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# The Myth That Only Brilliant People Are Good at Math and Its Implications for Diversity

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**Abstract:** A common misconception about math is that it requires raw intellectual talent or "brilliance." Only students who possess this sort of brilliance are assumed to be capable of success in math-related subjects. This harmful myth has far-reaching consequences for the success of girls and children from ethnic-minority backgrounds in these subjects. Because women and minorities are stereotyped as lacking brilliance, the myth that success in math requires this trait is a barrier that students from these groups have to overcome. In the first part of this paper, we detail the pervasiveness of this myth and explore its relation to gender and race gaps in math and beyond. In the second part, we highlight some potential sources of this myth in children's everyday experiences and offer some strategies for debunking it.

**Keywords:** brilliance; giftedness; stereotypes; gender gaps; race gaps; mindsets

## 1. Introduction

Many people seem to believe that, with respect to mathematics, the world consists of two groups: those who are "math people" and those who are not [1,2]. Underlying the very idea of a "math person" is the more fundamental notion that doing mathematics requires some sort of innate quality—a spark of brilliance or a "gift" whose presence determines whether someone is a math person or not. This is a myth: with suitable effort and strategies, as well as appropriate instructional guidance, every school student can become proficient in mathematics [3–6]. There is simply no magic spark that ensures success. While most myths are harmless, the myth that only brilliant people can do math is not. Brilliance is stereotypically associated with some groups more than others in our society (e.g., men more than women; white people more than black people) [7,8], which in turn leads to the assumption that some are more likely to be "math people" than others. In this way, the myth that math is for brilliant people acts as a barrier to math success in school (and, later, to participation in math-intensive careers) for students from groups who are not perceived to be brilliant.

In what follows, we document the myth that math is for brilliant people and examine its consequences for girls and minority children in math and related subjects. We also highlight some potential sources of this myth in children's everyday experiences and conclude by suggesting strategies that parents and educators could use to prevent this myth from stifling young people's aspirations.

## 2. The Myth that Math Requires Brilliance

What people believe is necessary for success varies across subjects. While hard work and dedication are thought to matter across the board, in some subjects this is not considered enough: a student must also have a certain degree of raw talent or brilliance [9] (for a review, see [10]). Whether a student possesses such brilliance is thought to be a matter of genes and heredity, and thus identifiable

at a very young age [11,12]. This is the logic of the "gifted and talented" programs that are so common in elementary schools in the United States and beyond. The mission of these programs is to "discover" the brilliant elementary school students from among their non-brilliant peers and cultivate their superior aptitude. In this paper, we use the terms "brilliance" and "giftedness" interchangeably to refer to the exceptional quality that members of our culture believe some children are born with and that is thought to be required for success in some subjects more than others.

What is the evidence that success in mathematics is believed to require a special gift? In a recent survey asking roughly 1800 academics what they believed was necessary for success in their fields, Leslie, Cimpian, Meyer, and Freeland [9] found that mathematics was actually one of the fields that valued brilliance the most (see Table S4 in [9]). The general public shares this opinion [13]. When non-academics were asked what they believed would lead to success in a variety of fields, they also attributed math success to a special gift that cannot be taught (see [14] for similar evidence with college students).

Although it is unclear why this myth exists, it may stem in part from common intuitions about what "doing math" entails. Some parents and teachers, for instance, might believe that math involves complex mental operations that only some students can accomplish. They might view math as so difficult, abstract and specialized that those who succeed in school must have the "right brain" for it [2,15,16]. This idea is unfounded. There is no special "gift" necessary to learn math in school. Rather, there is substantial evidence that success in school math is attainable for every student, given the right training and beliefs about ability [3,5,6,17]. We discuss this further in Section 4 below, where we also detail specific steps that parents and teachers can take to dispel the myth that math is only for brilliant people.

## 3. Consequences of the 'Math Requires Brilliance' Myth

If people believe that success in math requires brilliance, the natural question that follows is: who is perceived to be brilliant? Unfortunately, pervasive cultural stereotypes portray brilliance as a quality that is more common in white men than in women or minorities. For example, Fennema, Peterson, Carpenter, and Lubinski [18] surveyed first-grade teachers and found that they tended to attribute their female students' success to hard work (see also [19–23]). In contrast, when male students succeeded, they were viewed as especially gifted. Similarly, people often believe that any success that racial/ethnic minorities might achieve is less a function of an innate ability, and more likely due to factors such as institutional supports or extra personal effort [24].

In contexts where giftedness is emphasized, such as in the mathematics classroom or in mathematics-intensive subjects, the cultural association of this trait with white males poses an obstacle for students from other groups. In fact, these two beliefs—the myth that brilliance is required for success in mathematics and the stereotype that women and people of color lack this brilliance—have already been linked to racial and gender gaps. For instance, Leslie, Cimpian, et al. [9] found that the more that academics in a particular field considered brilliance important for success, the less likely their field was to have a strong representation of female and African-American PhD graduates. This was true not only for math and natural science fields, but for fields in the social sciences and humanities as well. Critically, field-level beliefs about brilliance predicted women's and African-Americans' representation above and beyond factors such as the number of hours per week people in that field typically spent working, on or off campus (i.e., factors relating to work–life balance), or the actual achievements of applicants to the field (as measured by the Graduate Record Examination [GRE]; [25]). Storage, Horne, Cimpian, and Leslie [14] replicated this finding using a more naturalistic measure of a field's beliefs: the frequency with which students use the words "brilliant" or "genius" to describe their professors on RateMyProfessors.com, a website that allows students to review their professors anonymously. Here, as usage of the words "brilliant" and "genius" in a field's course reviews increased, the representation of female and African-American PhD students in the field decreased. Again, usage

of these words predicted representation above and beyond variables such as a field's work–life balance or its applicants' actual intellectual skills.

How might this brilliance myth impede the success of women and minorities in mathematics and related fields? One possibility is that these beliefs cause people in positions of authority (e.g., teachers, professors, employers) to be biased against members of these stereotyped groups [26,27]. Even when John and Jennifer have identical grades in math, for instance, a teacher might consider John to be more talented and capable than Jennifer [22], which may in turn lead the teacher to favor John over Jennifer by providing more detailed feedback, more opportunities for enrichment, and so on [27]. Another possibility is that the brilliance myth affects women's and minorities' own interest in math-related activities. Support for this hypothesis is provided by Bian, Leslie, Murphy, and Cimpian [11]. In their experiments, participants were presented with a variety of hypothetical professional and educational opportunities. Critically, across participants, the descriptions of the opportunities emphasized that either brilliance or dedication would lead to success. If women are discouraged by messages about brilliance, then they should be less interested in the brilliance-focused than the dedication-focused opportunities. This is precisely what Bian et al. found: women, but not men, were less interested in the opportunity when it focused on brilliance rather than dedication. Brilliance language undermined women's interest in part by increasing their anxiety and decreasing their anticipated sense of belonging.

In summary, rather than being innocuous, the myth that only brilliant people do well in mathematics seems to have significant consequences for the educational and professional trajectories of students stereotyped as lacking this trait.

## 4. Where Do the Stereotypes about Intellectual Ability Come From?

Because the "math requires brilliance" myth acts in tandem with gender and race stereotypes about brilliance, we go on to consider these stereotypes, focusing in particular on their acquisition. When do children start associating brilliance with men, and when does this stereotype begin to shape their career aspirations? Gender stereotypes about brilliance and mathematics emerge remarkably early [7,28]. When asked to identify a "really, really smart" person, for instance, five-year-old girls and boys will both typically choose people of their own gender. By age six, however, girls begin to disassociate their gender with intelligence [7]. These stereotypes are also present in young children's interests: while five-year-old girls and boys show equal interest in a game for "really, really smart children", six- and seven-year-old girls are less interested than boys in such a game [7]. Given young children's limited experiences in the world, where could these stereotypes come from?

Language is one powerful way that parents might inadvertently communicate to their children that men, and not women, are brilliant. This could happen explicitly—parents may describe more male than female characters in books and movies as smart, or they may call their sons geniuses more often than they do their daughters. Some evidence supporting this possibility is provided by Storage et al. [14]: in their analyses of anonymous reviews on RateMyProfessors.com, they found that students were twice as likely to call male rather than female professors "brilliant", and three times as likely to call male rather than female professors "geniuses." But is there evidence that children are exposed to these biased beliefs? In a recent article in the *New York Times*, Stephens-Davidowitz [29] reported that parents are about twice as likely to Google the question "Is my son a genius?" than the question "Is my daughter a genius?" These are not just private expectations that parents reveal to Google; rather, they very likely shape the way parents (and other adults as well) interact with their children daily, even if they do not realize it. Since children are incredibly adept at tracking statistical regularities [30] and subtle social cues [31], a parent or teacher who shows similar gender bias in their interactions with children (e.g., when teaching children about famous scientists and mathematicians, or when praising their male and female students) could easily influence children's beliefs about who is gifted.

There are also subtle, more implicit ways that parents' language use could encourage the development of brilliance stereotypes. In many expressions of social comparison, for example, one group is framed as the standard for the other. In the statement "Girls are as good as boys

at math," boys are framed as the standard, and in the statement "Boys are as good as girls at math," girls are framed as the standard [32–34]. Note, however, that people rarely say "Boys are as good as girls at math" [35,36]. This is because people do not typically think of girls as setting the standard for math ability. Thus, even though these well-intentioned statements explicitly express similarity—it is not immediately apparent that "Girls are as good as boys" and "Boys are as good as girls" should have different meanings—latent in their structure is the idea that one group is nevertheless better. Importantly, in addition to *reflecting* beliefs about relative ability, these kinds of statements can also *perpetuate* such beliefs. Chestnut [36] recently showed, for instance, that upon reading sentences about non-stereotyped activities such as "Girls are as good as boys at snapping," both children and adults inferred that the gender framed as the standard (here, boys) was not only typically better at the activity, but naturally better, even though the activity was not associated with any pre-existing stereotypes. Consistently framing boys as the standard for girls—even when the statement is intended to be egalitarian—could thus actually teach children that boys have more raw talent.

Another seemingly productive behavior that can shape children's beliefs about their own ability is unsolicited or "intrusive" aid [37–39] (for a review, see [40]). The idea is that when an adult offers help to a child who has not asked for it, the child might infer that the adult has low expectations for them. As a result, the child might doubt their own competence. Although unsolicited aid could be equally problematic for both girls' and boys' confidence, Bhanot and Jovanovic [37] found that parents with strong math-gender stereotypes were more likely to provide unsolicited help on math problems to girls rather than boys. The authors also showed that girls who received this unsolicited support were more likely to underestimate their math ability. Parents' and teachers' tendency to offer help to girls in math classes, though well intentioned, could thus backfire and cause girls to believe that they do not have what it takes to succeed.

## 5. What Can We Do to Counter the Myth that Math is Only for Brilliant People?

Given the demotivating consequences of the "math requires brilliance" myth, it is important to consider what steps might be taken to counter it. What can educators and parents do to convince children that there's no such thing as a "math person"?

### *5.1. Emphasize Growth and Learning over Brilliance*

Ultimately, the concept of brilliance in itself is problematic, in part because it aligns with the maladaptive "fixed mindsets" investigated by social and developmental psychologists over the past four decades (for a review, see [41]). People with a fixed mindset believe that their abilities are stable and cannot be improved; in contrast, people with a growth mindset believe that their abilities can be expanded with the right mix of effort, strategies and mentoring. Because brilliance and giftedness are often seen as innate, biologically determined qualities, they naturally evoke a fixed mindset. As a result, a classroom climate that focuses on cultivating brilliance promotes the maladaptive patterns of thoughts and behaviors that accompany fixed mindsets: For instance, if children believe that brilliance is the key to success in math, then they might be less motivated to work hard and seek help when needed, regardless of their gender [40,42] (for a vivid illustration, see [43]). In a seminal study, Mueller and Dweck [44] showed that praising a child for either their intelligence or their effort influenced how children thought about their own ability. When children in their study were praised for their intelligence (e.g., "You're really smart!"), they were more likely to consider intelligence a fixed, immutable trait that they either did or did not have. When they were praised for their effort (e.g., "You worked really hard!"), on the other hand, they were more likely to view intelligence as something that could be improved with hard work.

Focusing one's feedback on children's "gifts" could thus encourage children to believe (1) that they do not need to work hard to succeed, because they will either have the necessary intellectual ability or not; and (2) that when they struggle with a problem, they probably don't have the requisite ability and should just give up. If parents and educators devote more time to emphasizing the role of effort and

strategies in success, then they might encourage both girls and boys to adopt more beneficial mindsets about their ability. This could be an effective way to fight the myth that math is just for brilliant people. However, it is important for parents and educators to be mindful of, and avoid, what Carol Dweck recently termed "false growth mindsets" [45]—the misleading belief that you can do anything if you simply put in enough effort. While valuing effort is an important component of a growth mindset, it is often not helpful to tell a student who made a mistake to try harder next time. What might be more productive instead is for parents and educators to focus on the process and strategies that caused a student to make mistakes, identify what went wrong, and help the student come up with more effective strategies. Focusing solely on students' effort (e.g., praising a student with "You must have worked really hard!") also runs the risk of being misinterpreted as suggesting that the student does not possess ability and must, therefore, compensate through effort [46]. When parents and educators emphasize effort, they should explicitly frame it as a way of *building* ability (e.g., "You can't become good at math unless you put in a lot of effort!") rather than leaving the door open to the interpretation that effort somehow substitutes for ability.

### 5.2. Promote 'Open' Approaches to Math in the Classroom

Another way of debunking the myth that math requires brilliance could be to change the way math is taught. In many math classrooms, teachers use a narrow "textbook" approach that focuses primarily on procedural knowledge [4,47,48]. In this approach, students typically memorize sets of rules and then apply those rules to a series of similarly structured problems. Although this approach equips students to solve math problems from a textbook, it makes it harder for them to transfer their knowledge to unfamiliar situations. Many students, for instance, end up feeling confused or intimidated by problems that look even slightly different from the ones they are used to, causing them to think that they simply do not have what it takes to understand math. Students from stereotyped groups may be particularly likely to draw this conclusion, making them especially vulnerable.

If, instead, teachers encourage students to engage more deeply with math by incorporating open-ended projects that are contextualized within the world outside the classroom (e.g., "What is the maximum-sized fence that can be built out of 36 gates?") [47], then their students will be more likely to view math as a valuable skill with relevance to their everyday lives. Seeing the utility of the classroom material is a strong predictor of persistence and success, especially for stereotyped groups [49]. Moreover, insofar as these complex, open-ended projects cause students to struggle on the way to a solution, they also signal that experiencing confusion and difficulty is just a normal part of doing math—it does not mean that a student is not a "math person."

### 5.3. Expose Children to Role Models

Considering that children as young as six are beginning to associate brilliance with males [7], and that this stereotype amplifies the negative effects of the brilliance myth about math [11,50], it is important to think about interventions to target this stereotype as well. Instilling a growth mindset about math could help, insofar as seeing success in math as a product of learning and growth might "immunize" a child against the idea that people like them simply cannot do well in this domain. In addition, parents might turn to examples of successful ingroup members (e.g., women, African Americans) to show children that careers in mathematics and the sciences are possible for them, too [51]. Some role models, however, are more effective than others. If parents highlight women such as Marie Curie, whose achievements are beyond what most people can hope to accomplish, they might inadvertently demotivate their children [52]. This is because women who achieve at the highest levels are often assumed to have some sort of special quality that sets them apart from others [53]; in turn, this inference might make the gulf between the child's present state and their ultimate goal (as instantiated in the role model) seem insurmountable. Thus, exposing children to successful role models should be done thoughtfully. One way to mitigate the potential backfiring effects could be to have children explicitly consider what they themselves could do to achieve the same level of success as

their role models [54]. Take, for example, a young girl who has just learned about Katherine Johnson's mathematical contributions that made space flight possible. To maximize the utility of this role model, the parent or educator might encourage the girl to think concretely about the steps she would need to take to reach a similar place and how she might achieve each of those steps [55,56].

### *5.4. Be Mindful of the Language Used*

As discussed above, parents and teachers might inadvertently communicate gender differences in natural ability through their language use. For example, they might be more likely to explicitly label men rather than women as brilliant, and they might tend to frame boys as the standard for girls in comparisons (e.g., "Girls are as smart as boys"). Fortunately, there are simple ways to reframe such statements so that they do not have these harmful implications. First, parents and educators could simply avoid describing men rather than women as "geniuses" or "gifted." In fact, they could try to reduce their use of these descriptions altogether, since they may encourage children to develop fixed mindsets about ability [40,57]. Second, parents and educators could reframe expressions of gender or racial equality so that no group serves as the standard for the other (e.g., "Girls and boys are equally good at math"). If it feels too unnatural in the conversation to do so, parents could also explain why one group is serving as the standard (e.g., boys have historically received more encouragement, and it has nothing to do with natural ability). Providing children with an alternative causal framework for understanding group-level disparities in achievement—a framework that does not rely on notions of innate ability—is often an effective way of reducing stereotyping and prejudice [58].

## 6. Conclusions

The myth of the brilliant "math person" is pervasive. In combination with the equally pervasive stereotype that women and minorities lack brilliance, this myth is a major obstacle for many students hoping to do well in math and pursue math-related careers. To reduce gender and race gaps in math and ensure that all children who want to pursue math-related careers feel they can do so, parents and educators will need to be mindful of the messages they send with their language and behavior. Only by working to dissociate mathematics and brilliance, brilliance and gender, and brilliance and race will we be able to repair some of the damage done by the myths than link these notions in our minds.

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