Gender Stereotypes and Education

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Abstract

By many standards, the intellectual achievements of girls and women have matched those of boys and men. However, the gender disparity in representation favoring men over women persists in many careers and domains. The present chapter focuses on the sociocultural factors shaping women’s participation in the STEM domain and beyond. In particular, I highlight two classes of stereotypes that may contribute to this phenomenon: (1) stereotypes against women’s and girls’ intellectual abilities and (2) stereotypes about the culture of the field. Throughout the chapter, I introduce the two clusters of stereotypes, describe the early emergence of the gender stereotypes about intelligence, illustrate the mechanisms working against women’s engagement, as well as discuss the means through which parents, educators and society can overcome the insidious effects. Overall, this chapter sheds light on the developmental roots of the gender imbalance across different fields and provides insights on potential interventions remedying this problem.

Key words: gender imbalance, education, achievement, stereotypes, STEM
By many standards, the intellectual achievements of girls and women have matched, if not surpassed, those of boys and men. Girls make up over half of the children in gifted and talented programs (National Association for Gifted Children, 2015) and get better grades than boys from kindergarten through twelfth grade (Voyer & Voyer, 2014). Likewise, women graduate from college at higher rates, as well as from master’s and doctoral programs (National Center for Education Statistics, 2017). Despite women’s significant advancement in educational achievements, the gender disparity in representation favoring men over women persists in many prestigious and well-paying careers and professions, such as those in the domain of Science, Technology, Engineering and Mathematics (“STEM” domain; Chamberlain, 2016). According to UNESCO (2018), girls and women account for less than a third of those employed in scientific research and development all over the world. In higher education, only 23% of the PhDs conferred in engineering in 2015 were women, and less than 20% of PhDs in computer science and physics were awarded to women in the United States (National Center for Science and Engineering Statistics, 2016). Therefore, women still face multiple challenges that compromise their education and careers.

What are these challenges? Over the past few decades, multiple theoretical accounts regarding this question have been offered, looking at biological or social mechanisms (e.g., Ceci, Williams & Barnett, 2009; Halpern et al., 2007). Some researchers on the biological end stress how men and women are inherently different in terms of their cognitive and socioemotional makeup, and these differences influence men’s and women’s aspirations, performance, and career choices, leading to the current gender disparities (e.g., Baron-Cohen, 2002; Geary, 2010; Hakim, 2006). One of the main hypotheses explaining women’s underrepresentation in the STEM domain suggests that men and women are at least partially inherently different with respect to their cognitive abilities (e.g., mathematical and spatial skills) that are necessary for
success in these fields (e.g., Geary, 1996; Kell, Lubinski, Benbow & Steiger, 2013; Moore & Johnson, 2008; Quinn & Liben, 2008; Wai, Lubinski, & Benbow, 2009). In other words, this hypothesis argues that hormonal, genetic, or evolutionary forces predispose men to be endowed with higher mathematical and spatial abilities than women (e.g., Geary, 2010; Lippa, Collaer, & Peters, 2010; Moore & Johnson, 2008; Quinn & Liben, 2008), and moreover, this gender difference is claimed to be more substantial in high-end samples consisting of talented people (e.g., Benbow & Stanley, 1980, 1983; Geary, 1996; Wai, Cacchio, Putallaz, & Makel, 2010). Since many fields are highly selective, the overrepresentation of males in the right tail of the distribution is regarded as a plausible explanation for the greater number of males than females in these fields.

In contrast, researchers holding the social position emphasize that men’s and women’s cognitive abilities, academic performances, and career aspirations are shaped by a range of sociocultural factors, which contribute to the current gender imbalances in participation (e.g., Bennet, 1996, 1997; Diekman, Brown, Johnston & Clark, 2010; Guiso, Monte, Sapienza, & Zingales, 2008; Hyde, Fennema, Ryan, Frost, & Hopp, 1990; Kirkcaldy, Noack, Furnham, & Siefen, 2007; Sugimoto, Lariviere, Gingras, & Cronin, 2013; Milkman, Akinola & Chugh, 2012, 2015; Moss- Racusin, Dovidio, Brescoll, Graham, & Handelsman, 2012; Pope & Sydnor 2010; Sheltzer & Smith, 2014; Spelke, 2005; Tiedemann, 2000; Upson & Friedman, 2012; Wennerås & Wold, 1997). These social influences take a number of forms (for a review, see Ceci et al., 2009), including cultural beliefs (e.g., Guiso et al., 2008), societal expectations (e.g., Diekman et al., 2010), differential treatments by parents and teachers (e.g., Beilock, Gunderson, Ramirez & Levine, 2010; Eccles & Jacobs, 1986), and other environmental factors (e.g., Levine, Vasilyeva, Lourenco, Newcombe, & Huttenlocher, 2005).
Although consensus has not yet been reached regarding the presumed gender differences in cognitive profiles, endorsing gendered beliefs about intelligence may contribute to women’s underrepresentation in the STEM domain and beyond. I focus this chapter on the stereotypes against women’s intellectual abilities (e.g., Ambady, Shih, Kim, & Pittinsky, 2001; Bian, Leslie, & Cimpian, 2017), one of the social factors that perpetuate the current gender disparities. Then, I will discuss a different class of stereotypes that concerns the overall culture of a field, which includes stereotyped beliefs about the characteristics of the field’s typical members, the typical work environment, and the field’s values (e.g., Cheryan, Master, & Melzoff, 2015). Overall, I hope this review provides evidence showing that the two types of stereotypes are unified to exhibit a strong force against women’s participation in certain fields. Throughout the chapter, I will highlight the common practices that parents and teachers apply in their everyday communications that may transmit these stereotypes to the next generation, and suggest potential interventions that could be implemented to counteract these beliefs, so as to remedy the gender disparity.

1.1 Gender stereotypes about intellectual abilities

Our culture presents a web of stereotypes and biases. A subset of stereotypes that may directly relate to gender imbalance are the stereotypes against women’s intellectual abilities (“ability stereotypes”). Possessing high math abilities or general intelligence is believed to be the prerequisite for success in many fields such as STEM (e.g., Cimpian & Leslie, 2015), therefore, the perception that girls lack these abilities is an obstacle to their advancement in this domain. In what follows, I provide a selective review of the evidence showing that ability stereotypes pervade families and schools (the two major environmental factors influencing children’s beliefs), emerge early in childhood, and exhibit detrimental consequences on girls’ and women’s engagement.
A great deal of research has shown that our culture holds a pervasive, negative stereotype against women’s mathematical abilities (e.g., Ambady et al., 2001; Boucher, Rydell & Murphy, 2015; Kirkcaldy et al., 2007; Tiedemann, 2000). For example, men typically estimate their own analytical and practical intelligence to be higher than women do (Kirkcaldy et al., 2007), despite the fact that there are no mean-level differences between men and women on these dimensions (Aluja-Fabregat, Colom, Abad, & Juan-Espinosa, 2000; Colom, García, Juan-Espinosa, & Abad, 2002; Saggino et al., 2014). Parents and teachers, the two major environmental influences on children’s development, internalize these stereotypes as well. For example, in middle school and high school, parents of boys believed that their child has higher math ability and expected their child to achieve more in math than parents of girls (Eccles, Jacobs, & Harold, 1990; Rammstedt & Rammsayer, 2000; Yee & Eccles 1988), despite the fact that girls actually receive slightly higher grades in math at school than boys (Voyer & Voyer, 2014). In addition, a cross-cultural study of parents and children in Taiwan, Japan, and the U.S. found that mothers of kindergarten children in all three cultures believed that boys were better at math than girls (Lummis and Stevenson, 1990). These stereotypes extend into school contexts as well. Elementary school teachers perceived boys as more capable of logical thinking than girls, even in the absence of real gender difference in math performance (Tiedemann, 2000). Additionally, these stereotypes influence teachers’ attributions of students’ math performance: They believed that it is the extra effort that girls spend on math problems that enables them to achieve a level of math performance comparable to boys’—without this extra effort, girls would fall behind (e.g., Robinson-Cimpian, Lubienski, Ganley, & Copur-Gencturk, 2014).

Given that the two major environmental sources are biased when evaluating boys’ and girls’ math abilities, it is not surprising that children in early elementary school years have acquired the beliefs that girls are not as good as boys at math (Cvencek, Melzoff, & Greenwald,
On explicit self-report measures, girls rated their math abilities lower than boys (Fredricks & Eccles, 2002). Findings from implicit measures provide converging evidence as well (e.g., Cvencek et al., 2011; Cvencek, Kapur, & Meltzoff, 2015). Cvencek and colleagues (2011) developed a child-friendly Implicit Association Task, requiring children between 6 and 10 years of age to use two computer response keys to sort boys’ and girls’ names, and the same response keys to sort math and reading words. This method capitalizes on the fact that it is easier to give the same response to items from two categories if the two categories are mentally associated, than if they are not. In this measure, if children implicitly associate math more with boys than with girls, they should respond faster when “boys” and “math” share the same response key than when “girls” and “math” are paired together. Indeed, children as young as second grade were faster when “math” was paired with “boys” than with “girls,” suggesting that the cultural stereotypes associating math with men begin to be assimilated in early elementary school years. These findings have been extended to other cultural contexts as well. In a sample of Singaporean elementary-school children, who had no gender differences in math achievement, both boys and girls associated math with boys more strongly than with girls on implicit and explicit measures (Cvencek et al., 2015; Cvencek, Meltzoff, & Kapur, 2014).

These findings constitute evidence that the gender stereotypes about math abilities are indeed detrimental to women’s engagement in the STEM domain. However, limiting the content of the gender stereotypes to math abilities obscures a critical observation that women actually have made more inroads in some STEM fields (e.g., molecular biology) than others (e.g., physics; NSF, 2013). For example, in a recent report by the National Science Foundation (NSF, 2013), about half of the PhD recipients in molecular biology and neuroscience were women, but women were awarded only about 20% of the PhDs in physics and computer science. Moreover, fields
that are typically not perceived as requiring a great amount of math abilities, such as the social sciences and humanities, in fact exhibit at least as much variability in participation in senior levels by women as STEM fields do (NSF, 2013). For example, although women were awarded more than 70% of PhDs in art history and psychology, statistics collected by the U.S. National Center for Educational Statistics showed that women make up only 21% of full-time philosophy faculty (Division APAP, 2011).

This variation in women’s representation, which cuts across the divide between STEM and non-STEM fields, prompts researchers to examine, in addition to domain-specific stereotypes, a broader and more influential stereotype that associates high intelligence more with men than with women (e.g., Bennett, 1996, 1997; Kirkcaldy et al., 2007; Tiedemann, 2000; Upson & Friedman, 2012). Even though the actual intelligence of men and women is not different (Aluja-Fabregat et al., 2000; Colom et al., 2002; Saggino et al., 2014), people tend to underestimate women’s intelligence, while overestimating men’s (e.g., Beloff, 1992; Furnham, Reeves, & Budhani, 2002; Rammstedt & Rammsayer, 2000). For instance, research focusing on self-estimated intelligence indicates that women themselves had lower perceptions of their intelligence than men (104.84 vs. 110.15; Furnham et al., 2002). Similar patterns have been reported with samples tested in Hong Kong, in which women estimated their IQs lower than men estimated theirs, regardless of their actual intelligence levels (Hamid & Lok, 1995).

These biases against women’s intelligence have been found in parents and teachers. In a New York Times article titled “Google, Tell Me. Is my Son a Genius?” (Stephens-Davidowitz, 2014), the author tallied anonymous Google searches and found that parents were two and a half times as likely to search “Is my son gifted?” as “Is my daughter gifted?” More generally, parents tended to make more intelligence-related searches about their boys than about their girls (Stephens-Davidowitz, 2014). In samples including both English and Icelandic parents (Furnham
& Valgeirsson, 2007), fathers estimated their own overall intelligence higher than mothers estimated theirs, and sons were estimated higher than daughters on overall intelligence. Teachers likely have differential expectations of their male and female students as well (Bianco, Harris, Garrison-Wade, & Leech, 2011). Bianco et al. (2011) provided teachers with identical information about a hypothetical male or female student and asked them whether they would refer the child to the gifted program in their school, and they found that teachers were significantly more likely to refer the male than the female student to gifted services, despite the identical descriptions.

Are young children susceptible to these gendered beliefs? Bian et al. (2017) investigated the developmental trajectory of children's beliefs about which gender is "really, really smart" — a child-friendly way of talking about high intelligence. A group of children from the United States were told a short story about a person who was really smart, without receiving any clues to the person's gender. Then, children saw pictures of 4 unfamiliar adults (2 men and 2 women), and guessed which one of them was the protagonist in the story. At the age of 5, both boys and girls picked people of their own gender as being "really, really smart". However, starting at age 6, girls picked females as "really, really smart" less often than boys picked males, suggesting that children begin to assimilate the “brilliance = males” stereotypes in early elementary school years. These findings are similar in both white and nonwhite children, do not seem to vary as a function of parental education and income, and have been replicated in other cultural contexts such as China (Bian, Shu, Hu, & Xu, 2019). Interestingly, 6- and 7-year-old girls in the original study (Bian et al., 2017) also thought that girls get better grades in school than boys (which is actually true; Voyer & Voyer, 2014)—a stark contrast with their judgments of who’s “really, really smart.” In other words, children’s judgments of brilliance were disconnected from one of the best
sources of evidence in their environments regarding intellectual ability, which speaks to the tenuous link between stereotypes and reality.

1.2 Stereotypes about the culture of a field

So far, we have reviewed evidence demonstrating the existence and early emergence of the stereotypes against women’s and girls’ intelligence. How do these gender stereotypes about abilities influence girls’ and women’s career choices? This question is best answered after taking into account the second type of stereotypes -- beliefs about the culture of a field. This class of stereotypes includes beliefs about the characteristics of the field’s typical members, the typical work environment, and the prototypical traits valued in this domain (e.g., Cheryan et al., 2017; Cheryan, Master, & Meltzoff, 2015). Encountering a field that embraces a culture that is incompatible with one’s self-concept is likely to make that field an unattractive career option (e.g., Cheryan & Plaut, 2010; Niedenthal, Cantor, & Kihlstrom, 1985). This mismatch serves as an overarching factor that works against girls’ intention to join certain fields.

Take the STEM domain as an example. Generally, the STEM domain is believed to embrace a masculine culture. To elaborate, computer scientists, engineers, and physicists are seen as stereotypically male (Cheryan, Plaut, Handron, & Hudson, 2013; Haines & Wallace, 2003; Hoh, 2009; Knight, & Cunningham, 2004; J. L. Smith, Morgan, & White, 2005). When asked to draw a mathematician, children in kindergarten and first grade are more likely to draw women than men; however, starting in the second grade, children become increasingly more likely to draw men (Rock & Shaw, 2000). Additionally, the STEM domain is believed to value traits that are incongruous with the female gender role (Cheryan et al., 2009; Diekman et al., 2010). Both male and female undergraduates stereotype computer scientists as socially awkward and singularly focused on technology (Beyer, DeKeuster, Walter, Colar, & Holcomb, 2005; Cheryan et al., 2009; Cheryan, Plaut, et al.,2013; Schott & Selwyn, 2000). In the U.K., physicists
are often portrayed as male, untidy, “fairly mad looking,” and surrounded by explosions, atoms, and lightning (McAdam, 1990, p. 104). Regarding perceptions of engineers, students in the elementary and middle school years indicate that they build and fix things such as cars (Fralick, Kearn, Thompson, & Lyons, 2009; Karatas, Micklos, & Bodner, 2008; Knight & Cunningham, 2004). This masculine culture surrounding the subject signals to women a lower sense of belonging, or that they would be less successful than their male counterparts.

Another feature that characterizes each discipline is the belief about which abilities are required for success (e.g., Leslie, Cimpian et al., 2015; Meyer, Cimpian & Leslie, 2015). In particular, some disciplines are more likely than others to endorse the idea that high-level success is a matter of raw intelligence rather than hard work and dedication. In philosophy, for example, there are widespread messages suggesting that success is largely determined by whether one possesses a spark of genius (e.g., Marshall, 2013). In a seminal study, Leslie, Cimpian and their colleagues (2015) recruited faculty, post-doctoral fellows, and graduate students from different research universities across the United States. Participants were asked to indicate to what extent they believe success in their field requires a special innate aptitude. As expected, some fields (e.g., physics, philosophy, economics) are more than others (e.g., microbiology, psychology, education) to believe that success relies on possessing high intellectual talents. Subsequent work replicated these results with a different measure of a field's emphasis on brilliance: namely, the frequency of the words “brilliant” and “genius” in anonymous reviews of college instructors on RateMyProfessors.com (Storage et al., 2016). Fields with such cultures may be especially unwelcoming and inhospitable to women’s engagement, because their cultural values are incongruent with the image that women are encouraged to adopt by the ability stereotypes (Bian, Leslie, Murphy, & Cimpian, 2018) or the norms of the current society (Eccles, 1987).
1.3 Links between the ability stereotypes and women’s representation

A critical precursor to entering a field is one’s confidence that they can succeed in the domain – the so-called “self-efficacy” (Bandura, 1997; Bandura, 1982; Eccles, 1994; Wigfield & Eccles, 2000). Given the negative stereotypes against females’ intellects, women are more vulnerable to the cultures that are perceived as valuing high abilities or masculine traits in at least three ways. First, girls and women may be less confident about their success in the domain, resulting in weaker senses of belonging and stronger anxiety than their male counterparts, which may undermine their motivation to pursue the fields with these cultures. Second, women may also experience stereotype threat, resulting in poor performance that ultimately confirms with what the stereotypes suggest and makes it more difficult for them to be accepted and valued than it would be for a nonstereotyped person in their position. Third, even though women surpass or match in performance with their male counterparts, the practitioners of these fields may hold low expectations of women’s qualifications and competence, offering them few opportunities. In what follows, I will review evidence illustrating each mechanism that contributes to the gender imbalance.

1.3.1 Motivation and interests

Notions associating high intellects with men more than with women are likely to undermine women’s and young girls’ confidence about their own intellectual abilities, which may ultimately steer them away from participating in fields that value brilliance (e.g., Jacobs, Davis-Kean, Bleeker, Eccles, & Malanchuk, 2005). According to self-to-prototype matching theory (e.g., Niedenthal et al., 1985; Setterlund & Niedenthal, 1993), many important life choices, including which careers to pursue, are informed by a comparison between the self and the prototypical person or the valued characteristics in the context being considered. Given that the culture of the STEM domain excludes women, they are likely to perceive a mismatch between
their self-concept (shaped by the ability stereotypes) and the culture of a field (shaped by the culture stereotypes). This mismatch leads women to be apprehensive about joining such fields and raises concerns about belonging (Bian et al., 2018). Anxiety and lack of belonging could ultimately undermine women's interest (e.g., Cheryan & Plaut, 2010; Cheryan, Plaut, Davies, & Steele, 2009; Cheyran, Zigler, Montoya, & Jiang, 2017; Dasgupta, 2011; Good, Rattan, & Dweck, 2012; Hannover & Kessels, 2004; Walton & Cohen, 2007, 2011; Walton, Cohen, Cwir, & Spencer, 2012). For example, after interacting with a stereotypical computer scientist (e.g., a person who wore glasses and a t-shirt that read “I code therefore I am,” and was a Star Wars fan), whether male or female, women were less confident that they would be able to succeed in the field and less interested in learning more about computer science (Cheryan, Siy, Vichayapai, Drury & Kim, 2011). This reaction was mediated by their feelings of dissimilarity to the prototypical members of the field and by a lack of sense of belonging. Moreover, this negative effect persisted for up to two weeks after this brief initial exposure (Cheryan, Drury & Vichayapai, 2013).

Studies presenting a “brilliance oriented” context provide converging evidence (e.g., Bian, Leslie, Murphy & Cimpian, 2018; Emerson & Murphy, 2015; Good, Rattan, & Dweck, 2012; Smith, Lewis, Hawthorne, & Hodges, 2013). In a series of experiments by Bian et al. (2018), college students and Mechanical Turk workers were provided with a range of hypothetical educational and professional opportunities (e.g., major, internship, job) that were portrayed as requiring either “a spark of genius” or “excellent work ethics”. Some experiments also included baseline conditions in which no additional information was provided about these opportunities. Then, participants’ motivation to pursue these opportunities was measured. Compared to men, women reported lower self-efficacy and consequently lower motivation towards the activities portrayed as for people of high intellectual ability. More importantly, these gender differences
were explained in part by women's perceptions that they were different from the typical person in these contexts.

Children suffer from these detrimental effects as well. Bian et al. (2017) showed 5-, 6-, and 7-year-olds an unfamiliar activity and told them that it was for children who are “really, really smart”. Children were asked a number of questions to assess how interested they were in this activity. Five-year-old boys and girls were equally interested in the activity for “really smart children”, but girls became less interested in it (relative to boys) at the age of 6 and 7, which parallels the developmental trajectory of children’s gendered beliefs about brilliance (Bian et al., 2017). Moreover, girls’ interest in this activity was lower if they endorsed the stereotype that brilliance is a male quality. In contrast, when the same game was framed as being for kids who “try really, really hard”, girls were just as interested in it as boys.

Similarly, the gender stereotypes against girls’ math abilities lead them to make lower evaluations of their math abilities than boys do (Huang, 2013), and this low self-efficacy in turn reduces children’s interest in pursuing future math-intensive academic courses and occupations (Correll, 2001, 2004; Denissen, Zarrett, & Eccles, 2007; Eccles, 1994; Frome, Alfeld, Eccles, & Barber, 2006; Killen, Margie, & Sinno, 2006; Liben, Bigler, & Krogh, 2001; Newcombe, 2007). Furthermore, the mismatch between children’s self-concept and the required identity for a specific task undermines their persistence. Rhodes and her colleagues (Rhodes, Leslie, Yee, & Saunders, 2019) introduced 4- to 9-year-old children to science as an identity (“Let's be scientists! Scientists explore the world and discover new things!”) or as action (“Let's do science! Doing science means exploring the world and discovering new things!”). Children were then asked to complete a new science game. Girls who were initially asked to “be scientists” spent less time playing on the subsequent science game than did girls who had been asked to “do science,”
presumably because girls encounter a conflict between the portrayed identity and their own identity in the latter condition.

Overall, the stereotypes about the culture of a field shape girls’ and women’s career aspirations and choices. When women and girls encounter a field embracing a culture loaded heavily with masculine traits, they detect a mismatch between their self-image and the type of people who commonly work in these setting. This perceived mismatch diminishes girls’ and women’s self-efficacy, reduces their sense of belonging, increases their negative emotional reactions, and ultimately pushes them away from the fields.

1.3.2 Stereotype threat

Just as comparisons between the self and the prototypical person in a field can influence interest, so can judgments about whether one's group is likely to be welcome and valued in a field. Messages about the cultural values of the field may act as a situational cue to inform these judgments. Imagine a girl is taking a test in a male-dominated program. She might fear that she would be misjudged based on her gender membership. This extra pressure is likely to result in performance decrements that confirm the stereotype against her gender group’s intellectual competence. This example illustrates stereotype threat—the threat of being judged through the lens of a negative stereotype about one's group (e.g., Davies, Spencer, Quinn, & Gerhardstein, 2002; Emerson & Murphy, 2015; Murphy, Steele, & Gross, 2007; Spencer, Steele & Quinn, 1999; Steele, 2013). A great deal of research has shown that stereotype threat gives rise to anxious feelings (e.g., Murphy et al., 2007; Osborne, 2007), low sense of belonging (e.g., Good et al., 2012), and low actual performance (Spencer, Logel, & Davies, 2016).

A longitudinal study by Good et al. (2012) revealed that female calculus students who perceived others in their class to endorse negative stereotypes about women's mathematical abilities and to believe that math abilities are fixed and stable (a fixed mindset; see Dweck, 1999,
2006), reported a lower sense of belonging and weaker intentions to take mathematics courses after a semester. Similarly, Emerson and Murphy (2015) found that when women imagined being in a consulting firm believing that intelligence is innate and cannot be improved (which is what so-called “fixed mindsets”; e.g., Dweck, 2006), they anticipated being judged on the basis of their gender and, as a result, exhibited less trust and more defensive behavior in the face of negative feedback from the company.

The threat of being stereotyped not only takes a toll on girls’ and women’s senses of belonging and interests, it also has a detrimental effect on their actual performance. One study showed that six-year-old girls’ math performance decreased after being incidentally exposed to the gender stereotype about math (Galdi, Cadinu & Tomasetto, 2014). After coloring a picture of a boy successfully solving a math problem and a girl failing to do so, young girls performed worse than boys on the subsequent math test. In contrast, girls performed as well as boys after they colored a picture of a girl solving a math problem successfully and a boy failing to respond. These results indicate an influence of the negative stereotype targeting girls’ math ability, which was activated by the picture (even though presumably the girls themselves were not consciously aware of its activation). Other studies similarly showed that 5- to 7-year-old girls’ math performance decreased when their gender identity was activated (e.g., Neuville & Croizet, 2007; Tomasetto, Alparone, & Cadinu, 2011). Thus, activating the social identity that is being negatively stereotyped in a domain leads to poorer performance. In contrast, activating the social identity that is being positively stereotyped may buffer against this effect. In a clever study on stereotype threat by Shih and colleagues (1999), Asian American female participants’ math performance was undermined when their gender identity was made salient, whereas their performance was improved when their racial identity was activated. The threat can also be reduced by deemphasizing the group differences that may show up in the test. For example,
women who read that a math test did not show gender differences performed equally to men, whereas women who read instructions that the test showed gender differences underperformed (Spencer et al., 1999).

Taken together, findings on stereotype threat suggest that many benchmarks used to assess people’s abilities systematically underestimate women’s and girls’ true ability in intellectual settings (for a review, see Walton & Spencer, 2009). To remedy this effect, creating environments that are identity-safe and open to a variety of values may unlock women’s hidden abilities and allow them to achieve their full potential.

1.3.3 External biases

A third potential mechanism involving the ability stereotypes that contributes to women’s underrepresentation is the following: the ability stereotype also makes women the targets of bias in fields that value these abilities, which in turn creates an inhospitable environment for them. As a result, women might be less likely to pursue these areas in the long term. Specifically, given the stereotypes against women’s intellectual abilities, members of the masculine fields may exhibit bias against them because they view women as less competent and capable, providing them with fewer opportunities, lower salaries, and fewer accolades (e.g., Sugimoto, Lariviere, Ni, Gingras, & Cronin, 2013; Milkman et al., 2012, 2015; Moss-Racusin, et al., 2012; Sheltzer & Smith, 2014; Wennerås & Wold, 1997; but see Williams & Ceci, 2015, for inconsistent results). For instance, female students were less likely to get responses from faculty than their male counterparts when they contacted them to discuss research opportunities, regardless of the gender of the faculty member (Milkman et al., 2012, 2015). Speaking to the gender bias in opportunities and salary, when faculty members in biological and physical sciences were asked to evaluate the suitability of a male or a female applicant with identical backgrounds for a lab manager position, both male and female faculty rated the male as more suited for the position,
were more likely to offer the male mentoring, and provided him a higher starting salary (e.g., Moss-Racusin et al., 2012). The female was seen as less suited for the position, even though she was exactly as qualified as the male applicant and rated as more likable. In two initial experiments presenting a job opportunity (Bian, Leslie, & Cimpian, 2018), participants were split into two groups and asked to refer someone for a job. In each experiment, one group was told the job required someone with a high level of intelligence, while the other was told the position needed someone with “consistent effort.” Participants were much less likely to recommend a woman for the “high IQ” job, with researchers concluding that a woman’s odds of being referred are 25.3 percent lower when “intellect” is included in the job description.

Even after women surmount these challenges and obtain advanced degrees, they may still face discrimination with respect to their academic productivity and the value of their research. For instance, Sugimoto et al. (2013) analyzed the scientific impact of all articles published between 2008 to 2012 across all disciplines, and revealed that articles were cited fewer times when women were in the most prominent author positions than when men were. Moreover, according to the data from the peer review system of the Swedish Medical Research Council, females were less likely to be awarded postdoctoral fellowships, and were perceived as less competent than males who were, in fact, equally productive (Wennerås & Wold, 1997).

More strikingly, this bias has developmental roots in early childhood (Bian et al., 2018). Five- to 7-year-olds were presented with an unfamiliar team game, but half were told the games were for “really, really, really” smart children. Next, the children were asked to select teammates among six unfamiliar children for the new games. At first, they tended to choose teammates who were their own gender, which was consistent with the ingroup favoritism that children typically display when they choose friends (e.g., Dunham et al., 2011). But in the third selection round, girls were only chosen as teammates for the “smart” game 37.6 percent of the time, versus 53.4
percent for the game not portrayed as for “really really smart” children. Boys and girls were equally likely to exhibit this bias. These findings suggest that these ability stereotypes against women’s intelligence begin to influence children’s attitudes and behaviors as soon as they are acquired. Specifically, they bias children’s evaluations of other girls’ competence for activities said as requiring brilliance.

As outlined above, the current gender disparity is in part due to the unified force of the two types of stereotypes: the stereotypes against women’s intellects and the stereotypes about the culture of a field. To promote girls’ aspirations in pursuing all kinds of careers, strategies and interventions should focus on undermining the two clusters of stereotypical beliefs to alleviate their consequences. In the next section, I go on to discuss these strategies and interventions.

1.4 Changing stereotypes about abilities

Inoculating people from the negative ability stereotypes can promote girls’ self-efficacy, allow them to reach actual levels of performance, and minimize the biases involved in the selection process. Prior research has suggested two potential ways of revising people’s, especially girls’, gendered beliefs about intellectual abilities.

The first, and most commonly used strategy, is to foster growth mindsets about abilities. A growth mindset is the belief that one’s abilities in a domain (such as STEM) can be improved with consistent effort, effective strategies, and guidance from teachers and mentors (e.g., Dweck, 2006). One reason that the stereotypes about intellects are very powerful is because intellectual abilities are usually conceptualized as inherent and unchangeable (“fixed mindsets”; Dweck, 2006). This essentialized view of intelligence gives rise to tendencies to perpetuate and justify group inequalities: If one group is perceived as possessing lower intelligence than its counterparts from the very beginning, this disadvantage is believed to be pre-determined, cannot be changed, and should not be changed (e.g., Hussak & Cimpian, 2015; Roberts, Gelman, & Ho,
However, a growth mindset leads students to view high intelligence as something that can grow and that emerges from learning, practice and effective mentoring. Since anyone can engage in these processes, growth mindsets offer a concrete path toward improvement and success for students, especially those from the disadvantaged groups who are vulnerable to the ability stereotypes. Indeed, growth mindset interventions have improved girls’ performance in mathematics (Good, Aronson, & Inzlicht, 2003) and, more generally, the academic outcomes of students from a range of stereotyped groups (Yeager, Romero, et al., 2016).

In everyday practice, fixed mindsets can be instilled through subtle linguistic cues. One particular language form that has received a lot of attention in cognitive, social and developmental psychology is generic language, such as “boys have short hair”, “zebras have stripes.” Generic statements are powerful because they encourage essentialist beliefs, the beliefs that certain social categories mark fundamentally distinct kinds of people, which serve as the cognitive basis for stereotypes and biases. In a seminal series of experiments, Rhodes, Leslie and Tworek (2012) found that parents who held essentialist beliefs were more likely to use generic statements about the social category (e.g., “Feppies eat flowers”) in their conversations with their children. Moreover, hearing generic statements about a novel social category led both preschoolers and adults to develop essentialist beliefs about the category. In contrast, parents who did not believe that category membership marks inherently different kinds of people were more likely to use non-generic language (e.g., “This feppy eats flowers”), and as a result, their children did not develop inherent beliefs about the social categories. To extrapolate these findings to the ability stereotypes, using non-generic language to describe individuals’ achievements (e.g., “Tom does well on his math test.”) as opposed to using generic language to
describe performances as groups (“Boys do well on their math tests.”) may block the transmission of these ability gender stereotypes.

Relatedly, even well-intentioned messages may backfire. For example, saying “girls are as good as boys at math” reinforces the gender bias it is intended to reduce (Chestnut & Markman, 2018). On the surface, the sentence tries to convey that both genders are equal in their abilities. However, because of its grammatical structure, it implies that being good at math is more common or natural for boys than girls. In Chestnut and Markman (2018), adults read a summary of research that showed no gender differences in math skills. The text for each condition was identical except one subtle difference in how the lack of gender difference was framed. In particular, participants read one of the four statements: “Girls do just as well as boys at math,” “boys do just as well as girls at math,” “girls and boys are equally good at math,” and “boys and girls are equally good at math.” Next, adults were asked which gender they thought was naturally skilled at math. Of those who read “girls do just as well as boys at math,” 71% chose boys as naturally skillful at math, but this pattern was reversed for those who read “boys do just as well as girls at math,” in which only 32% picked boys. Thus, putting both boys and girls in the same position in the sentence (e.g., “boys and girls are equally good at math”) as opposed to comparing the two groups (e.g., “girls do just as well as boys at math”), may undermine the gender biases about abilities.

Another primary strategy to inoculate girls against ability stereotypes is to expose them to examples of women who have achieved success in traditionally male-dominant fields (Dasgupta, 2011). Specifically, seeing other members of their gender pursue successful careers in these fields may bolster girls’ confidence in their own abilities and lessen their concerns about being stereotyped, which in turn may increase girls’ sense of belonging in this field and improve their performance (e.g., Dasgupta, 2011; Else-Quest et al., 2010). As illustrated in Stout, Dasgupta,
Hunsinger, & McManus (2011), even brief interactions with female experts in the STEM fields enhances women's positive attitudes toward STEM and motivation to pursue STEM careers. In the domain of politics, women politicians’ visibility on national news coverage is positively related to American adolescent girls’ intention to be politically active (Campbell & Wolbrecht, 2006). Moreover, girls may benefit from playing the role of a competent character. Past studies in developmental and clinical psychology demonstrate that impersonating a superhero is beneficial to children’s task performance because it allows children to cognitively transform themselves into a competent character and behave in line with that character’s powers, even if they believe they themselves do not have these powers (Karniol, Galili, Shtilerman, Naim, Stern, Manjoch, & Silverman, 2011).

Although presenting role models are likely to inoculate girls from the negative stereotypes, figuring out the best ways to portray the role models is still challenging. As reviewed before, seeing oneself as similar to the successful role model may be motivating (e.g., Bian et al., 2018), whereas feeling a mismatch between one’s identity and that of the role model may backfire. For example, role models whose success seems extraordinary and unobtainable can made young students feel threatened rather than motivated (Betz & Sekaquaptewa, 2012). Therefore, highlighting the similarities between the target group (e.g., girls) and the role models seems necessary and important to consider in devising interventions.

1.5 Changing stereotypes about the culture of a field

As outlined above, elements of the stereotypes about a field’s culture include the representative people working in the field and the characteristics of the work they perform. Therefore, changing the beliefs about the field’s culture requires alternations of these components. With respect to the beliefs about the prototypical members of a field, research by Cheryan and her colleagues (e.g., Cheryan et al., 2017) suggests that these beliefs are malleable,
and the revised beliefs encourage women to be more engaged with the STEM field. For example, after interacting with a non-stereotypical computer science major student whose hobbies were playing sports, hanging out with friends, and listening to music, undergraduate women expressed greater interest in majoring in this field than when they interacted with a more stereotypical major student (Cheryan, Drury, & Vichayapai, 2013). Similarly, 13- to 15-year-old students reported revising their initial conception of scientists from “boring” and “nerdy” to “approachable” and “ordinary” after having face-to-face interactions with several scientists from different fields (Woods-Townsend et al., 2016).

With respect to the second component, emphasizing that science involves working with people and serves communal goals, goals that are often more highly valued by women than by men when considering occupations (Diekman & Eagly, 2008), may boost women’s participation. These values are also in line with the reality – as reported by National Academy of Engineering (2017), many modern scientists and engineers in fact work collaboratively toward solving problems of great societal significance. Portraying a scientist’s job as involving working with other people and helping them solve problems, as opposed to solving problems alone, led undergraduates to hold more positive attitudes toward a career in science (Clark, Fuesting, & Diekman, 2016; see also Brown, Smith, Thoman, Allen, & Muragishi, 2015). Similarly, preschoolers were more engaged in group-based science activities than when they had to work on the problems alone (Master, Cheryan, & Meltzoff, 2017), suggesting that adding the collaborative component to science work makes it more approachable to people.

**Conclusion**

The bulk of research reviewed in this chapter suggests that the exposure to cultural stereotypes about women’s intellectual abilities and the stereotypes about the culture of a field influence girls’ career choices, leading them to shy away from certain areas that they may have
chosen otherwise. By combating the two types of stereotypes through strategic communications and educational practices, boys and girls are likely to be put on a more equal playing field to freely pursue their career aspirations.
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