addition, graph) and *reading* (e.g., books, story). The reason for this choice is that Asians and Whites have historically had the highest average SAT-Math scores (Snyder & Dillow, 2012), and

therefore this presents a fine-grained and conservative test of the societal stereotype—one that distinguishes between two groups that are both stereotyped as doing well in school and well in mathematics. In addition, reading is a natural contrast to math because: (1) reading and math education are mandated from the first grade on and (2) standardized tests across many countries have reading and math portions.

In our IAT scoring, positive scores indicated stronger association of *math* with *Asian* than with *White*; this was captured by the *D*-score (Greenwald, Nosek, & Banaji, 2003), which quantifies the strength and direction of the association. The researcher administered the IAT measures in a separate room outside of the main classroom. Students were tested in groups of four on school laptops. The administration of the IAT measure took 15 min. For more details about the Child IAT procedure, see Cvencek et al. (2011) and Cvencek, Meltzoff, and Kapur (2014).

RESULTS

Preliminary analyses examined the main effects and interactions of gender and ethnicity on the dependent measures of stereotype awareness, endorsement, and IAT scores. The main conclusion from these preliminary analyses was that these factors did not significantly influence the dependent measures, nor were there any interactions between them (all $ps > .26$), which allowed collapsing across gender and ethnicity for the remainder of the analyses.

Stereotype About Asians' Mathematical Ability

Explicit math-race stereotype questionnaire data. The results indicated that, collapsed across all four school grades, students were both aware of and endorsed the stereotype that Asians are better at math than Whites. More specifically, across all grades, the *awareness* ratings about the math ability of Asians ($M = 4.50$, $SD = 0.83$) were significantly higher than the awareness ratings about the math ability of Whites ($M = 4.04$, $SD = 0.98$), $t(140) = 4.57$, $p < .001$, $d = .50$. Similarly, the *endorsement* of the belief that Asians are good at math ($M = 4.58$, $SD = 0.72$) was significantly higher than the endorsement of the belief that Whites are good at math ($M = 4.04$, $SD = 0.90$), $t(138) = 6.09$, $p < .001$, $d = .66$. Broken down more finely, for the adolescents the awareness and endorsement measures each showed a significant effect for the

Asians = math stereotype ($ps < .001$); for the elementary-school children, the corresponding effects were $p = .07$ for awareness and nonsignificant ($p > .34$) for the personal endorsement measure (possible developmental changes are discussed below).

Implicit math-race stereotype IAT data. As is customary both in adult and child data, noise in the IAT data was reduced by excluding participants who were identified as outliers on the basis of preestablished criteria (e.g., Cvencek et al., 2011). These criteria excluded 20 (14%) of the participants, leaving $n = 122$ participants for statistical analysis. The IAT results show that, across all four school grades, children manifest significant racial stereotypes linking *Asians* with *math* ($M = 0.09$, $SD = 0.43$), $t(121) = 2.19$, $p = .03$, $d = .21$. These results mean that children associated math more strongly with Asians than with Whites—evidence for the implicit Asian-math race stereotype.

Relationship Between Explicit and Implicit Math-Race Stereotype Measures

To examine the relationship between the participants' explicit verbal report (awareness and endorsement) and their implicit cognition as measured nonverbally (IAT), we transformed the four explicit questions to two difference scores, so they could be directly compared to the IAT *D*-score. For each of the two explicit measures (awareness and endorsement), the scores on the "White" item were subtracted from the scores on the "Asian" item. Thus, positive values for the awareness difference score indicated the awareness of a cultural stereotype that Asians are better at math than Whites. Similarly, positive values for the endorsement difference score indicated the personal endorsement of a stereotype that Asians are better at math than Whites. Children's implicit stereotype scores are already expressed as a difference score—the *D*-score, which captures the direction and strength of the difference (Greenwald et al., 2003). The sample included in this analysis comparing the explicit to implicit measures at the individual participant level encompassed $n = 95$ children, who had data for the implicit measure as well as the two explicit measures. The participants' explicit awareness and endorsement measures were correlated with each other, $r(95) = .48$, $p < .001$. The participants' IAT scores were significantly correlated with their explicit awareness, $r(95) = .30$, $p = .004$, but not with their personal endorsement, $r(95) = .16$, $p = .13$.

Age Differences in Explicit and Implicit Math–Race Stereotypes

Table 2 presents the means for the students' awareness and endorsement of the math–race stereotype as a function of school grade. A repeated-measures ANOVA was conducted with school grade as a between-subject factor and the four explicit measure types (i.e., awareness of the stereotype that Asians are good at math, awareness of the stereotype that Whites are good at math, endorsement of the stereotype that Asians are good at math, and endorsement of the stereotype that Whites are good at math) as within-subject measures. The main effect of the school grade was statistically significant, $F(3, 134) = 2.64, p = .05$. The interaction between school grade and explicit measure type was also statistically significant, $F(3, 134) = 8.28, p < .001$. Post hoc t -tests using the Bonferroni correction indicated that children's awareness of stereotypes about Asians' math ability was significantly stronger in Grade 8 than in Grades 4, 5, and 7 (all $ts > 2.36, ps < .021, ds > .57$). Children's endorsement of stereotypes about Asians' math ability was significantly stronger in Grade 7 and Grade 8 than in Grade 5 ($ts > 2.93, ps < .005, ds > .85$). Children's endorsement of stereotypes about Whites' math ability was significantly weaker in Grade 8 than in Grades 4, 5, and 7 ($ts > 2.43, ps < .019, ds > .72$).

We can also compare the explicit measures (stereotype awareness and endorsement) concerning the Asians versus Whites directly to one another. Comparing the mean awareness scores for Asians and Whites revealed that the awareness of the Asian–math stereotype was significantly higher

than the awareness of the White–math stereotype in Grades 5, 7, and 8 ($ts > 2.08, ps < .043, ds > .40$), but not in Grade 4 ($p > .45$). Comparing the mean personal endorsement scores toward Asians and Whites revealed that the endorsement of the Asian–math stereotype was significantly higher than the endorsement for White–math stereotype in Grades 7 and 8 ($ts > 4.78, ps < .001, ds > .80$), but not in Grades 4 and 5 ($ps > .47$).

The implicit measure also supported this general pattern as a function of age. A one-way ANOVA was conducted with school grade as a between-subject factor and the IAT score as a dependent measure. The main effect of the school grade was statistically significant, $F(3, 118) = 3.81, p = .012$. Post hoc t -tests using the Bonferroni correction indicated that children in Grades 7 and 8 associated *Asian* with *math* more strongly than children in Grade 5 did ($ts > 2.36, ps < .022, ds > .68$). The implicit stereotype was significantly different from zero in Grade 8 ($t = 3.94, p = .001, d = .86$), but not significantly different from 0 in Grades 4, 5, or 7 (all $ps > .08$). (The Grade 5 data were in the negative direction, thus suggesting a slightly weaker implicit association of *Asian* with *math* than *White* with *math*.)

DISCUSSION

We investigated the pervasive American racial stereotype that Asians are good at math. We employed both explicit and implicit measures within the same study. Three chief findings emerged. First, on the explicit measure of stereotype awareness, both elementary students as early as fifth grade as well as adolescents demonstrated

TABLE 2
Results for the Explicit and Implicit Stereotype Measures by School Grade

Measure	Fourth Grade		Fifth Grade		Seventh Grade		Eighth Grade	
	M	SD	M	SD	M	SD	M	SD
Explicit awareness								
"Asians are good at math"	4.28 _a	0.97	4.25 _b	0.79	4.54 _c	0.85	4.96 _{abc}	0.20
"Whites are good at math"	4.17	0.97	3.92	0.88	4.12	1.08	3.75	0.79
Explicit endorsement								
"Asians are good at math"	4.54	0.82	4.13 _{ab}	0.85	4.71 _a	0.56	4.75 _b	0.61
"Whites are good at math"	4.39 _a	0.84	3.95 _b	0.84	4.09 _c	0.94	3.42 _{abc}	0.65
Implicit stereotype								
Asian = math association	0.07	0.45	−0.15 _{ab}	0.33	0.13 _a	0.43	0.32 _b	0.37

Note. Means in a row sharing a subscript are significantly different from each other. For the awareness and endorsement measures, the scores range from +1 to +5, with higher scores indicating a stronger awareness/endorsement of the stereotype that the racial group is "very good at math." For the Child IAT measure, the scores range between −2 and +2, with positive scores indicating a stronger Asian = math association.

the awareness of the racial stereotype that *Asians = math*. Second, on the explicit measure of endorsement, only the adolescents personally endorsed the *Asian = math* linkage. Third, the IAT measure of implicit cognition revealed that adolescents associated *Asian = math* at a nonverbal level that lies below conscious awareness and deliberation. Interestingly, the IAT-measured stereotypes were significantly related to students' awareness of the stereotypes as being "in the air" (Steele, 1997), but not their explicit personal endorsement of this stereotype. Taken together, the results suggest that as students transition into adolescence, they become more aware of stereotypes about Asian and math in our society and are more likely to internalize them as their personal beliefs.

Students' explicit awareness and endorsement of stereotypes about Asians and math were stronger in adolescence than in elementary school. Why? One possibility is that, as students become older, they are increasingly exposed to cultural stereotypes and that such exposure engenders not only awareness but also endorsement. Another possibility is that with age children may observe (or hear about) links between race and school grades or test scores: On average, in the U.S. samples, Asian students outperform others in the domain of mathematics (Snyder & Dillow, 2012), which is exacerbated and made more salient by tracking practices in schools (Eccles & Roeser, 2011). At the same time, it is also known that stereotype formation is not an irresistible processes and that some individual children actively challenge the cultural stereotypes using success in school as a form of "resistance" to stereotypes about their social groups (McGee & Martin, 2011; Way et al., 2013). The stronger stereotype awareness and endorsement in adolescents than in elementary school children may also reflect cognitive-developmental changes in how adolescents interpret and introspectively reason about the social world. While younger children may be more egalitarian with regard to academic achievement of racial groups, older children may revise and begin to crystallize their beliefs and attitudes about racial groups (see Quintana, 1994).

The implicit measure provides converging evidence for age-related differences in race stereotypes about math. On the surface, the observed age changes in implicit stereotypes may not seem to fit with previous work which suggested that certain race attitudes pertaining to in-groups form relatively early and remain stable over childhood (Dunham, Chen, & Banaji, 2013). However, we here reported age differences in implicit beliefs about "who does

math." We would underscore the distinction between race *stereotypes* and race *attitudes* (e.g., Greenwald & Banaji, 1995). Stereotypes involve beliefs about social groups (e.g., social group *x* is high-achieving in math), whereas attitudes involve valenced evaluations of or feelings about social groups (e.g., social group *x* is more likeable or preferred by me). Academic stereotypes and other beliefs about race may develop gradually and be especially susceptible to change and designed interventions. Given the relative nature of the IAT measures, a positive IAT score could also be interpreted as a stronger association of Whites with reading than Asians with reading. To begin to address this alternative explanation, future IAT research could take into account and control for explicit beliefs about Whites' and Asians' reading ability.

The current study suggests that issues of race and achievement are salient for adolescents. Supporting their salience, we found that stereotypes about the academic competence of Asian students did not significantly vary across the racial groups in our sample (see the preliminary statistical analyses in the Results). Indeed, the title of our study derives from a conversation with a seventh grade Latina female participant in this study, who said (verbatim): "They say that, like I said again, Chinese are the best at math. Or Asian. Or Filipinos."

Early adolescence may be a key developmental window in which to support students in discussing and dissecting the origins, causes, and consequences of pervasive cultural stereotypes. Previous work with middle-school girls has shown that mentoring students about cognitive malleability positively influences standardized math test scores (Good, Aronson, & Inzlicht, 2003). Taking this one step further, it would seem possible to mentor students about the pernicious nature of cultural stereotypes about "who does math" and how—even though such beliefs exist on a societal level—they themselves as individual learners, need not personally subscribe to such stereotypes or apply stereotypes to themselves. One could also highlight the potential deleterious effect that even seemingly "positive" stereotypes may have on *other* children. Stereotypes are often relational, and a stereotype highlighting one group as being "good at math" or "good at school" may indirectly imply that another group is not. Promoting a more continuous interpretation of people's skills significantly affects children's thinking and behavior, suggesting theoretically driven intervention strategies (Cohen, Garcia, Apfel, & Master, 2006).

Our data call attention to individual variations in children's implicit and explicit stereotypes and their change over time. It would now be interesting to test whether children develop these racial stereotypes within a tightly defined age period, or whether there are different developmental paths for children from different racial and ethnic groups, school settings, and experiential backgrounds. In addition, for both theoretical and applied reasons, it will be important to explore the relation between these academic stereotypes and actual academic performance.

We know from the stereotype threat literature (Steele, 1997) that stereotypes do not have to be personally endorsed (or even consciously available) in order to affect individuals from the targeted group—negative stereotypes only need be activated (Schmader et al., 2008). With respect to stereotypes about Asians' math ability, research has shown that, even among White undergraduate students who are otherwise high achieving in math, the activation of *Asian = math* stereotypes can undermine their math achievement when a math test is said to assess "whether Asians are superior at all types of math problems or only certain types" (Aronson et al., 1999). The current study provides insights into the early development of implicit and explicit racial stereotypes about academic domains, and more multimethod studies will permit the assessment of children's developing racial stereotypes in a richer and more nuanced fashion.

CONCLUSIONS

The present research demonstrates stereotypes about the academic competence of Asian students using both explicit and implicit measures and suggests the salience of these stereotypes to children in a diverse school setting. In addition, the results show that—relative to elementary school children—adolescents are more aware of stereotypes about Asians and math in American society and more likely to internalize them and endorse them as their personal beliefs. Future studies will profit from multimethod approaches using a diverse array of measurement tools (Meltzoff, Kuhl, Movellan, & Sejnowski, 2009) to advance our knowledge about the mechanisms, developmental timeline, and personal experiences surrounding racial stereotypes in children.

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