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Cultural Stereotypes and Sense of Belonging Contribute to Gender Gaps in STEM

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ABSTRACT

There is a need to help more students succeed in science, technology, engineering, and mathematics (STEM) education, with particular interest in reducing current gender gaps in motivation and participation. We propose a new theoretical model, the STEreotypes, Motivation, and Outcomes (STEMO) developmental model, to account for and integrate recent data emerging in social and developmental psychology. Based on this model, we synthesize research suggesting that social factors, such as stereotypes and self-representations about "belonging," are powerful contributors to observed gender differences in STEM interest and academic outcomes. The review has four parts. First, we examine how *cultural stereotypes* specific to STEM contribute to gender gaps by negatively impacting interest and academic outcomes. Second, we review the central role of the *self-representations* affected by those stereotypes, including the particular importance of a sense of belonging. Third, we discuss various *interventions* that buffer against stereotypes and enhance a sense of belonging to reduce gender gaps in STEM interest and academic outcomes. Finally, we suggest *theory-driven directions* for future research. By organizing the research in this way, our review and theoretical analysis clarify key factors contributing to current gender gaps in STEM and mechanisms by which psychological interventions can help address STEM gender gaps.

KEYWORDS

STEM, motivation, identity, gender, belonging, stereotypes, academic outcomes, social cognition

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INTRODUCTION

Education in science, technology, engineering, and mathematics (STEM) helps both individuals and society. It provides benefits to individuals by sharpening their critical thinking skills, problem solving, and understanding of the physical world; it benefits society by providing groundwork for innovation and invention. The current demand for STEM workers exceeds the supply. The United States would need to increase the number of undergraduates receiving STEM degrees by 33% to keep up with projected demand for STEM professionals (Holdren & Lander, 2012; Xue & Larson, 2015). This suggests that society would benefit by improving STEM education to inspire more students to enter these fields (National Research Council, 2011). Many methods for improving STEM education have been proposed, such as promoting the quality and quantity of STEM learning in both formal and informal environments (National Research Council, 2009; State of Computer Science Education, 2019). In this integrative review, we take a different but complementary perspective and focus on *motivational and identity* factors, which strongly predict academic outcomes. By "academic outcomes," we include both academic choices and achievement.

Improving students' motivation in STEM is important as a way of altering developmental trajectories starting from an early age. We define motivation from a social-cognitive perspective (Dweck & Leggett, 1988) as a pattern of responses that energizes students toward particular activities. These involve cognitions (beliefs, goals, attributions, values), behaviors (task persistence, effort), and affective responses (interest). Together, these motivational factors can push students to take maximal advantage of STEM learning opportunities and impact students' academic outcomes, including performance and participation (Wigfield et al., 2015). For example, the best predictor of college students' choice to major in STEM (for both males and females) is *interest* in STEM before college, compared to other variables such as prior STEM courses, GPA in STEM courses, earning potential, or the influence of friends, parents, and teachers (Maltese & Tai, 2011). Overall motivation in math and science shows a particular decrease during adolescence compared to other fields (Wigfield et al., 2015). Between fourth and eighth grade, the number of U.S. children reporting positive attitudes about math and science drops from about 71% to about 48%, and a significant gender gap emerges (Martin, Mullis, & Foy, 2008; Mullis, Martin, & Foy, 2008; TIMSS 2007 Assessment, 2009).

Although some students may initially approach STEM with more interest and enthusiasm than others, motivation is malleable. We offer a conceptualization that integrates educational, developmental, and social-psychological research in a novel way and organizes recent research on boosting students' motivation in STEM. Our theoretical model describes the mechanism by which students who face negative stereotypes, such as women in STEM, integrate those stereotypes into their self-representations, with negative consequences for their interest and academic outcomes in STEM. This model highlights the central role of students' self-representations, especially a sense of belonging, which we argue should have a more prominent place in research on STEM. By the term *self-representations* (Markus & Wurf, 1987), we mean self-relevant motivational beliefs including how much students personally identify with that domain or value it (*identification*), their conceptions of how good they are in a domain (*ability beliefs*), and how much they think they fit in with others (*sense of belonging*) in the domain.

Although we strive to include papers that address as wide a range of countries and diverse populations as possible, participants in the studies we describe are mainly from the United States (unless noted otherwise).

The Problem of Underrepresentation of Women in STEM

Understanding how stereotypes affect motivation may help alleviate a key issue within contemporary STEM education—the underrepresentation of women in certain STEM fields. The underrepresentation of women in STEM is problematic both because women disproportionately fail to benefit from lucrative, high-status careers in fields like computer science, and because this reduces diversity that could increase technological and scientific innovations (C. Hill, Corbett, & St. Rose, 2010). The roots of this underrepresentation start early. Boys in Germany report more interest than girls in math in elementary and middle school (Frenzel, Goetz, Pekrun, & Watt, 2010), and boys in the United States report more interest than girls in computer science and engineering by age six (Master, Cheryan, Moscatelli, & Meltzoff, 2017). Thus, there is a particularly strong need to understand *when* and *why* young girls show less motivation for STEM, and to work to improve girls' STEM motivation.

Women's underrepresentation in STEM is a complex problem with multiple causes and approaches for addressing it (Ceci, Williams, & Barnett, 2009; Cheryan, Ziegler, Montoya, & Jiang, 2017; Wang & Degol, 2013). Recent evidence suggests that the most likely explanations involve gender differences in *preferences* and *choices* rather than *abilities* and *performance* (Dasgupta & Stout, 2014; Riegle-Crumb, King, Grodsky, & Muller, 2012). There are no reliable gender differences in math ability and only small differences in spatial ability during kindergarten through 12th grade (K-12) schooling (Halpern et al., 2007; Hyde & Linn, 2006). Indeed, high school girls may have strong skills across multiple academic fields, thus preparing them for more career options than boys (Wang, Eccles, & Kenny, 2013). Thus, the current debate has largely become one about the source of gender differences in preferences and interests (Ceci & Williams, 2010).

Variation Across STEM Fields

Crucially, STEM fields are not identical, and differ widely in their representation of women. Some STEM fields have achieved near-equality in gender representation. For example, in 2016, women in the United States earned 60% of bachelor's degrees in biological sciences and 43% of degrees in math and statistics (U.S. Department of Education, 2017). In contrast, women's representation was significantly lower in fields such as computer science (19%) and engineering (20%). Over the past decade, these percentages have been fairly stable. There are similar patterns of underrepresentation throughout the academic pipeline from high school AP exams to higher education degrees in computer science, engineering, and physics (Cheryan et al., 2017). Computer science is not the same as math, biology, or chemistry. Any full explanations for women's underrepresentation in STEM must also take into account the large variations among STEM fields (Ceci, Ginther, Kahn, & Williams, 2014).

Our review highlights one important source of variation in underrepresentation among STEM fields—stereotypes. Previous explanations for women's underrepresentation have pointed to the math-based nature of STEM fields (e.g., Wang et al., 2013), but this does not explain why women are proportionally *more likely* to major in math than computer science. We argue that one contributor is that there are differences in the cultural stereotypes about particular STEM fields (Leslie, Cimpian, Meyer, & Freeland, 2015; Master, Cheryan, Moscatelli, et al., 2017). By *cultural stereotypes*, we mean stereotypes held in a particular society that transcend beliefs within an individual, and are expressed through patterns within many aspects of that culture, including physical objects, media representations, social interactions, and language use (Markus & Kitayama, 2010). These stereotypes can act as gatekeepers that drive girls away from STEM fields such as computer science and engineering (Cheryan, Master, & Meltzoff, 2015). Although limited research has directly connected variation in stereotypes about STEM fields to variation in women's participation in STEM, we take care in this review to specify the field(s) in each study. Due to the limited number of studies, we cannot yet make clear comparisons across fields or draw firm inferences about variation among STEM fields, so we suggest more direct comparisons across STEM fields as a future direction.

Organization, Scope, and Novelty of this Review

We first present our STEreotypes, Motivation, and Outcomes (STEMO) developmental model, and then analyze and synthesize work on four key topics: (a) STEM-gender stereotypes, (b) self-representations affected by stereotypes, including a "sense of belonging" in STEM, (c) interventions that can help draw more students to STEM, chiefly by reducing the impact of stereotypes and enhancing students' sense of belonging, and (d) recommendations for targeted new theory-driven research that can use the STEMO developmental model to specifically address pressing questions in educational theory and practice (thus closing the loop between developmental science, social-psychological studies, and education science). We aim to provide a coherent framework that psychologists can use to better understand recent social-psychological interventions to reduce gender gaps in STEM. Because of space limitations, we postpone discussion of other important issues that contribute to gender gaps, such as societal and institutional structures that have historically contributed to inequality, in part because these have been comprehensively reviewed in other articles (e.g., Ceci et al., 2009; Lee, 2017; Nasir & Hand, 2006). We have aimed to include a comprehensive set of research articles, but note that this is not a complete review of the vast literature on stereotypes, self-representations, and motivation in STEM. We focused our review primarily on research relevant to our new theoretical model.

This paper differs from previous reviews on STEM stereotypes in three specific ways by: (a) emphasizing the importance of sense of belonging; (b) acknowledging variation between STEM fields as part of our conceptualization rather than glossing over differences; and (c) considering developmental issues and the motivation of students from preschool through college. To our knowledge, no other review has united these perspectives.

Regarding the sense of belonging, our model is compatible with other theories of student motivation that focus on the link between self-concepts and academic outcomes or factors that make students want to engage with a domain (e.g., Eccles, 2011; Oyserman & Lewis, 2017; for a review, see Wigfield et al., 2006), but also emphasizes the importance of a sense of belonging (see also Eddy & Brownell, 2016; Fiske, 2010; Lewis, Stout, Pollock, Finkelstein, & Ito, 2016). Much research on sense of belonging and STEM has been conducted within social psychology (e.g., Walton & Cohen, 2007), and we aim to bring together this line of research with an expectancy-value perspective. Expectancy-value theory highlights how students' expectations of success and valuing of an academic domain influence their academic choices and behaviors, and has been a dominant focus in research on academic motivation (for a review, see Eccles, 2011). We focus on a subset of the variables typically included within expectancy-value theory to highlight the theoretical pathway by which stereotypes affect students' academic outcomes, and show how sense of belonging fits into this pathway. Although sense of belonging is not explicitly mentioned as part of the expectancy-value framework (Eccles, 2011), it is highly relevant for women and underrepresented minorities' motivation in STEM fields. Pervasive negative stereotypes and common social and environmental cues can signal to members of these groups that they do not belong, which reduces their motivation to pursue these fields (Good, Rattan, & Dweck, 2012; Lewis et al., 2016; Master, Cheryan, & Meltzoff, 2016a; Murphy, Steele, & Gross, 2007; Walton & Cohen, 2007).

Regarding variation in STEM fields, in this review we do not lump all STEM fields together because we see important differences among them. We specify the particular STEM fields used in each research study (e.g., math vs. engineering) throughout this review, and highlight recent research that suggests that differences in gender participation across STEM fields align with differences in stereotypes about each field. The unique cultural stereotypes about different STEM fields reduce many students' sense of belonging in those fields and make social identity particularly meaningful for STEM motivation. By incorporating stereotypes into our developmental model, we offer a way for future researchers to continue to organize important differences between STEM fields.

Regarding including preschool and early developmental phases, we differ from other valuable reviews (e.g., Ceci & Williams, 2011; Rosenzweig & Wigfield, 2016) by considering students from preschool through college. In recent years studies have emerged showing that starting as early as preschool and early elementary school, social identities and group memberships can influence students' STEM motivation (Master, Cheryan, & Meltzoff, 2017). This is part of the foundation of human development (Meltzoff, 2007). Examining STEM motivation starting at such a young age is important, because the *recruitment* of young women into a variety of STEM fields is a larger problem than *retaining* women in these fields (Miller & Wai, 2015). In addition, interventions designed to address recruitment or spark interest in STEM may be most effective if they start early (Maltese & Tai, 2010; Master, Cheryan, Moscatelli, et al., 2017; Musu-Gillette, Wigfield, Harring, & Eccles, 2015), with the potential for cascading effects across the lifespan.

NEW CONCEPTUAL MODEL: THE STEMO DEVELOPMENTAL MODEL

The chief goal for this paper is to synthesize evidence that cultural stereotypes have an effect on students throughout the lifespan by affecting their self-representations, which in turn drive many outcomes in STEM. Figure 1 shows our developmental model (in solid lines) and how theory-based interventions fit into this conceptualization (in dashed lines).

This conceptualization, which we call the STEreotypes, Motivation, and Outcomes (STEMO) developmental model, is different from previous models in several ways that we articulate below. However, it builds upon expectancy-value theory (Eccles, 2011) by integrating it with social-psychological research on the importance of social identities for academic motivation (Cohen & Garcia, 2008; Master, Cheryan, & Meltzoff, 2016b) and developmental research that has shown the effects of societal stereotypes in children as early as preschool (Hilliard & Liben, 2010; Patterson & Bigler, 2006; Rhodes, Leslie, & Tworek, 2012). Our developmental model is not intended to displace expectancy-value theory, but provides a way to complement it by incorporating newer research that emphasizes *sense of belonging* as a particularly central self-representation for students who face negative stereotypes about their social identities. We also note that this model currently focuses on individuals' social beliefs, attitudes, and representations, and does not (yet) explicitly incorporate the many ways in which the social context can affect all of these elements.

As shown in Figure 1, the STEMO developmental model highlights how social factors (e.g., pervasive stereotypes about one's own social identities, such as gender) influence students' interest and academic outcomes in STEM through self-representations. When students have a social identity that is the target of negative stereotypes in a domain such as a STEM field, they may experience more negative self-representations in that domain, such as reduced identification, reduced belief in their ability to succeed, and a lower sense of belonging. These negative self-representations lead to less interest and poorer academic outcomes in STEM (e.g., choosing not to enroll in optional STEM courses). Not all arrows in Figure 1 are depicted as bi-directional to simplify the illustration. However, we acknowledge that each element in the figure may affect the others as these processes influence others and play out continuously over time (e.g., Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002; Marsh & Martin, 2011).

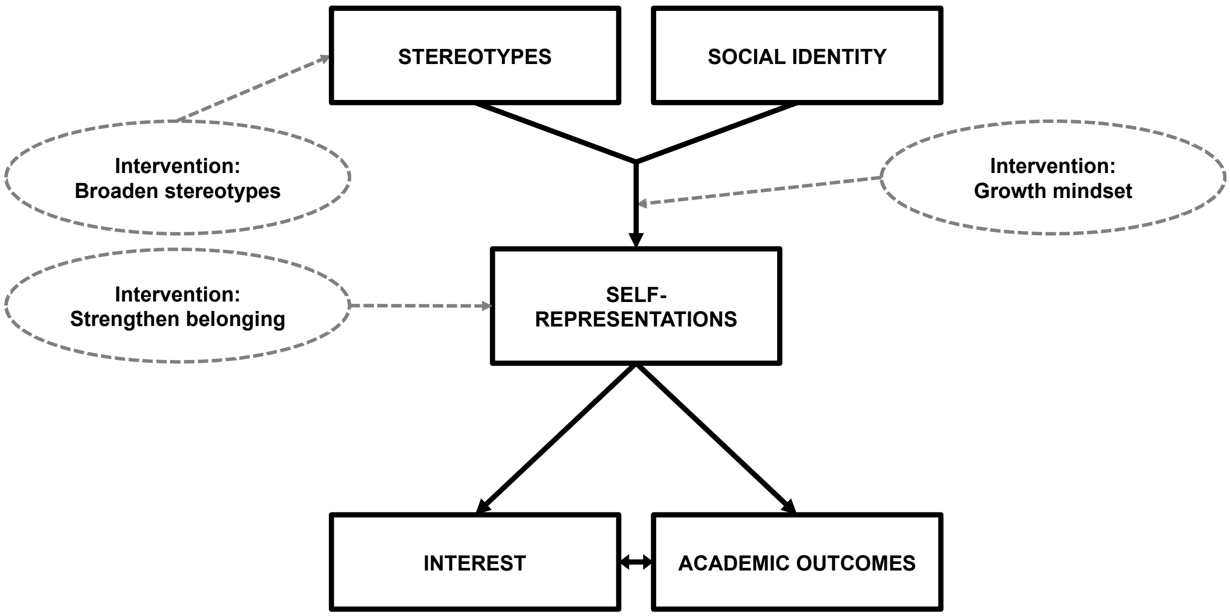

Fig 1 *Visualization of the STEMO model. The solid lines show our conceptualization of a pathway by which stereotypes and social identities impact STEM academic outcomes according to the STEreotypes, Motivation, and Outcomes (STEMO) developmental model. The dashed lines show where we can intervene to change outcomes. In this model, students encounter stereotypes about social groups (e.g., STEM-gender stereotypes that women do not fit or have as much ability in STEM as men). When those stereotypes are relevant to students' own social identity (e.g., gender), this affects their self-representations in STEM, including less identification, reduced ability beliefs, and a lower sense of belonging. This can impair their interest and academic outcomes (e.g., participation) in STEM. This STEMO model differs from previous motivational models (such as expectancy-value theory) by highlighting the importance of sense of belonging in fostering motivation for STEM and also by considering empirical effects starting as early as preschool. The STEMO model is also unique in incorporating information about where we can best intervene (dashed lines) to (a) broaden stereotypes to include diverse people and goals; (b) reduce the impact of stereotypes with growth mindsets, and (c) strengthen belonging by reducing belonging uncertainty. Such interventions can benefit women's motivation and outcomes in STEM.*

We also emphasize the role of developmental processes within this model in several ways. First, we consider these processes to begin to emerge with children's first experiences in school, during preschool and early elementary school, or perhaps even earlier. As soon as children learn about social categories, they begin to use that information to organize their expectations of the social world (Hilliard & Liben, 2010; Master, Markman, & Dweck, 2012; Patterson & Bigler, 2006). Second, we use this model as a framework to ask developmental questions: when do children begin to endorse these stereotypes, and when do stereotypes begin to affect their self-representations? How does this process unfold over time as children gain new social and academic experiences? Current research suggests that stereotypes are already linked to self-representations by early elementary school (Cvencek, Meltzoff, & Greenwald, 2011; Master, Cheryan, Moscatelli, et al., 2017). Finally, once we have a better understanding of how this process emerges developmentally, the model can be used in the design of future interventions to help make predictions about which interventions will be effective at which ages.

Value of the Model

The STEMO model has three valuable characteristics. First, it can be applied to any stereotyped social identity. Similar processes to those proposed here would apply for members of other groups who face negative stereotypes in STEM, such as certain racial/ethnic groups. In this paper, we focus on gender to illustrate our model, due to the large amount of research on this social identity, and we return to the issue of other stereotyped groups at the end of this review. Second, we explicitly emphasize developmental processes and change over time in this model. It can be applied to students from preschool through higher education. Thus, the model is directed at the roots and earliest manifestations of the role of stereotypes, even before formal schooling begins. Although these dynamic processes are often overlooked outside of developmental psychology, they have important practical implications, such as insights into the optimal timing for different types of interventions. Third, a unique feature of the STEMO developmental model is that it also serves as a basis for designing and classifying interventions that effectively buffer against the effects of stereotypes and enhance women's self-representations in STEM, as shown by the dashed lines in Figure 1.

When combined with research into the development of stereotypes and self-representations, the STEMO developmental model can help make predictions about which interventions will be successful at what ages, and the mechanisms by which they work. In a separate section of this paper, we will use the model to discuss three types of evidence-based interventions.

Distinctiveness of the Model

The STEMO model is related to Eccles and colleagues' seminal expectancy-value theory with several differences, including the emphasis on sense of belonging. Another notable difference is in our use of "interest" as a motivational outcome influenced by self-representations such as ability beliefs (our superordinate term that includes expectations of success). Expectancy-value theory models typically use "interest/enjoyment/intrinsic value" as a predictor of behavioral outcomes such as achievement-related choices and performance, in *parallel* with ability beliefs

(Eccles, 2011). In contrast, our model uses interest as an outcome variable, with ability beliefs as one of its *predictors*. We do this for three reasons.

First, ability beliefs are more likely to predict interest over time than the reverse (Wigfield & Eccles, 2002), which provides empirical support for our approach. Second, interest has distinct motivational properties, including the predisposition to re-engage with a domain over time (Hidi, 2006; Renninger & Hidi, 2011; Sansone, 2009). This makes it particularly valuable to consider as an outcome for long-term STEM pathways. Third, many studies have found empirically that interest more strongly predicts academic choices than ability beliefs do (Barron & Hulleman, 2015; Wigfield et al., 2015). This means that interest plays a critically important role in students' academic outcomes, and interventions that target interest may have a high likelihood of impacting academic choices. By highlighting interest as an outcome variable, we can discuss experiments and interventions that seek to causally increase students' interest, and thereby influence long-term academic pathways.

The STEMO model is also conceptually related to a large body of literature on the relation between group stereotypes and self-representations. This is a bi-directional relation, in which stereotypes of the group influence beliefs about the self at the same time that beliefs about the self influence perceptions of the group. This distinction has been referred to as self-stereotyping vs. self-anchoring, or deduction-to-the-self vs. induction-to-the-group, in social psychology (Latrofa, Vaes, Cadinu, & Carnaghi, 2010; van Veelen, Otten, Cadinu, & Hansen, 2016); as the attitudinal pathway versus the personal pathway in developmental psychology (Liben & Bigler, 2002); and is theorized to be balanced in a three-way relation among self, group, and academic field (e.g., math) in balanced identity theory (Cvencek et al., 2011; Cvencek, Meltzoff, & Kapur, 2014; Patterson & Bigler, 2018).

Our STEMO model focuses on one pathway in this theorized three-way relation: how group stereotypes exert an influence on self-representations. We do so for several reasons. First, this pathway is supported by empirical developmental data. Although data is limited, it appears that endorsement of stereotypes about the group precedes the development of gender differences in self-concepts (Cvencek et al., 2011; Eccles, 2009; see also Eccles, Wigfield, Harold, & Blumenfeld, 1993; Liben & Bigler, 2002). Second, research suggests that this pathway is especially strong when a group has lower status, such as women in STEM (Latrofa et al., 2010). Third, we do so for pragmatic reasons. We are focused on explaining motivation at the individual level, rather than explaining the formation of beliefs about the social group. Thus, we focus on how beliefs about the group influence beliefs about the self, rather than the other way around. This direction of causality is also more relevant for interventions targeting girls' low interest in STEM. If stereotypes have a causal impact on interest, then interventions can focus on girls who endorse cultural stereotypes in hopes of changing their stereotypes to boost their motivation in STEM.

STEM-GENDER STEREOTYPES

There are prevalent cultural stereotypes in Western countries associating boys and men with many STEM fields (Master, Cheryan, & Meltzoff, 2014). We will refer to these stereotypes collectively as *STEM-gender stereotypes*. These stereotypes are transmitted to students by parents, teachers, peers, and media (Cheryan et al., 2015; Cvencek, Kapur, & Meltzoff, 2015; Cvencek et al., 2011; Gunderson, Ramirez, Levine, & Beilock, 2012; Keller, 2001; Leaper, Farkas, & Brown, 2012; Rhodes & Leslie, 2017; Riegle-Crumb & Morton, 2017). According to our STEMO model (Figure 1), as children learn about cultural stereotypes, those stereotypes begin to shape the development of their self-representations.

Our review distinguishes between two types of STEM-gender stereotypes (Cheryan et al., 2015; Master & Meltzoff, 2016; Wynn & Correll, 2017): stereotypes about who likes or is associated with a field (which we will refer to as stereotypes about *interest*; also referred to as stereotypes about cultural fit) and stereotypes about who is good at or has superior ability in a field (which we will refer to as stereotypes about *ability*). These two types of stereotypes show different developmental patterns and may have different relations to STEM self-representations and interest (Master, Meltzoff, & Cheryan, 2020). The *combination* of both types of stereotypes about STEM fields contributes to the underrepresentation of women in these fields by acting as a gatekeeper that keeps women from entering. Women may worry both that they do not *fit* the image of a STEM person and that they do not have the *ability* to succeed in STEM. In distinguishing between these two types, our evaluation of the influence of stereotypes is much broader than the influence of *stereotype threat* research, which focuses on how ability stereotypes impact women’s performance in STEM. Stereotype threat itself may be insufficient to account for gender gaps in participation (Stoet & Geary, 2012), and represents only one small piece of a larger mechanism by which stereotypes influence STEM participation.

When Do STEM-Gender Stereotypes First Develop?

Stereotypes about interest. Stereotypes about interest encompass beliefs about which social groups typically enjoy or are interested in STEM (as well as stereotypes about who is associated with STEM fields, although these may be slightly different conceptually). Interest stereotypes have been measured using both direct (e.g., self-report) and indirect methods. Indirect methods include implicit measures, such as the Child Implicit Association Test (e.g., Cvencek et al., 2011), which assesses children’s implicit reactions that boys are linked with math and girls with reading. This test is built on the principle that people respond more quickly to associations that are congruent with their implicit stereotypes and biases (e.g., *math = boys* and *reading = girls*) than to associations that are incongruent with those stereotypes (*reading = boys* and *math = girls*). In terms of math, North American children as early as second grade already register the implicit stereotype that *math = boys* (Cvencek et al., 2011), and Chilean boys report this implicit stereotype in kindergarten (del Río, Strasser, Cvencek, Susperreguy, & Meltzoff, 2019). Another indirect method, the Draw-a-Scientist test, has found that children become more likely to draw a male scientist than a female scientist as they get older, with girls more likely than chance to draw a male scientist beginning around age 10 (Miller, Nolla, Eagly, & Uttal, 2018). In terms of technology, 6-year-old North American children explicitly report that boys will enjoy a programming or robotics activity more than girls (Master, Cheryan, Moscatelli, et al., 2017), and 6th graders are more likely to depict a computer expert as male than female (Mercier, Barron, & O'Connor, 2006). In terms of science, by fourth grade (the youngest age tested so far) European and North American girls and boys associate boys with science, and expect boys to enjoy science more than girls (Archer et al., 2012; Farenga & Joyce, 1999). Thus, endorsement of cultural stereotypes about interest appears to emerge during elementary school across multiple STEM fields.

Stereotypes about ability. Most previous research has focused on stereotypes about whether boys or girls are "better at math" (often conceptualized as having more fixed or innate ability). Very little research has examined children's stereotypes about ability in technology, engineering, or computer science. The existing findings suggest a developmental shift during elementary school, although findings differ based on nationality and the exact methods and wording used to measure stereotypes. When explicitly asked which group is "better" at math or science, in the youngest ages tested (from kindergarten to second grade), North American and some European children report either that the genders are equal in ability (Hargreaves, Homer, & Swinnerton, 2008; J. Steele, 2003) or show a bias that their own-gender group is better (Kurtz-Costes, Rowley, Harris-Britt, & Woods, 2008; Master, Cheryan, Moscatelli, et al., 2017; Passolunghi, Rueda Ferreira, & Tomasetto, 2014), although this can vary by culture (Lummis & Stevenson, 1990). Research suggests that some European and Chinese girls do not endorse the stereotype that boys are better at math until fourth grade or later (Martinot & Désert, 2007; Muzzatti & Agnoli, 2007; Passolunghi et al., 2014; Zhao, Zhang, Alterman, Zhang, & Yu, 2018; see also del Río & Strasser, 2013), although North American middle school students sometimes report counter-stereotypes that girls are better than boys at math and science (Evans, Copping, Rowley, & Kurtz-Costes, 2011; Plante, Théoret, & Favreau, 2009; Rowley, Kurtz-Costes, Mistry, & Feagans, 2007). In terms of technology, North American children begin to believe that boys are better than girls at computer science and engineering by age six (Master, Cheryan, Moscatelli, et al., 2017). Thus, endorsement of cultural stereotypes about ability appears to emerge later and less consistently across fields than stereotypes about interest.

Concurrent developments involving career choices, aspirations, and values. Children's career aspirations begin to form during elementary school, which is also the period during which children become more familiar with stereotypes involving both interest and ability. The choice of whether students intend to pursue science careers in particular often occurs during middle school (Tai, Liu, Maltese, & Fan, 2006). This is also an important time period for the long-term trajectories of students' expectations of success and valuing of different fields (Jacobs et al., 2002). Thus, as girls begin to form and express these early career choices, they are already aware that boys are associated with and widely believed to be better than girls at many STEM fields. Endorsement of these stereotypes is also correlated with lower interest in STEM among girls and higher interest in STEM among boys (Blažev, Karabegović, Burušić, & Selimbegović, 2017; Master, Cheryan, Moscatelli, et al., 2017; Plante, De la Sablonnière, Aronson, & Théorêt, 2013; see also Weisgram, Bigler, & Liben, 2010).

How Parental and Teacher Stereotypes Impact Students

Stereotypes may also influence students externally through the people around them, who socialize girls and boys differently when it comes to STEM (Eccles, 2009, 2015; for a review, see Gunderson et al., 2012). Parents and teachers may hold math- and science-gender stereotypes and attitudes that influence their expectations for and interactions with children (e.g., Beilock, Gunderson, Ramirez, & Levine, 2010; Gunderson et al., 2012), which then influence children's self-concepts (del Río et al., 2019; Friedrich, Flunger, Nagengast, Jonkmann, & Trautwein, 2015).

Parents may provide more or fewer opportunities for their children to participate in math and science activities, depending on their beliefs about gender-appropriate activities (Jacobs, Davis-Kean, Bleeker, Eccles, & Malanchuk, 2005). In one study, parents who endorsed gender stereotypes were also more likely to give intrusive, uninvited assistance on math homework to girls, which led to lower math ability beliefs for those girls (Bhanot & Jovanovic, 2005). Parents explain less about scientific concepts to girls than boys (Crowley, Callanan, Tenenbaum, & Allen, 2001), and underestimate their daughters' interest in science books (Ford, Brickhouse, Lottero-Perdue, & Kittleson, 2006). On average, parents also believe that science is less interesting and more difficult for daughters compared to sons, and their beliefs are correlated with their children's science interest and beliefs about their ability to learn science (Tenenbaum & Leaper, 2003). Parents are also influenced by the gendered packaging of mechanical toys when they guide their children in play, encouraging more building for "boys' toys" and more narrative play for "girls' toys" (Coyle & Liben, 2020).

Potential ways that teachers' stereotypes affect their students may include explicit verbal statements about gender, differential treatment (e.g., interacting more with boys than girls in math class; Becker, 1981), or modeling their own math anxiety (Beilock et al., 2010; Gunderson et al., 2012). Elementary school math teachers' gender biases have long-lasting effects, including the number of advanced math and science courses that students take in high school (Lavy & Sand, 2018). Even well-intentioned language such as "Girls are as good as boys at math" can unintentionally emphasize the talent of boys and reinforce stereotypes (Chestnut & Markman, 2018). Although not specific to STEM, teachers may give more negative academic feedback to girls in general (compared to negative behavioral feedback to boys), which has a negative impact on girls' ability beliefs (Dweck, Davidson, Nelson, & Enna, 1978). Thus, stereotypes may cause parents and teachers to treat girls and boys differently when it comes to STEM, which may affect children's opportunities and attitudes.

Social Identity Threat

As students become aware that others hold these stereotypes, they may begin to experience social identity threat. "Social identity threat" refers to the concern about being viewed negatively due to social group membership (C. Steele, Spencer, &

Aronson, 2002). For members of negatively stereotyped groups (e.g., women in STEM), a situation in which that group identity is highlighted raises the possibility that others will make assumptions about them based on their membership in that group. Certain cues in the environment can confirm this possibility and create a sense of social identity threat. These cues include the social identities of other people in that environment, such as a male-dominated group of students or teachers (Master et al., 2014); the social identities of other people in a *potential* environment (Murphy et al., 2007); and the design of the physical classroom environment (Master et al., 2016a). For social identity threat, students' *awareness* of stereotypes may be more influential than their *endorsement* of stereotypes (Cvencek, Nasir, O'Connor, Wischnia, & Meltzoff, 2015; Huguet & Régner, 2009), although students' self-representations may be shaped more strongly by their endorsement (Master, Cheryan, & Meltzoff, 2019; Owens & Massey, 2011).

Social identity threat is a broad category that includes *stereotype threat*, the concern about being seen through the lens of a negative stereotype about one's group (C. Steele, 1997). Many studies have shown that making group membership salient (e.g., checking a box for gender) leads to decreased performance for members of stereotyped groups (for a meta-analysis, see Nguyen & Ryan, 2008), especially those who identify strongly with that domain (Kahalon, Shnabel, & Becker, 2018; Schmader, 2002). Stereotype threat affects children and early adolescents as well as adults (Flore & Wicherts, 2015). Although most stereotype threat research has examined *performance* as the outcome, some research has examined effects on motivation (Murphy et al., 2007; Thoman, Smith, Brown, Chase, & Lee, 2013). Negative effects of stereotype threat on performance and motivation can create a negative feedback loop that harms students' self-representations, which leads to further negative effects on performance and motivation (Cohen, Garcia, Purdie-Vaughns, Apfel, & Brzustoski, 2009; Cohen & Sherman, 2014). In the next section, we discuss the important role of students' self-representations in greater detail.

SELF-REPRESENTATIONS

Stereotypes can also influence students by changing how they view themselves (Cvencek et al., 2011; Cvencek et al., 2014; Tobin et al., 2010). According to our STEMO developmental model, when students with a stereotyped social identity start to endorse these stereotypes, they may develop representations of the self that are aligned with those stereotypes. In turn, those representations shape their developing interest in STEM fields and influence their STEM outcomes. Again, we intend for the term *self-representations* (also known as self-perceptions; Banchefsky, Lewis, & Ito, 2019) to include self-concepts and self-relevant motivational beliefs. We focus on three specific self-representations: identification, ability beliefs, and sense of belonging in STEM. We focus only on these three specific self-representations due to space limitations and due to their strong and established relations to STEM-gender stereotypes (Eddy & Brownell, 2016), but other beliefs and values are also important, such as the perceived costs (Perez, Cromley, & Kaplan, 2014) or utility value associated with STEM fields (Rozek, Hyde, Svoboda, Hulleman, & Harackiewicz, 2015). Stereotypes have also been linked directly to academic outcomes, such as participation in science. For example, one study found that gender differences in college students' plans to pursue a career in science or the humanities were driven by students' implicit associations between science and gender (Lane, Goh, & Driver-Linn, 2012). Across 66 countries, science-gender stereotypes are correlated with women's lower participation in science at the college and professional levels (Miller, Eagly, & Linn, 2015), highlighting the importance of gender stereotypes for STEM outcomes cross-culturally. Relatedly, when students feel more similar to the prototypical student in a field, they report greater interest in that field themselves (Kessels, 2005; Kessels, Heyder, Latsch, & Hannover, 2014).

We view the literature as supporting our STEMO model if: (a) correlational and/or experimental studies link that self-representation to interest and academic outcomes in STEM, (b) gender differences related to STEM are evident for that self-representation (to confirm that gender moderates the effects of stereotypes), and (c) correlational and/or experimental studies link stereotyping to that self-representation. We review each type of evidence below.

Identification

Links to STEM outcomes. Identification involves both linking the self to a domain or social group (e.g., "I'm a math person") and valuing that domain or group (e.g., "math is important to me"). It is highly similar to "attainment value" as described in expectancy-value theory, when applied to a domain such as math (Wang & Degol, 2013). Identification can predict students' interest and academic outcomes (Osborne & Jones, 2011). Women's science, engineering, and physics identification is significantly correlated with their career intentions and persistence in science/engineering/physics in college (Hazari, Sonnert, Sadler, & Shanahan, 2010; Jones, Ruff, & Paretti, 2013; Smith, Brown, Thoman, & Deemer, 2015; Stout, Dasgupta, Hunsinger, & McManus, 2011; Young, Rudman, Buettner, & McLean, 2013). Girls' sense that "being a scientist" is incompatible with their gender identity can decrease their interest in STEM (Lei, Green, Leslie, & Rhodes, 2019). For this reason, describing science with identity language ("Let's be scientists!") instead of action language ("Let's do science!") decreased girls' persistence in science games (Rhodes, Leslie, Yee, & Saunders, 2019).

Gender differences. Gender differences in identification with STEM emerge surprisingly early. As early as elementary school, U.S. girls identify less strongly with math than do boys, as measured by their performance on a Child Implicit Association Test (Cvencek et al., 2011), and middle school girls report lower science identity than boys (Vincent-Ruz & Schunn, 2018). Adult women also report lower identification than men in physics and math (Hazari et al., 2010; Seyranian et al., 2018; Smith & White, 2001).

Links to stereotypes. Although causal pathways have not been empirically determined, several studies have found that endorsement of STEM-gender stereotypes correlates negatively with girls' identification with STEM. Singaporean and German girls' implicit and explicit math-gender stereotypes are negatively correlated with their math identification in elementary school (Cvencek et al., 2011; Cvencek et al., 2014; Cvencek, Kapur, et al., 2015; Steffens, Jelenec, & Noack, 2010). Similarly, college-aged women's implicit science-gender stereotypes are negatively correlated with their science identification (Cundiff, Vescio, Loken, & Lo, 2013; Young et al., 2013; see also Smith et al., 2015). Women in Silicon Valley tech companies who endorsed interest stereotypes about tech workers also reported lower identification with the tech profession (Wynn & Correll, 2017). Conversely, the more that college-age women implicitly associate women with math, the stronger their math identification and interest (Gilbert, O'Brien, Garcia, & Marx, 2015). Experiences of stereotype threat may also cause women to disidentify from scientific domains, choosing other domains instead (Smith et al., 2015).

Ability Beliefs about the Self

Links to STEM outcomes. We use *ability beliefs* to refer to students' judgments about their ability to succeed in a particular domain or task, including beliefs about present ability or future level of success, as well as confidence in that domain. When students approach a STEM task or domain, do they have the sense that they can be successful? We use ability beliefs as an umbrella term to cover several types of beliefs that have been measured in previous research, including "self-efficacy" (beliefs about current ability to succeed in a task or domain), "expectations of success" (beliefs about future success), "perceived competence," "self-confidence," or "academic self-concept" (which can be measured for perceived abilities in a specific academic domain). These types of beliefs are typically highly linked to one another empirically (Eccles & Wigfield, 1995; Eccles, 2009). These beliefs about the self can play an important role in students' interest and academic outcomes (Perez et al., 2014).

Ability beliefs about the self are correlated with course selection and major. One study found that North American girls' math self-concept in both 6th and 10th grade predicted the number of math courses they took in high school, and science self-concept in 10th grade predicted the number of science courses they took in high school (Simpkins, Davis-Kean, & Eccles, 2006). Women who believed they had the ability to master challenging math tasks in 12th grade were three times more likely to major in physical science, engineering, math, and computer science in college than women who did not believe they had that ability (Perez-Felkner, Nix, & Thomas, 2017). College students with high computing self-efficacy were more likely to take a computer science class during the following year (Beyer, 2014). A longitudinal study from 12th grade through the second year of college found that Canadian college students with stable or increasing science self-efficacy were more likely to persist across a variety of science majors compared to students with decreasing self-efficacy (Larose, Ratelle, Guay, Senécal, & Harvey, 2006). Ability beliefs predict STEM interest and outcomes above and beyond prior performance. One study found that 12th grade students' math ability self-concepts predicted their participation in a variety of STEM careers at age 29, even controlling for math performance (Eccles & Wang, 2016).

As posited by expectancy-value theory, positive ability beliefs in STEM are a necessary but not sufficient predictor of STEM interest and academic outcomes (Wang & Degol, 2013). Even when girls have the belief that they can succeed in math and science, they may still be uninterested in math and science activities and careers (Jacobs et al., 2005; Weisgram & Bigler, 2007). Ability beliefs also may be more strongly linked to girls' motivation in STEM compared to boys' motivation. One study found that actual performance and perceived math self-concept predicted Australian and North American female adolescents' career plans for a variety of STEM fields, but not male adolescents' plans (Watt et al., 2017).

Gender differences. A large international dataset with students ages 14-16 found that boys reported higher math self-confidence than girls, with a small effect size of d = .15 (Else-Quest, Hyde, & Linn, 2010). Boys report higher math ability beliefs than girls even when their objective ability is identical (Perez-Felkner et al., 2017). Several studies with adults have also found that adult women underestimate their scientific capabilities compared to men and hold themselves to a higher standard before applying to math- and science-related college majors or job openings (Ayalon, 2003; Ehrlinger & Dunning, 2003), and this underestimation is linked to their lower interest in math-related fields (Bench, Lench, Liew, Miner, & Flores, 2015). Other studies have also found that boys in the United States, Australia, and Germany have more positive math self-concepts than girls, although competence beliefs decline for both boys and girls across grades K-12 (Nagy et al., 2010; see also Carr, Steiner, Kyser, & Biddlecomb, 2008). Middle school boys in the United States were more likely to report high confidence in their science ability than girls (P.W. Hill et al., 2017). In terms of STEM fields other than math and science, one study found that high school boys in Sweden reported higher self-efficacy than girls in engineering and computer programming, and this gender difference partially mediated the gender difference in interest in these fields (Tellhed, Bäckström, & Björklund, 2017). College women in computer science, physics, and math also report lower self-efficacy than men (Ellis, Fosdick, & Rasmussen, 2016; Lewis et al., 2017).

Links to stereotypes. Girls' lower ability beliefs in STEM are correlated with cultural stereotypes that girls have lower ability in these domains. As early as elementary school, North American and European girls' explicit endorsements of math-gender and programming-gender stereotypes are negatively correlated with their self-perceptions of math ability, programming self-efficacy, and math academic self-concepts (Master, Cheryan, Moscatelli, et al., 2017; Passolunghi et al., 2014; Plante et al., 2013; Steffens et al., 2010). Similarly, for adults, college women who worried about negative stereotypes reported lower science self-efficacy and lower intentions to major in physics (Deemer, Thoman, Chase, & Smith, 2014; Stout et al., 2011), and female engineers with higher implicit stereotypes linking *male = engineering* also reported lower self-efficacy in engineering (Block, Hall, Schmader, Inness, & Croft, 2018). Even within a sample of German women majoring in computer science and engineering who had positive academic self-concepts, the more that women endorsed interest and ability stereotypes about STEM, the lower their STEM self-concept (Ertl, Luttenberger, & Paechter, 2017). The more that high school girls endorsed ability stereotypes about math, the more they underestimated their own performance on a high-stakes math exam (Chatard, Guimond, & Selimbegovic, 2007). Similarly, the more that college women in math-related majors endorsed ability stereotypes about math, the lower their confidence in their future math performance (Schmader, Johns, & Barquissau, 2004).

Sense of Belonging

Links to STEM outcomes. Sense of belonging is a self-representation that indicates how much students see themselves as fitting in with those around them (Master et al., 2016a). We argue that sense of belonging plays a particularly important role in students' STEM interest and academic outcomes. Belonging has been described as one of five core social motives (Fiske, 2010), or as one of the psychological needs that facilitate intrinsic motivation (Ryan & Deci, 2016). Students who feel a strong sense of belonging and social connectedness in school show positive changes in motivation and academic achievement over time (Osterman, 2000). Connections to others can also help to trigger greater interest in STEM subjects (Thoman, Sansone, Fraughton, & Pasupathi, 2012).

College women's sense of belonging across a variety of STEM fields strongly correlates with their motivation in those fields (Lewis et al., 2017; Smith, Lewis, Hawthorne, & Hodges, 2013). Longitudinal studies of college students majoring in a variety of STEM fields have found that sense of belonging is positively correlated with women's intentions to persist and actual persistence in their major, to a greater extent than men's sense of belonging (Banchefsky et al., 2019; London, Rosenthal, Levy, & Lobel, 2011; see also Good et al., 2012; Stout & Blaney, 2017). Similarly, women's perceptions that they matched the cultural stereotype of people who succeed in technology (in other words, that they "fit in") was a stronger predictor of intentions to persist in technology companies than their sense that they matched the skill stereotype of people who succeed in technology in a simultaneous regression analysis (Wynn & Correll, 2017). Belonging is also related to academic performance. In one study, the more that college women wrote about social belonging during a values affirmation, the better they performed on a subsequent math test (Shnabel, Purdie-Vaughns, Cook, Garcia, & Cohen, 2013). Although limited research on sense of belonging has been conducted with young children, preschool children showed greater persistence and performance on STEM tasks when they felt socially connected to a group (Master et al., 2017).

Different types of belonging may matter for different groups in STEM. For members of racial/ethnic minority groups, both *social* belonging (concerns that they may not fit in with others around them due to their numeric minority status) and *academic* belonging (concerns that other students around them have skills that they lack) may be uncertain. For girls and women in STEM, academic belonging in STEM may be especially salient at times when they are sufficiently numerically represented (Lewis & Hodges, 2015; see also Aday & Schmader, 2019). Important influences that may decrease academic belonging for women in STEM include perceptions that they have fewer skills or that they have to work harder than other students to succeed (Smith et al., 2013; Walton & Cohen, 2007). Both academic and social belonging predict women's intentions to persist in STEM fields (Banchefsky et al., 2019).

Gender differences. Adult women feel a lower sense of social belonging than men in STEM fields such as computer science and physics (Lewis et al., 2017; Stout & Blaney, 2017), and this gender gap can widen over the course of a single introductory college course (Sax et al., 2018). Girls in Western countries feel a lower sense of belonging in STEM fields such as computer science and engineering by high school, which is correlated with lower interest, even controlling for other variables such as expectations of success and utility value (Ito & McPherson, 2018; Master et al., 2016a; Tellhed et al., 2017).

Links to stereotypes. Students' sense of belonging in STEM is directly related to culturally-held STEM-gender stereotypes (Dasgupta, 2011). For example, college-age women's awareness of stereotypes about ability correlates with lower sense of belonging in a variety of STEM majors (Ahlqvist, London, & Rosenthal, 2013), and female engineers with higher implicit *male = engineering* stereotypes reported a lower sense of fit with their organization (Block et al., 2018). Similarly, college women who felt less similar to the "prototypical" computer scientist or engineer reported lower interest in computer science and engineering (Ehrlinger et al., 2018).

Experimental studies indicate that changing stereotypical cues in the environment can increase women's sense of belonging and interest in computer science (Cheryan, Meltzoff, & Kim, 2011; Cheryan, Plaut, Davies, & Steele, 2009). A classroom that contained objects fitting a stereotypical image of computer science as "geeky" and masculine made high school girls feel that they would not belong in that classroom (Master et al., 2016a). Girls also reported low interest in taking a computer science course in that classroom. In contrast, a classroom that contained neutral objects (e.g., potted plants) made girls feel a significantly higher sense of belonging, with greater interest in taking that course. In this way, stereotypes can act as a barrier or "gatekeeper" that prevents girls from feeling a sense of belonging in STEM, and thus keeps them out of these fields (Cheryan et al., 2015).

WHAT CAN BE DONE? EFFECTIVE INTERVENTIONS

Boys show greater motivation than girls for many STEM fields starting at an early age, but motivation is malleable, and can be changed. Experimentally designed interventions have succeeded in using social influences to boost students' identification (Ramsey, Betz, & Sekaquaptewa, 2013; Stout et al., 2011), ability beliefs (Dennehy & Dasgupta, 2017; Luzzo, Hasper, Albert, Bibby, & Martinelli, 1999; Shin, Levy, & London, 2016), and sense of belonging (Gehlbach et al., 2016; Walton, Logel, Peach, Spencer, & Zanna, 2015; see also Yeager & Walton, 2011).

In this section we highlight three promising intervention approaches. See Figure 1 for how each intervention targets the key components of our proposed STEMO model. These experimental interventions have been able to: (a) broaden stereotypes about STEM and who belongs in STEM, (b) reduce the impact of negative stereotypes through a growth mindset, or (c) strengthen belonging by reducing belonging uncertainty. These interventions are in no way intended to absolve the people within STEM disciplines, classrooms, and workspaces from their responsibility to reduce structural and societal disparities. However, they provide a way for teachers and students to reduce the effect of cultural stereotypes while larger societal issues remain. These three types of interventions create a buffer that protects students' self-representations in STEM despite pervasive societal stereotypes.

Intervention Type 1: Broaden Stereotypes about STEM
Broadening cultural stereotypes. If women feel that they do not belong in STEM because of cultural stereotypes, one solution is to change the stereotypes. Although eliminating cultural stereotypes is difficult (J. Steele, 2003), an alternative is to *broaden* the stereotypes by giving students diverse examples of who does STEM and what STEM involves. For example, changing the objects in a computer science classroom or office environment to be less stereotypically masculine and "geeky" can encourage high school girls to show an interest in that environment (Master et al., 2016a). Showing non-stereotypical role models with diverse personalities and interests can increase women's math identification, as well as their sense of belonging, expectations of success, and interest in computer science (Cheryan, Drury, & Vichayapai, 2013; Stout et al., 2011). Female role models may also reduce high school girls' worries about being negatively stereotyped in a computer science class (Master et al., 2014).

Creating an image of STEM as communal. Another stereotype about STEM is that it involves solitary, non-communal work (Diekman, Clark, Johnston, Brown, & Steinberg, 2011). Studies have found that the more that people value communal goals (which include both altruistic helping and collaborating with others), the less interested they are in science and engineering careers, even controlling for differences in previous experiences and STEM self-efficacy (Diekman, Brown, Johnston, & Clark, 2010). One way that stereotypes about STEM may decrease women's identification with science is by undermining their perception that science is communal (Smith et al., 2015). Changing these stereotypes by helping young women and members of other underrepresented groups see the potential for communal experiences in STEM can boost students' self-representations in STEM (Thoman, Muragishi, & Smith, 2017). Experimentally highlighting communal values can have a causal boost on students' interest in STEM. For example, female college students who learned about a day in the life of a scientist whose daily activities were highly collaborative had more positive attitudes towards science careers compared to students who learned about an independent scientist (Diekman et al., 2011).

Intervention Type 2: Growth Mindsets to Reduce the Impact of Stereotypes
Growth mindsets and STEM. One way to reduce the impact of stereotypes is by teaching growth mindsets. A growth mindset is the idea that abilities such as intelligence are malleable and can be changed through effort (Dweck & Master, 2009). This is in contrast to a fixed mindset, the idea that abilities such as intelligence are fixed and unchangeable. Growth mindsets may make students more willing to take on challenging STEM courses. Growth mindsets about intelligence in 6th grade predicted enrollment in more advanced math courses in middle school (Romero, Master, Paunesku, Dweck, & Gross, 2014), and endorsing growth mindsets about math in 9th grade predicted intent to take college math courses (Priess-Groban & Hyde, 2017). A belief that abilities are fixed may also be related to women's underrepresentation in STEM fields. Research has shown that the more

that people within a field endorse the belief that "natural" talent or genius (often conceived of as biologically fixed) is required for that field, the lower the proportion of women in the field (Leslie et al., 2015). These beliefs are more frequent within fields such as computer science and engineering. Similarly, learning about genetic sex differences increased adolescent girls' belief that science ability is innate, which in turn decreased their future STEM interest (Donovan, Stuhlsatz, Edelson, & Buck Bracey, 2019).

The effects of stereotypes on self-representations may be particularly strong for those who hold fixed mindsets. Indeed, fixed ability beliefs predict increased concerns about belonging for women in STEM (Bian, Leslie, Murphy, & Cimpian, 2018; Deiglmayr, Stern, & Schubert, 2019). In contrast, the growth mindset can help students realize that social identities will not prevent them from achieving success and that stereotypes are not destiny (Good et al., 2012). High school girls who endorsed a growth mindset about math had higher expectancies of success in math, which predicted higher math achievement (Degol, Wang, Zhang, & Allerton, 2018).

Teachers' and parents' mindsets can also influence students' self-representations and academic outcomes. For example, students from negatively stereotyped racial groups earned higher grades and reported greater motivation in STEM courses when their professors endorsed a growth mindset (Canning, Muenks, Green, & Murphy, 2019). Adults with fixed mindsets can also send messages to students that have a negative impact on their motivation (Park, Gunderson, Tsukuyama, Levine, & Beilock, 2016). Even well-meaning messages (for example, to reassure students struggling in math that "not everyone can be a math person") can inadvertently *undermine* students' motivation if they reinforce a fixed mindset. This type of "comfort-oriented" feedback sends the message that teachers have low expectations, which undermined students' expectations for success in math in one study (Rattan, Good, & Dweck, 2012).

Growth mindset interventions. In one study, college students who were experimentally taught to have a growth mindset about using computers subsequently showed greater self-efficacy in that domain (Martocchio, 1994). Similarly, when teachers emphasized the mistakes, failures, and struggles of others in science (emphasizing how famous scientists worked hard and learned over time), high school students showed greater interest and learning in science (Hong & Lin-Siegler, 2012). Interventions that have taught a growth mindset have shown benefits to students' motivation and academic outcomes (Blackwell, Trzesniewski, & Dweck, 2007), especially for members of negatively-stereotyped groups (Aronson, Fried, & Good, 2002; Broda et al., 2018) and low-achieving students (Paunesku et al., 2015; Yeager et al., 2019). A growth-mindset intervention in computer science classes significantly increased students' sense of belonging and interest in computer science (Burnette et al., 2020). In terms of women in STEM, hearing a STEM professor communicate the belief that everyone has the potential for growth eliminated the gender gap in STEM majors' sense of belonging in a STEM course (Rattan et al., 2018). An intervention that incorporated growth messages into an invitation to a tutoring program in an introductory STEM course led to more women signing up and attending the program, which then improved their course grades (Covarrubias, Laiduc, & Valle, 2019).

Intervention Type 3: Strengthen Belonging

Belonging uncertainty. Stereotypes can make members of stereotyped groups more vigilant for cues about whether their group membership will be relevant. This can also lead to a phenomenon known as "belonging uncertainty" (Walton & Cohen, 2007). When students from negatively stereotyped groups have doubts about their belonging in academic settings, they may show constant alertness for cues (such as environmental cues, Master et al., 2016a) about whether they belong. Their sense of belonging may be contingent on the most recent cues they experience. On good days, they may feel that they belong, but minor incidents (such as being excluded from social events by other students) can threaten their sense of fit in that environment (Cohen & Garcia, 2008). In this way, students who are uncertain of whether they belong may base their current sense of belonging on their most recent experiences in that setting.

Interventions to strengthen sense of belonging. Some interventions have strengthened women's sense of belonging by targeting belonging uncertainty: by framing adversity as normal, something all students experience that gets better over time (Walton & Cohen, 2007). This changes how students interpret adversity – as normal and temporary, instead of a sign that the student does not belong there. An intervention with first-year students in strongly male-dominated engineering majors found that this social-belonging intervention increased women's GPA compared to a control condition, and led women to report more positive experiences and greater confidence that they could succeed in engineering (Walton et al., 2015; see also Ramsey et al., 2013). Similarly, a letter from a female role model that normalized concerns about belonging improved women's course grades in chemistry (Herrmann et al., 2016).

Other interventions have used role models to strengthen women's sense of belonging. An intervention with pre-med majors found that exposure to successful female physicians increased women's sense of belonging, which led to increased interest in a medical career (Rosenthal, Levy, London, Lobel, & Bazile, 2013).

LOOKING FORWARD: RECOMMENDATIONS FOR ENRICHING THEORY AND PRACTICE

This integrated review has provided a developmental model for how stereotypes and self-representations (including identification, ability beliefs, and sense of belonging) can affect students' motivation in STEM, and also provided summaries of evidence-based interventions that have been effective. However, there are some key gaps in the literature.

Recommendation 1: New Correlational and Experimental Longitudinal Studies

Correlational longitudinal studies. New longitudinal studies are needed to examine differences in individual trajectories and to gain insights into potential causal linkages in development. It is an open question how the awareness of different types of stereotypes develops together with and influences students' self-representations (including sense of belonging) and interest in STEM (e.g., Musu-Gillette et al., 2015). If stereotypes truly have an influence on girls' sense of belonging in STEM, then awareness and endorsement of stereotypes about a STEM field should develop before or concurrently with a lower sense of belonging in that field and predict changes in belonging over time. We also are unaware of existing longitudinal studies examining how girls' sense of belonging in various STEM and non-STEM fields changes over time. Although there are some valuable existing longitudinal data sets, many of these studies (e.g., exploring expectancy-value theory; Jacobs et al., 2002; Musu-Gillette et al., 2015; Nagy et al., 2010) were conducted in the 1980s or 1990s, examined only math-related variables, and did not measure students' sense of belonging.

Interventions with long-term follow-ups. There is also a strong need for intervention studies that test mechanisms experimentally and then continue to follow students over time to show how long causal effects on behavior may last (e.g., Goyer et al., 2019; Harackiewicz, Rozek, Hulleman, & Hyde, 2012). This may be particularly important for studies with elementary and middle school students that aim to foster students' STEM interest at a young age. Can interventions at a young age have a lasting impact on students' academic choices, or will they "fade out" over time (Bailey, Duncan, Odgers, & Yu, 2017)? Can these interventions demonstrate measurable impact on behaviors (such as choosing to participate in optional after-school STEM programs) and implicit measures of identification with STEM, and not merely on explicit attitudes toward STEM?

Recommendation 2: Testing Intervention Generalizability

There are also few studies testing how well interventions work among different age groups or populations. There is a strong need to test effective interventions at scale and examine factors that moderate their effectiveness.

Developmental generalizability. An important question is whether different types of interventions are more effective for students at different ages. It remains unclear what types of interventions are more effective at younger ages (e.g., by shaping children's developing trajectories) or older ages (e.g., by targeting students when they are making college major decisions). For example, interventions to broaden stereotypes may be more effective at younger ages before stereotypes have taken root (e.g., early elementary school interventions to boost interest in math and science), and interventions that boost students' sense of belonging may become more effective for students in middle school or later, when students become more concerned with fitting in with peers. In addition, more research is necessary to test whether interventions that have been successful with college-aged women could be effectively adapted for younger girls. Both growth mindset interventions and social belonging interventions have resulted in positive outcomes for middle school students (Blackwell et al., 2007; Goyer et al., 2019), although their specific benefits for girls' STEM interest and outcomes at this age have yet to be shown.

Underrepresented minority groups and intersectionality in STEM. It is also important to examine the effectiveness of different interventions for members of underrepresented minority groups. For example, Black individuals represent 13.4% of the U.S. population and 13.6% of enrolled college students, but earned only 8.5% of STEM degrees in 2017 (U.S. Census Bureau, 2018; U.S. Department of Education, 2018b, 2018c). Researchers should also consider how intersectionality might affect students in STEM who belong to multiple stereotyped groups. Although this article has focused primarily on gender, and has only briefly mentioned racial/ethnic minority status, there are many important social identities that intersect with gender in students' experience of stereotypes (e.g., Rogers & Meltzoff, 2017; Turner & Brown, 2007). For example, Black women majoring in STEM report lower sense of belonging in STEM compared to other groups (Rainey, Dancy, Mickelson, Stearns, & Moller, 2018), and may benefit from both academic belonging interventions and social belonging interventions (Lewis & Hodges, 2015). Are belonging interventions most effective for young girls with multiple stereotyped identities, who may worry that they do not belong due to both their gender and racial identities? On the other hand, there is also some evidence that ethnic minority girls are less likely to endorse STEM-gender stereotypes and less likely to be subject to STEM-gender stereotypes from others (Casad, Hale, & Wachs, 2017; O'Brien, Blodorn, Adams, Garcia, & Hammer, 2015; Purdie-Vaughns & Eibach, 2008).

Other variables such as general racial stigma, information about and support for attending higher education, and family influences on self-representations may also be important for understanding the academic experiences of members of these groups (Simpkins, Price, & Garcia, 2015). Much of the existing research on negatively stereotyped groups such as racial minority students is highly compatible with our model and supports the importance of examining these students' sensitivity to stereotypes and sense of belonging (e.g., Gillen-O'Neel & Fuligni, 2013; Thoman et al., 2017). Nevertheless, it remains valuable to explore how psychological constructs are similar or different across social groups that are often underrepresented in research (Hall, Yip, & Zárate, 2016), as well as to recognize students as individuals who participate in cultural communities and practices rather than using their ethnic group as a trait for making generalizations (Gutiérrez & Rogoff, 2003).

Other moderators of effectiveness. There may be other differences between groups of students that impact the effectiveness of interventions. For example, growth mindset interventions are often most effective for struggling students (Paunesku et al., 2015; Yeager et al., 2019). Are growth mindset interventions more effective for girls who worry that their effort is a sign that they do not belong in STEM (Smith et al., 2013)? Are interventions to broaden stereotypes more effective for girls with a tendency to essentialize gender differences (Coleman & Hong, 2008; McPherson, Banchefsky, & Park, 2018)? There may also be meaningful variations in STEM stereotypes across cultural contexts that impact the effectiveness of interventions (e.g., Rattan, Savani, Naidu, & Dweck, 2012). The strength of the stereotype that *STEM = boys* also varies across countries (Nosek et al., 2009), so interventions to broaden stereotypes may be less effective than other approaches in countries where gender stereotypes are weaker.

Recommendation 3: Variations Within STEM
Recent findings suggest that researchers should pay attention to variations among STEM fields. Although math abilities and self-representations are important for a variety of STEM fields (Watt et al., 2017), researchers may gain predictive power by examining beliefs *specific to each STEM field separately*. There may be crucial differences in the stereotypes about different STEM fields (Cheryan et al., 2017). Fields which are believed to require natural ability, such as computer science, engineering, and physics, are also the fields in which women are most underrepresented (Leslie et al., 2015; Meyer, Cimpian, & Leslie, 2015). Even as early as elementary school, computer science and engineering gender stereotypes are stronger than gender stereotypes about math and science (Master, Cheryan, Moscatelli, et al., 2017; Master et al., 2020; see also Leslie et al., 2015). In college-aged students, there are differences even among different types of engineering fields (Walton et al., 2015). All STEM fields cannot be lumped together. In this review, our ability to directly compare STEM fields was limited by the fact that most studies described here were conducted within a single STEM domain, so we were unable to compare across multiple domains.

Our STEMO model (Fig. 1) would predict that the strength of stereotypes among STEM fields should correspond to more negative self-representations, as well as greater underrepresentation of women. In other words, the STEM fields with the strongest stereotypes should also be the fields in which women report the lowest levels of identification, ability beliefs, sense of belonging, and interest. Although some evidence does support this prediction (Leslie et al., 2015; Master, Cheryan, Moscatelli, et al., 2017), future research could directly quantify the strength of stereotypes across different STEM fields and relate that to girls' and women's self-representations and interest within those fields.

Another question for future research involves the root causes of differences in stereotypes across fields. Why might computer science and engineering have stronger gender stereotypes than math and biology? One source of this variation may be the relative lack of experience that students have with these fields (Cheryan et al., 2017). For example, students have many opportunities to see girls enjoying and succeeding at math, which may help to counter traditional stereotypes. Students may have very few experiences to counter traditional gender stereotypes about computer science. Another source of variation may lie in the masculine cultures of the fields, including the norms and values within these fields and how family-friendly they are perceived to be (Diekman et al., 2011; Weisgram & Diekman, 2017). Computer science and engineering are perceived to have particularly masculine cultures (Cheryan et al., 2015). Finally, it is difficult to tease apart the causal links between stereotypes about gender representation, stereotypes about ability, and stereotypes about interest in each field. Believing that few women participate in engineering may lead students to infer both that women are less interested and that they have lower ability compared to men. Conversely, believing that most women are uninterested in engineering may lead to inferences that they are unlikely to choose that field and that they lack engineering talent. In this way, stereotypes can act as self-fulfilling prophecies. Knowing these stereotypes pushes girls away from these fields, and reinforces the stereotypes for the next generation.

Recommendation 4: Open, Replicable, and Meaningful Science
Finally, there is a need for more pre-registered studies and replications in education (see Makel & Plucker, 2014). Pre-registration allows improved transparency (van't Veer & Giner-Sorolla, 2016) and reduces the frequency of the selective reporting of only statistically significant results out of multiple analyses, also known as p-hacking (Nelson, Simmons, & Simonsohn, 2018). Few of the studies reviewed here were pre-registered, and many of the interventions have not yet been reproduced by independent groups of researchers. Reproducibility and replication are especially important for educational interventions (U.S. Department of Education, 2018a). These interventions typically replace classroom learning opportunities, so it is important to examine them systematically to better understand when and for which students they are effective (Schneider, 2018). We also urge researchers to consider effect sizes and confidence intervals when evaluating the effectiveness of interventions (Cumming, 2013; C. J. Hill, Bloom, Black, & Lipsey, 2008). For example, if a growth mindset intervention leads to an increase of d = .11 in grade points for low-achieving students, how meaningful is such an effect (Yeager et al., 2019)? The average effect size, scalability (which has implications for cumulative impact across large numbers of students), and cost effectiveness of such interventions should all be considered (Kraft, 2019).

CONCLUSIONS

We have presented the STEMO developmental model to show the way that social identities and the stereotypes about them can impact students' STEM interest and academic outcomes through self-representations (Figure 1). When students face negative stereotypes about their social identity, those stereotypes can affect their self-representations. Those self-representations, in turn, can affect interest and academic outcomes (such as choice of STEM career or grades in STEM courses). We have argued that self-representations, including identification and ability beliefs, are a key part of this process. In particular, we emphasize the importance of students' sense of belonging for interest and academic outcomes in STEM. By organizing and synthesizing the research in this way, our goal is to draw attention to research on students' sense of belonging for STEM education.

We have also drawn attention to the many ways that *stereotypes* about students' social identities can impact their STEM outcomes through their beliefs, attitudes, and behavior regarding STEM. We have described both negative pathways (e.g., negative stereotypes about social groups that reduce students' sense of belonging in STEM) and positive pathways (e.g., interventions that broaden beliefs about STEM, use growth mindsets to reduce the impact of stereotypes, and normalize doubts about belonging) between stereotypes and STEM outcomes.

Our STEMO developmental model makes several novel contributions to our understanding of gender gaps in STEM. To help contribute to a more interdisciplinary and nuanced perspective on STEM education, we have made efforts to: (a) emphasize the importance of self-representations such as sense of belonging, (b) distinguish among STEM fields instead of grouping them together, and (c) consider developmental processes across a wide range of ages starting as early as preschool. Although the self-representations discussed here (identification, ability beliefs, and sense of belonging) are quite distinct from each other, our STEMO model highlights how each can be shaped by cultural stereotypes and social identities to change how students view themselves in relation to academic fields. Am I a STEM person? Do I have what it takes to succeed? Do I belong here? Each self-representation also acts in similar ways to shape students' interest and academic outcomes. By bringing together these disparate constructs, we aim to draw other researchers' attention to the parallels between them.

We also hope that the STEMO model outlined here can help guide educational research from correlational toward more experimental studies showing causal links between constructs. The emphases on stereotypes, social identity, variations among STEM fields, and developmental processes can help guide discussions about future interventions to provide theoretically-informed predictions. When and for whom will interventions be most effective when scaled up among heterogeneous populations of students?

We suggest that by changing messages about "who belongs" and can succeed in STEM, we can help girls, women, and members of other underrepresented groups feel a greater sense of belonging in a variety of STEM fields. In turn, this may encourage them to develop interest, pursue STEM opportunities, and contribute to the next generation of STEM innovators.

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REFERENCES

Aday, A., & Schmader, T. (2019). Seeking authenticity in diverse contexts: How identities and environments constrain "free" choice. *Social and Personality Psychology Compass*, *13*, e12450. doi:10.1111/spc3.12450

Ahlqvist, S., London, B., & Rosenthal, L. (2013). Unstable identity compatibility: How gender rejection sensitivity undermines the success of women in science, technology, engineering, and mathematics fields. *Psychological Science, 24,* 1644-1652. doi:10.1177/0956797613476048

Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B., & Wong, B. (2012). "Balancing acts": Elementary school girls' negotiations of femininity, achievement, and science. *Science Education*, *96,* 967-989. doi:10.1002/sce.21031

Aronson, J., Fried, C. B., & Good, C. (2002). Reducing the effects of stereotype threat on African American college students by shaping theories of intelligence. *Journal of Experimental Social Psychology, 38,* 113-125. doi:10.1006/jesp.2001.1491

Ayalon, H. (2003). Women and men go to university: Mathematical background and gender differences in choice of field in higher education. *Sex Roles*, *48*, 277-290. doi:10.1023/A:1022829522556

Bailey, D. H., Duncan, G., Odgers, C., & Yu, W. (2017). Persistence and fadeout in the impacts of child and adolescent interventions. *Journal of Research on Educational Effectiveness, 10,* 7-39. doi:10.1080/19345747.2016.1232459

Banchefsky, S., Lewis, K., & Ito, T. (2019). The role of social and ability belonging in men and women's pSTEM persistence. *Frontiers in Psychology*, *10*, 2386. doi:10.3389/fpsyg.2019.02386

Barron, K. E., & Hulleman, C. S. (2015). Expectancy-value-cost model of motivation. In J. D. Wright (Ed.), *International encyclopedia of the social & behavioral sciences* (2nd ed., Vol. 8, pp. 503–509). Oxford: Elsevier.

Becker, J. R. (1981). Differential treatment of females and males in mathematics classes. *Journal for Research in Mathematics Education, 12,* 40–53. doi:10.2307/748657

Beilock, S. L., Gunderson, E. A., Ramirez, G., & Levine, S. C. (2010). Female teachers' math anxiety affects girls' math achievement. *Proceedings of the National Academy of Sciences*, *107,* 1860-1863. doi:10.1073/pnas.0910967107

Bench, S. W., Lench, H. C., Liew, J., Miner, K., & Flores, S. A. (2015). Gender gaps in overestimation of math performance. *Sex Roles*, *72*, 536-546. doi:10.1007/s11199-015-0486-9

Beyer, S. (2014). Why are women underrepresented in Computer Science? Gender differences in stereotypes, self-efficacy, values, and interests and predictors of future CS course-taking and grades. *Computer Science Education*, *24*, 153-192. doi:10.1080/08993408.2014.963363

Bhanot, R., & Jovanovic, J. (2005). Do parents' academic gender stereotypes influence whether they intrude on their children's homework? *Sex Roles*, *52*, 597-607. doi:10.1007/s11199-005-3728-4

Bian, L., Leslie, S. J., Murphy, M. C., & Cimpian, A. (2018). Messages about brilliance undermine women's interest in educational and professional opportunities. *Journal of Experimental Social Psychology*, *76*, 404-420. doi:10.1016/j.jesp.2017.11.006

Blackwell, L. S., Trzesniewski, K. H., & Dweck, C. S. (2007). Implicit theories of intelligence predict achievement across an adolescent transition: A longitudinal study and an intervention. *Child Development, 78,* 246-263. doi:10.1111/j.1467-8624.2007.00995.x

Blažev, M., Karabegović, M., Burušić, J., & Selimbegović, L. (2017). Predicting gender-STEM stereotyped beliefs among boys and girls from prior school achievement and interest in STEM school subjects. *Social Psychology of Education*, *20*, 831-847. doi:10.1007/s11218-017-9397-7

Block, K., Hall, W. M., Schmader, T., Inness, M., & Croft, E. (2018). Should I stay or should I go? Women's implicit stereotypic associations predict their commitment and fit in STEM. *Social Psychology, 49,* 243-251. doi:10.1027/1864-9335/a000343

Broda, M., Yun, J., Schneider, B., Yeager, D. S., Walton, G. M., & Diemer, M. (2018). Reducing inequality in academic success for incoming college students: A randomized trial of growth mindset and belonging interventions. *Journal of Research on Educational Effectiveness, 11,* 317-338. doi:10.1080/19345747.2018.1429037

Burnette, J. L., Hoyt, C. L., Russell, V. M., Lawson, B., Dweck, C. S., & Finkel, E. (2020). A growth mind-set intervention improves interest but not academic performance in the field of computer science. *Social Psychological and Personality Science*, *11,* 107-116. doi:10.1177/1948550619841631

Canning, E. A., Muenks, K., Green, D. J., & Murphy, M. C. (2019). STEM faculty who believe ability is fixed have larger racial achievement gaps and inspire less student motivation in their classes. *Science Advances*, *5*, eaau4734. doi:10.1126/sciadv.aau4734

Carr, M., Steiner, H. H., Kyser, B., & Biddlecomb, B. (2008). A comparison of predictors of early emerging gender differences in mathematics competency. *Learning and Individual Differences*, *18*, 61-75. doi:10.1016/j.lindif.2007.04.005

Casad, B. J., Hale, P., & Wachs, F. L. (2017). Stereotype threat among girls: Differences by gender identity and math education context. *Psychology of Women Quarterly*, *41*, 513-529. doi:10.1177/0361684317711412

Ceci, S. J., Ginther, D. K., Kahn, S., & Williams, W. M. (2014). Women in academic science: A changing landscape. *Psychological Science in the Public Interest, 15,* 75-141. doi:10.1177/1529100614541236

Ceci, S. J., & Williams, W. M. (2010). Sex differences in math-intensive fields. *Current Directions in Psychological Science, 19,* 275-279. doi:10.1177/0963721410383241

Ceci, S. J., & Williams, W. M. (2011). Understanding current causes of women's underrepresentation in science. *Proceedings of the National Academy of Sciences, 108,* 3157-3162. doi:10.1073/pnas.1014871108

Ceci, S. J., Williams, W. M., & Barnett, S. M. (2009). Women's underrepresentation in science: Sociocultural and biological considerations. *Psychological Bulletin, 135,* 218-261. doi:10.1037/a0014412

Chatard, A., Guimond, S., & Selimbegovic, L. (2007). "How good are you in math?" The effect of gender stereotypes on students' recollection of their school marks. *Journal of Experimental Social Psychology*, *43*, 1017-1024. doi:10.1016/j.jesp.2006.10.024

Cheryan, S., Drury, B. J., & Vichayapai, M. (2013). Enduring influence of stereotypical computer science role models on women's academic aspirations. *Psychology of Women Quarterly, 37,* 72-79. doi:10.1177/0361684312459328

Cheryan, S., Master, A., & Meltzoff, A. N. (2015). Cultural stereotypes as gatekeepers: Increasing girls' interest in computer science and engineering by diversifying stereotypes. *Frontiers in Psychology, 6,* 49. doi:10.3389/fpsyg.2015.00049

Cheryan, S., Meltzoff, A. N., & Kim, S. (2011). Classrooms matter: The design of virtual classrooms influences gender disparities in computer science classes. *Computers & Education*, *57*, 1825-1835. doi:10.1016/j.compedu.2011.02.004

Cheryan, S., Plaut, V. C., Davies, P. G., & Steele, C. M. (2009). Ambient belonging: how stereotypical cues impact gender participation in computer science. *Journal of Personality and Social Psychology*, *97*, 1045-1060. doi:10.1037/a0016239

Cheryan, S., Ziegler, S. A., Montoya, A. K., & Jiang, L. (2017). Why are some STEM fields more gender balanced than others? *Psychological Bulletin, 143,* 1-35. doi:10.1037/bul0000052

Chestnut, E. K., & Markman, E. M. (2018). "Girls are as good as boys at math" implies that boys are probably better: A study of expressions of gender equality. *Cognitive Science*, *42*, 2229-2249. doi:10.1111/cogs.12637

Cohen, G. L., & Garcia, J. (2008). Identity, belonging, and achievement: A model, interventions, implications. *Current Directions in Psychological Science, 17,* 365-369. doi:10.1111/j.1467-8721.2008.00607.x

Cohen, G. L., Garcia, J., Purdie-Vaughns, V., Apfel, N., & Brzustoski, P. (2009). Recursive processes in self-affirmation: Intervening to close the minority achievement gap. *Science, 324,* 400-403. doi:10.1126/science.1170769

Cohen, G. L., & Sherman, D. K. (2014). The psychology of change: Self-affirmation and social psychological intervention. *Annual Review of Psychology, 65,* 333-371. doi:10.1146/annurev-psych-010213-115137

Coleman, J. M., & Hong, Y. Y. (2008). Beyond nature and nurture: The influence of lay gender theories on self-stereotyping. *Self and Identity*, *7*, 34-53. doi:10.1080/15298860600980185

Covarrubias, R., Laiduc, G., & Valle, I. (2019). Growth messages increase help-seeking and performance for women in STEM. *Group Processes & Intergroup Relations*, *22*, 434-451. doi:10.1177/1368430218802958

Coyle, E. F., & Liben, L. S. (2020). Gendered packaging of a STEM toy influences children's play, mechanical learning, and mothers' play guidance. *Child Development*, *91*, 43-62. doi:10.1111/cdev.13139

Crowley, K., Callanan, M. A., Tenenbaum, H. R., & Allen, E. (2001). Parents explain more often to boys than to girls during shared scientific thinking. *Psychological Science, 12,* 258-261. doi:10.1111/1467-9280.00347

Cumming, G. (2013). *Understanding the new statistics: Effect sizes, confidence intervals, and meta-analysis*. New York: Routledge.

Cundiff, J. L., Vescio, T. K., Loken, E., & Lo, L. (2013). Do gender–science stereotypes predict science identification and science career aspirations among undergraduate science majors? *Social Psychology of Education*, *16,* 541-554. doi:10.1007/s11218-013-9232-8

Cvencek, D., Kapur, M., & Meltzoff, A. N. (2015). Math achievement, stereotypes, and math self-concepts among elementary-school students in Singapore. *Learning and Instruction, 39,* 1-10. doi:10.1016/j.learninstruc.2015.04.002

Cvencek, D., Meltzoff, A. N., & Greenwald, A. G. (2011). Math-gender stereotypes in elementary school children. *Child Development, 82,* 766-779. doi:10.1111/j.1467-8624.2010.01529.x

Cvencek, D., Meltzoff, A. N., & Kapur, M. (2014). Cognitive consistency and math–gender stereotypes in Singaporean children. *Journal of Experimental Child Psychology*, *117*, 73-91. doi:10.1016/j.jecp.2013.07.018

Cvencek, D., Nasir, N. S., O'Connor, K., Wischnia, S., & Meltzoff, A. N. (2015). The development of math–race stereotypes: "They say Chinese people are the best at math." *Journal of Research on Adolescence*, *25*, 630-637. doi:10.1111/jora.12151

Dasgupta, N. (2011). Ingroup experts and peers as social vaccines who inoculate the self-concept: The stereotype inoculation model. *Psychological Inquiry, 22,* 231-246. doi:10.1080/1047840X.2011.607313

Dasgupta, N., & Stout, J. G. (2014). Girls and women in science, technology, engineering, and mathematics: STEMing the tide and broadening participation in STEM careers. *Policy Insights from the Behavioral and Brain Sciences, 1,* 21-29. doi:10.1177/2372732214549471

Deemer, E. D., Thoman, D. B., Chase, J. P., & Smith, J. L. (2014). Feeling the threat: Stereotype threat as a contextual barrier to women's science career choice intentions. *Journal of Career Development, 41,* 141-158. doi:10.1177/0894845313483003

Degol, J. L., Wang, M. T., Zhang, Y., & Allerton, J. (2018). Do growth mindsets in math benefit females? Identifying pathways between gender, mindset, and motivation. *Journal of Youth and Adolescence*, *47*, 976-990. doi:10.1007/s10964-017-0739-8

Deiglmayr, A., Stern, E., & Schubert, R. (2019). Beliefs in "brilliance" and belonging uncertainty in male and female STEM students. *Frontiers in Psychology*, *10*, 1114. doi:10.3389/fpsyg.2019.01114

del Río, M. F., & Strasser, K. (2013). Preschool children's beliefs about gender differences in academic skills. *Sex Roles, 68,* 231-238. doi:10.1007/s11199-012-0195-6

del Río, M. F., Strasser, K., Cvencek, D., Susperreguy, M. I., & Meltzoff, A. N. (2019). Chilean kindergarten children's beliefs about mathematics: Family matters. *Developmental Psychology, 55,* 687-702. doi:10.1037/dev0000658

Dennehy, T. C., & Dasgupta, N. (2017). Female peer mentors early in college increase women's positive academic experiences and retention in engineering. *Proceedings of the National Academy of Sciences, 114,* 5964-5969. doi:10.1073/pnas.1613117114

Diekman, A. B., Brown, E. R., Johnston, A. M., & Clark, E. K. (2010). Seeking congruity between goals and roles: A new look at why women opt out of science, technology, engineering, and mathematics careers. *Psychological Science, 21,* 1051-1057. doi:10.1177/0956797610377342

Diekman, A. B., Clark, E. K., Johnston, A. M., Brown, E. R., & Steinberg, M. (2011). Malleability in communal goals and beliefs influences attraction to stem careers: Evidence for a goal congruity perspective. *Journal of Personality and Social Psychology, 101,* 902-918. doi:10.1037/a0025199

Donovan, B. M., Stuhlsatz, M. A., Edelson, D. C., & Buck Bracey, Z. E. (2019). Gendered genetics: How reading about the genetic basis of sex differences in biology textbooks could affect beliefs associated with science gender disparities. *Science Education*, *103,* 719-749. doi:10.1002/sce.21502

Dweck, C. S., Davidson, W., Nelson, S., & Enna, B. (1978). Sex differences in learned helplessness: II. The contingencies of evaluative feedback in the classroom and III. An experimental analysis. *Developmental Psychology*, *14*, 268-276. doi:10.1037/0012-1649.14.3.268

Dweck, C. S., & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. *Psychological Review, 95,* 256-273. doi:10.1037/0033-295X.95.2.256

Dweck, C. S., & Master, A. (2009). Self-theories and motivation: Students' beliefs about intelligence. In K. R. Wentzel & A. Wigfield (Eds.), *Handbook of motivation at school* (pp. 123-140). New York, NY: Routledge.

Eccles, J. (2009). Who am I and what am I going to do with my life? Personal and collective identities as motivators of action. *Educational Psychologist*, *44,* 78-89. doi:10.1080/00461520902832368

Eccles, J. (2011). Gendered educational and occupational choices: Applying the Eccles et al. model of achievement-related choices. *International Journal of Behavioral Development, 35,* 195-201. doi:10.1177/0165025411398185

Eccles, J. S. (2015). Gendered socialization of STEM interests in the family. *International Journal of Gender, Science and Technology*, *7*, 116-132. Retrieved from http://genderandset.open.ac.uk/index.php/genderandset/article/view/419

Eccles, J. S., & Wang, M. T. (2016). What motivates females and males to pursue careers in mathematics and science? *International Journal of Behavioral Development, 40,* 100-106. doi:10.1177/0165025415616201

Eccles, J. S., & Wigfield, A. (1995). In the mind of the actor: The structure of adolescents' achievement task values and expectancy-related beliefs. *Personality and Social Psychology Bulletin*, *21,* 215-225. doi:10.1177/0146167295213003

Eccles, J. S., Wigfield, A., Harold, R. D., & Blumenfeld, P. (1993). Age and gender differences in children's self-and task perceptions during elementary school. *Child Development, 64,* 830-847. doi:10.1111/j.1467-8624.1993.tb02946.x

Eddy, S. L., & Brownell, S. E. (2016). Beneath the numbers: A review of gender disparities in undergraduate education across science, technology, engineering, and math disciplines. *Physical Review Physics Education Research, 12*, 020106. doi:10.1103/PhysRevPhysEducRes.12.020106

Ehrlinger, J., & Dunning, D. (2003). How chronic self-views influence (and potentially mislead) estimates of performance. *Journal of Personality and Social Psychology*, *84*, 5-17. doi:10.1037/0022-3514.84.1.5

Ehrlinger, J., Plant, E. A., Hartwig, M. K., Vossen, J. J., Columb, C. J., & Brewer, L. E. (2018). Do gender differences in perceived prototypical computer scientists and engineers contribute to gender gaps in computer science and engineering? *Sex Roles*, *78*, 40-51. doi:10.1007/s11199-017-0763-x

Ellis, J., Fosdick, B. K., & Rasmussen, C. (2016). Women 1.5 times more likely to leave STEM pipeline after calculus compared to men: Lack of mathematical confidence a potential culprit. *PLoS ONE*, *11*, e0157447. doi:10.1371/journal.pone.0157447

Else-Quest, N. M., Hyde, J. S., & Linn, M. C. (2010). Cross-national patterns of gender differences in mathematics: A meta-analysis. *Psychological Bulletin, 136,* 103-127. doi:10.1037/a0018053

Ertl, B., Luttenberger, S., & Paechter, M. (2017). The impact of gender stereotypes on the self-concept of female students in STEM subjects with an under-representation of females. *Frontiers in Psychology*, *8*, 703. doi:10.3389/fpsyg.2017.00703

Evans, A. B., Copping, K. E., Rowley, S. J., & Kurtz-Costes, B. (2011). Academic self-concept in Black adolescents: Do race and gender stereotypes matter? *Self and Identity*, *10*, 263-277. doi:10.1080/15298868.2010.485358

Farenga, S. J., & Joyce, B. A. (1999). Intentions of young students to enroll in science courses in the future: An examination of gender differences. *Science Education, 83,* 55-75. doi:10.1002/(SICI)1098-237X(199901)83:1<55::AID-SCE3>3.0.CO;2-O

Fiske, S. T. (2010). *Social beings: Core motives in social psychology*. New York: Wiley.

Flore, P. C., & Wicherts, J. M. (2015). Does stereotype threat influence performance of girls in stereotyped domains? A meta-analysis. *Journal of School Psychology, 53,* 25-44. doi:10.1016/j.jsp.2014.10.002

Ford, D. J., Brickhouse, N. W., Lottero-Perdue, P., & Kittleson, J. (2006). Elementary girls' science reading at home and school. *Science Education, 90,* 270-288. doi:10.1002/sce.20139

Frenzel, A. C., Goetz, T., Pekrun, R., & Watt, H. M. G. (2010). Development of mathematics interest in adolescence: Influences of gender, family, and school context. *Journal of Research on Adolescence, 20,* 507-537. doi:10.1111/j.1532-7795.2010.00645.x

Friedrich, A., Flunger, B., Nagengast, B., Jonkmann, K., & Trautwein, U. (2015). Pygmalion effects in the classroom: Teacher expectancy effects on students' math achievement. *Contemporary Educational Psychology*, *41*, 1-12. doi:10.1016/j.cedpsych.2014.10.006

Gehlbach, H., Brinkworth, M. E., King, A. M., Hsu, L. M., McIntyre, J., & Rogers, T. (2016). Creating birds of similar feathers: Leveraging similarity to improve teacher-student relationships and academic achievement. *Journal of Educational Psychology, 108,* 342-352. doi:10.1037/edu0000042

Gilbert, P. N., O'Brien, L. T., Garcia, D. M., & Marx, D. M. (2015). Not the sum of its parts: Decomposing implicit academic stereotypes to understand sense of fit in Math and English. *Sex Roles, 72,* 25-39. doi:10.1007/s11199-014-0428-y

Gillen-O'Neel, C., & Fuligni, A. (2013). A longitudinal study of school belonging and academic motivation across high school. *Child Development, 84,* 678-692. doi:10.1111/j.1467-8624.2012.01862.x

Good, C., Rattan, A., & Dweck, C. S. (2012). Why do women opt out? Sense of belonging and women's representation in mathematics. *Journal of Personality and Social Psychology, 102,* 700-717. doi:10.1037/a0026659

Goyer, J. P., Cohen, G. L., Cook, J. E., Master, A., Apfel, N., Lee, W., ... & Walton, G. M. (2019). Targeted identity-safety interventions cause lasting reductions in discipline citations among negatively stereotyped boys. *Journal of Personality and Social Psychology*, *117*, 229-259. doi:10.1037/pspa0000152

Gunderson, E. A., Ramirez, G., Levine, S. C., & Beilock, S. L. (2012). The role of parents and teachers in the development of gender-related math attitudes. *Sex Roles, 66,* 153-166. doi:10.1007/s11199-011-9996-2

Gutiérrez, K., & Rogoff, B. (2003). Cultural ways of learning: Individual traits or repertoires of practice. *Educational Researcher, 32,* 19-25. doi:10.3102/0013189X032005019

Hall, G. C. N., Yip, T., & Zárate, M. A. (2016). On becoming multicultural in a monocultural research world: A conceptual approach to studying ethnocultural diversity. *American Psychologist, 71,* 40-51. doi:10.1037/a0039734

Halpern, D. F., Benbow, C. P., Geary, D. C., Gur, R. C., Hyde, J. S., & Gernsbacher, M. A. (2007). The science of sex differences in science and mathematics. *Psychological Science in the Public Interest, 8,* 1-51. doi:10.1111/j.1529-1006.2007.00032.x

Harackiewicz, J. M., Rozek, C. S., Hulleman, C. S., & Hyde, J. S. (2012). Helping parents to motivate adolescents in mathematics and science: An experimental test of a utility-value intervention. *Psychological Science, 23,* 899-906. doi:10.1177/0956797611435530

Hargreaves, M., Homer, M., & Swinnerton, B. (2008). A comparison of performance and attitudes in mathematics amongst the 'gifted.' Are boys better at mathematics or do they just think they are? *Assessment in Education: Principles, Policy & Practice, 15,* 19–38. doi:10.1080/09695940701876037

Hazari, Z., Sonnert, G., Sadler, P. M., & Shanahan, M. C. (2010). Connecting high school physics experiences, outcome expectations, physics identity, and physics career choice: A gender study. *Journal of Research in Science Teaching*, *47*, 978-1003. doi:10.1002/tea.20363

Herrmann, S. D., Adelman, R. M., Bodford, J. E., Graudejus, O., Okun, M. A., & Kwan, V. S. (2016). The effects of a female role model on academic performance and persistence of women in STEM courses. *Basic and Applied Social Psychology*, *38*, 258-268. doi:10.1080/01973533.2016.1209757

Hidi, S. (2006). Interest: A unique motivational variable. *Educational Research Review*, *1*, 69-82. doi:10.1016/j.edurev.2006.09.001

Hill, C., Corbett, C., & St. Rose, A. (2010). *Why so few? Women in science, technology, engineering, and mathematics*. Washington, DC: AAUW.

Hill, C. J., Bloom, H. S., Black, A. R., & Lipsey, M. W. (2008). Empirical benchmarks for interpreting effect sizes in research. *Child Development Perspectives*, *2*, 172-177. doi:10.1111/j.1750-8606.2008.00061.x

Hill, P.W., McQuillan, J., Talbert, E., Spiegel, A., Gauthier, G., & Diamond, J. (2017). Science possible selves and the desire to be a scientist: Mindsets, gender bias, and confidence during early adolescence. *Social Sciences, 6,* 55. doi:10.3390/socsci6020055

Hilliard, L. J., & Liben, L. S. (2010). Differing levels of gender salience in preschool classrooms: Effects on children's gender attitudes and intergroup bias. *Child Development*, *81*, 1787-1798. doi.org/10.1111/j.1467-8624.2010.01510.x

Holdren, J. P., & Lander, E. (2012). Engage to excel: Producing one million additional college graduates with degrees in science, technology, engineering, and mathematics. In President's Council of Advisors on Science and Technology (Ed.), *Report to the president*. Washington, DC: Executive Office of the President.

Hong, H., & Lin-Siegler, X. (2012). How learning about scientists' struggles influences students' interest and learning in physics. *Journal of Educational Psychology, 104,* 469-484. doi:10.1037/a0026224

Huguet, P., & Régner, I. (2009). Counter-stereotypic beliefs in math do not protect school girls from stereotype threat. *Journal of Experimental Social Psychology*, *45*, 1024-1027. doi:10.1016/j.jesp.2009.04.029

Hyde, J. S., & Linn, M. C. (2006). Gender similarities in mathematics and science. *Science, 314,* 599-600. doi:10.1126/science.1132154

Ito, T., & McPherson, E. (2018). Factors influencing high school students' interest in STEM. *Frontiers in Psychology*, *9*, 1535. doi:10.3389/fpsyg.2018.01535

Jacobs, J. E., Davis-Kean, P., Bleeker, M., Eccles, J. S., & Malanchuk, O. (2005). "I can, but I don't want to": The impact of parents, interests, and activities on gender differences in math. In A. M. Gallagher & J. C. Kaufman (Eds.), *Gender differences in mathematics: An integrative psychological approach* (pp. 246-263). Cambridge, UK: Cambridge University Press.

Jacobs, J. E., Lanza, S., Osgood, D. W., Eccles, J. S., & Wigfield, A. (2002). Changes in children's self-competence and values: Gender and domain differences across grades one through twelve. *Child Development, 73,* 509-527. doi:10.1111/1467-8624.00421

Jones, B. D., Ruff, C., & Paretti, M. C. (2013). The impact of engineering identification and stereotypes on undergraduate women's achievement and persistence in engineering. *Social Psychology of Education*, *16*, 471-493. doi:10.1007/s11218-013-9222-x

Kahalon, R., Shnabel, N., & Becker, J. C. (2018). Positive stereotypes, negative outcomes: Reminders of the positive components of complementary gender stereotypes impair performance in counter-stereotypical tasks. *British Journal of Social Psychology*, *57*, 482-502. doi:10.1111/bjso.12240

Keller, C. (2001). Effect of teachers' stereotyping on students' stereotyping of mathematics as a male domain. *The Journal of Social Psychology, 141*, 165–173. doi:10.1080/00224540109600544

Kessels, U. (2005). Fitting into the stereotype: How gender-stereotyped perceptions of prototypic peers relate to liking for school subjects. *European Journal of Psychology of Education*, *20*, 309-323. doi:10.1007/BF03173559

Kessels, U., Heyder, A., Latsch, M., & Hannover, B. (2014). How gender differences in academic engagement relate to students' gender identity. *Educational Research*, *56*, 220-229. doi:10.1080/00131881.2014.898916

Kraft, M. (2019). Interpreting effect sizes of education interventions. Retrieved from Annenberg Institute at Brown University: http://www.edworkingpapers.com/ai19-10

Kurtz-Costes, B., Rowley, S. J., Harris-Britt, A., & Woods, T. A. (2008). Gender stereotypes about mathematics and science and self-perceptions of ability in late childhood and early adolescence. *Merrill-Palmer Quarterly, 54,* 386-409. doi:10.1353/mpq.0.0001

Lane, K. A., Goh, J. X., & Driver-Linn, E. (2012). Implicit science stereotypes mediate the relationship between gender and academic participation. *Sex Roles, 66,* 220-234. doi:10.1007/s11199-011-0036-z

Larose, S., Ratelle, C. F., Guay, F., Senécal, C., & Harvey, M. (2006). Trajectories of science self-efficacy beliefs during the college transition and academic and vocational adjustment in science and technology programs. *Educational Research and Evaluation, 12,* 373-393. doi:10.1080/13803610600765836

Latrofa, M., Vaes, J., Cadinu, M., & Carnaghi, A. (2010). The cognitive representation of self-stereotyping. *Personality and Social Psychology Bulletin*, *36*, 911-922. doi:10.1177/0146167210373907

Lavy, V., & Sand, E. (2018). On the origins of gender gaps in human capital: Short- and long-term consequences of teachers' biases. *Journal of Public Economics*, *167*, 263-279. doi:10.1016/j.jpubeco.2018.09.007

Leaper, C., Farkas, T., & Brown, C. S. (2012). Adolescent girls' experiences and gender-related beliefs in relation to their motivation in math/science and English. *Journal of Youth and Adolescence*, *41*, 268-282. doi:10.1007/s10964-011-9693-z

Lee, C. D. (2017). Integrating research on how people learn and learning across settings as a window of opportunity to address inequality in educational processes and outcomes. *Review of Research in Education, 41,* 88-111. doi:10.3102/0091732X16689046

Lei, R. F., Green, E. R., Leslie, S.-J., & Rhodes, M. (2019). Children lose confidence in their potential to "be scientists," but not in their capacity to "do science." *Developmental Science*, *22,* e12837. doi:10.1111/desc.12837

Leslie, S.-J., Cimpian, A., Meyer, M., & Freeland, E. (2015). Expectations of brilliance underlie gender distributions across academic disciplines. *Science, 347,* 262-265. doi:10.1126/science.1261375

Lewis, K. L., & Hodges, S. D. (2015). Expanding the concept of belonging in academic domains: Development and validation of the ability uncertainty scale. *Learning and Individual Differences, 37,* 197-202. doi:10.1016/j.lindif.2014.12.002

Lewis, K. L., Stout, J. G., Finkelstein, N. D., Pollock, S. J., Miyake, A., Cohen, G. L., & Ito, T. A. (2017). Fitting in to move forward: Belonging, gender, and persistence in the physical sciences, technology, engineering, and mathematics (pSTEM).

Psychology of Women Quarterly, *41*, 420-436. doi:10.1177/0361684317720186

Lewis, K. L., Stout, J. G., Pollock, S. J., Finkelstein, N. D., & Ito, T. A. (2016). Fitting in or opting out: A review of key social-psychological factors influencing a sense of belonging for women in physics. *Physical Review Physics Education Research, 12,* 020110. doi:10.1103/PhysRevPhysEducRes.12.020110

Liben, L. S., & Bigler, R. S. (2002). II. Review of Past Work. *Monographs of the Society for Research in Child Development*, *67*, 7-21. doi:10.1111/1540-5834.00189

London, B., Rosenthal, L., Levy, S. R., & Lobel, M. (2011). The influences of perceived identity compatibility and social support on women in nontraditional fields during the college transition. *Basic and Applied Social Psychology, 33,* 304-321. doi:10.1080/01973533.2011.614166

Lummis, M., & Stevenson, H. W. (1990). Gender differences in beliefs and achievement: A cross-cultural study. *Developmental Psychology, 26,* 254–263. doi:10.1037/0012-1649.26.2.254

Luzzo, D. A., Hasper, P., Albert, K. A., Bibby, M. A., & Martinelli, E. A., Jr. (1999). Effects of self-efficacy-enhancing interventions on the math/science self-efficacy and career interests, goals, and actions of career undecided college students. *Journal of Counseling Psychology, 46,* 233-243. doi:10.1037/0022-0167.46.2.233

Makel, M. C., & Plucker, J. A. (2014). Facts are more important than novelty: Replication in the education sciences. *Educational Researcher*, *43*, 304-316. doi:10.3102/0013189X14545513

Maltese, A. V., & Tai, R. H. (2010). Eyeballs in the fridge: Sources of early interest in science. *International Journal of Science Education, 32,* 669-685. doi:10.1080/09500690902792385

Maltese, A. V., & Tai, R. H. (2011). Pipeline persistence: Examining the association of educational experiences with earned degrees in STEM among U.S. students. *Science Education, 95,* 877-907. doi:10.1002/sce.20441

Markus, H. R., & Kitayama, S. (2010). Cultures and selves: A cycle of mutual constitution. *Perspectives on Psychological Science*, *5,* 420-430. doi:10.1177/1745691610375557

Markus, H., & Wurf, E. (1987). The dynamic self-concept: A social psychological perspective. *Annual Review of Psychology, 38,* 299-337. doi:10.1146/annurev.ps.38.020187.001503

Marsh, H. W., & Martin, A. J. (2011). Academic self-concept and academic achievement: Relations and causal ordering. *British Journal of Educational Psychology, 81,* 59-77. doi:10.1348/000709910X503501

Martin, M. O., Mullis, I. V. S., & Foy, P. (with Olson, J. F., Erberber, E., Preuschoff, C., & Galia, J.) (2008). *TIMSS 2007 international science report: Findings from IEA's trends in international mathematics and science study at the fourth and eighth grades*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

Martinot, D., & Désert, M. (2007). Awareness of a gender stereotype, personal beliefs and self-perceptions regarding math ability: When boys do not surpass girls. *Social Psychology of Education, 10,* 455-471. doi:10.1007/s11218-007-9028-9

Martocchio, J. J. (1994). Effects of conceptions of ability on anxiety, self-efficacy, and learning in training. *Journal of Applied Psychology, 79,* 819-825. doi:10.1037/0021-9010.79.6.819

Master, A., Cheryan, S., & Meltzoff, A. N. (2014). Reducing adolescent girls' concerns about STEM stereotypes: When do female teachers matter? *International Review of Social Psychology, 27,* 79-102.

Master, A., Cheryan, S., & Meltzoff, A. N. (2016a). Computing whether she belongs: Stereotypes undermine girls' interest and sense of belonging in computer science. *Journal of Educational Psychology, 108,* 424-437. doi:10.1037/edu0000061

Master, A., Cheryan, S., & Meltzoff, A. N. (2016b). Motivation and identity. In K. R. Wentzel & D. B. Miele (Eds.), *Handbook of motivation at school* (2nd ed., pp. 300-319). New York, NY: Routledge.

Master, A., Cheryan, S., & Meltzoff, A. N. (2017). Social group membership increases STEM engagement among preschoolers. *Developmental Psychology*, *53*, 201-209. doi:10.1037/dev0000195

Master, A., Cheryan, S., & Meltzoff, A. N. (2019, March). How endorsement and awareness of gender stereotypes predict girls' motivation in STEM. In D. Cvencek (Chair), *Intergroup stereotypes about STEM and intellectual abilities: Interdisciplinary evidence from Singapore, USA, and Chile*. Symposium conducted at the meeting of the Society for Research in Child Development (SRCD), Baltimore, MD. Retrieved from https://osf.io/ys49e

Master, A., Cheryan, S., Moscatelli, A., & Meltzoff, A. N. (2017). Programming experience promotes higher STEM motivation among first-grade girls. *Journal of Experimental Child Psychology, 160,* 92-106. doi:10.1016/j.jecp.2017.03.013

Master, A., Markman, E. M., & Dweck, C. S. (2012). Thinking in categories or along a continuum: Consequences for children's social judgments. *Child Development*, *83*, 1145-1163. doi:10.1111/j.1467-8624.2012.01774.x

Master, A., & Meltzoff, A. N. (2016). Building bridges between psychological science and education: Cultural stereotypes, STEM, and equity. *Prospects*, *46*, 215-234. doi:10.1007/s11125-017-9391-z

Master, A., Meltzoff, A. N, & Cheryan, S. (2020). *Interest stereotypes deter girls from computer science and engineering.* Manuscript in preparation, University of Washington.

McPherson, E., Banchefsky, S., & Park, B. (2018). Using social psychological theory to understand choice of a pSTEM academic major. *Educational Psychology*, *38*, 1278-1301. doi:10.1080/01443410.2018.1489526

Meltzoff, A. N. (2007). 'Like me': a foundation for social cognition. Developmental Science, 10, 126-134. doi:10.1111/j.1467-7687.2007.00574.x

Mercier, E. M., Barron, B., & O'Connor, K. (2006). Images of self and others as computer users: The role of gender and experience. *Journal of Computer Assisted Learning, 22,* 335-348. doi:10.1111/j.1365-2729.2006.00182.x

Meyer, M., Cimpian, A., & Leslie, S. J. (2015). Women are underrepresented in fields where success is believed to require brilliance. *Frontiers in Psychology*, *6*, 235. doi:10.3389/fpsyg.2015.00235

Miller, D. I., Eagly, A. H., & Linn, M. C. (2015). Women's representation in science predicts national gender-science stereotypes: Evidence from 66 nations. *Journal of Educational Psychology, 107,* 631-644. doi:10.1037/edu0000005

Miller, D. I., Nolla, K. M., Eagly, A. H., & Uttal, D. H. (2018). The development of children's gender-science stereotypes: A meta-analysis of 5 decades of U.S. draw-a-scientist studies. *Child Development*, *89*, 1943-1955. doi:10.1111/cdev.13039

Miller, D. I., & Wai, J. (2015). The bachelor's to Ph.D. STEM pipeline no longer leaks more women than men: A 30-year analysis. *Frontiers in Psychology, 6,* 37. doi:10.3389/fpsyg.2015.00037

Mullis, I. V. S., Martin, M. O., & Foy, P. (with Olson, J. F., Preuschoff, C., Erberber, E., Arora, A., & Galia, J.) (2008). *TIMSS 2007 international mathematics report: Findings from IEA's trends in international mathematics and science study at the fourth and eighth grades*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

Murphy, M. C., Steele, C. M., & Gross, J. J. (2007). Signaling threat: How situational cues affect women in math, science, and engineering settings. *Psychological Science, 18,* 879-885. doi:10.1111/j.1467-9280.2007.01995.x

Musu-Gillette, L. E., Wigfield, A., Harring, J. R., & Eccles, J. S. (2015). Trajectories of change in students' self-concepts of ability and values in math and college major choice. *Educational Research and Evaluation, 21,* 343-370. doi:10.1080/13803611.2015.1057161

Muzzatti, B., & Agnoli, F. (2007). Gender and mathematics: Attitudes and stereotype threat susceptibility in Italian children. *Developmental Psychology, 43,* 747-759. doi:10.1037/0012-1649.43.3.747

Nagy, G., Watt, H. M. G., Eccles, J. S., Trautwein, U., Lüdtke, O., & Baumert, J. (2010). The development of students' mathematics self-concept in relation to gender: Different countries, different trajectories? *Journal of Research on Adolescence, 20,* 482-506. doi:10.1111/j.1532-7795.2010.00644.x

Nasir, N. S., & Hand, V. M. (2006). Exploring sociocultural perspectives on race, culture, and learning. *Review of Educational Research, 76,* 449-475. doi:10.3102/00346543076004449

National Research Council. (2009). *Learning science in informal environments: People, places, and pursuits*. Washington, DC: The National Academies Press. doi:10.17226/12190

National Research Council. (2011). *Successful K-12 STEM education: Identifying effective approaches in science, technology, engineering, and mathematics.* Washington, DC: The National Academies Press. doi:10.17226/13158

Nelson, L. D., Simmons, J., & Simonsohn, U. (2018). Psychology's renaissance. *Annual Review of Psychology*, *69*, 511-534. doi:10.1146/annurev-psych-122216-011836

Nguyen, H.-H. D., & Ryan, A. M. (2008). Does stereotype threat affect test performance of minorities and women? A meta-analysis of experimental evidence. *Journal of Applied Psychology, 93,* 1314-1334. doi:10.1037/a0012702

Nosek, B. A., Smyth, F. L., Sriram, N., Lindner, N. M., Devos, T., Ayala, A., ... & Kesebir, S. (2009). National differences in gender–science stereotypes predict national sex differences in science and math achievement. *Proceedings of the National Academy of Sciences*, *106*, 10593-10597. doi:10.1073/pnas.0809921106

O'Brien, L. T., Blodorn, A., Adams, G., Garcia, D. M., & Hammer, E. (2015). Ethnic variation in gender-STEM stereotypes and STEM participation: An intersectional approach. *Cultural Diversity and Ethnic Minority Psychology*, *21*, 169-180. doi:10.1037/a0037944

Osborne, J. W., & Jones, B. D. (2011). Identification with academics and motivation to achieve in school: How the structure of the self influences academic outcomes. *Educational Psychology Review, 23,* 131-158. doi:10.1007/s10648-011-9151-1

Osterman, K. F. (2000). Students' need for belonging in the school community. *Review of Educational Research, 70,* 323-367. doi:10.2307/1170786

Owens, J., & Massey, D. S. (2011). Stereotype threat and college academic performance: A latent variables approach. *Social Science Research, 40,* 150-166. doi:10.1016/j.ssresearch.2010.09.010

Oyserman, D., & Lewis, N. A., Jr. (2017). Seeing the destination AND the path: Using identity-based motivation to understand and reduce racial disparities in academic achievement. *Social Issues and Policy Review*, *11*, 159-194. doi:10.1111/sipr.12030

Park, D., Gunderson, E. A., Tsukayama, E., Levine, S. C., & Beilock, S. L. (2016). Young children's motivational frameworks and math achievement: Relation to teacher-reported instructional practices, but not teacher theory of intelligence. *Journal of Educational Psychology*, *108*, 300-313. doi:10.1037/edu0000064

Passolunghi, M. C., Rueda Ferreira, T. I., & Tomasetto, C. (2014). Math-gender stereotypes and math-related beliefs in childhood and early adolescence. *Learning and Individual Differences, 34,* 70-76. doi:10.1016/j.lindif.2014.05.005

Patterson, M. M., & Bigler, R. S. (2006). Preschool children's attention to environmental messages about groups: Social categorization and the origins of intergroup bias. *Child Development*, *77*, 847-860. doi.org/10.1111/j.1467-8624.2006.00906.x

Patterson, M. M., & Bigler, R. S. (2018). Effects of consistency between self and in-group on children's views of self, groups, and abilities. *Social Development*, *27*, 154-171. doi:10.1111/sode.12255

Paunesku, D., Walton, G. M., Romero, C., Smith, E. N., Yeager, D. S., & Dweck, C. S. (2015). Mind-set interventions are a scalable treatment for academic underachievement. *Psychological Science, 26,* 784-793. doi:10.1177/0956797615571017

Perez, T., Cromley, J. G., & Kaplan, A. (2014). The role of identity development, values, and costs in college STEM retention. *Journal of Educational Psychology, 106,* 315-329. doi:10.1037/a0034027

Perez-Felkner, L., Nix, S., & Thomas, K. (2017). Gendered pathways: How mathematics ability beliefs shape secondary and postsecondary course and degree field choices. *Frontiers in Psychology, 8*, 386. doi:10.3389/fpsyg.2017.00386

Plante, I., De la Sablonnière, R., Aronson, J. M., & Théorêt, M. (2013). Gender stereotype endorsement and achievement-related outcomes: The role of competence beliefs and task values. *Contemporary Educational Psychology*, *38*, 225-235. doi:10.1016/j.cedpsych.2013.03.004

Plante, I., Théorêt, M., & Favreau, O. E. (2009). Student gender stereotypes: Contrasting the perceived maleness and femaleness of mathematics and language. *Educational Psychology, 29*, 385-405. doi:10.1080/01443410902971500

Priess-Groban, H. A., & Hyde, J. S. (2017). Implicit theories, expectancies, and values predict mathematics motivation and behavior across high school and college. *Journal of Youth and Adolescence, 46,* 1318-1332. doi:10.1007/s10964-016-0579-y

Purdie-Vaughns, V., & Eibach, R. P. (2008). Intersectional invisibility: The distinctive advantages and disadvantages of multiple subordinate-group identities. *Sex Roles*, *59*, 377-391. doi:10.1007/s11199-008-9424-4

Rainey, K., Dancy, M., Mickelson, R., Stearns, E., & Moller, S. (2018). Race and gender differences in how sense of belonging influences decisions to major in STEM. *International Journal of STEM Education*, *5*, 10. doi:10.1186/s40594-018-0115-6

Ramsey, L. R., Betz, D. E., & Sekaquaptewa, D. (2013). The effects of an academic environment intervention on science identification among women in STEM. *Social Psychology of Education, 16,* 377-397. doi:10.1007/s11218-013-9218-6

Rattan, A., Good, C., & Dweck, C. S. (2012). “It’s ok – Not everyone can be good at math”: Instructors with an entity theory comfort (and demotivate) students. *Journal of Experimental Social Psychology, 48,* 731-737. doi:10.1016/j.jesp.2011.12.012

Rattan, A., Savani, K., Komarraju, M., Morrison, M. M., Boggs, C., & Ambady, N. (2018). Meta-lay theories of scientific potential drive underrepresented students’ sense of belonging to science, technology, engineering, and mathematics (STEM). *Journal of Personality and Social Psychology*, *115*, 54-75. doi:10.1037/pspi0000130

Rattan, A., Savani, K., Naidu, N. V. R., & Dweck, C. S. (2012). Can everyone become highly intelligent? Cultural differences in and societal consequences of beliefs about the universal potential for intelligence. *Journal of Personality and Social Psychology*, *103*, 787-803. doi:10.1037/a0029263

Renninger, K. A., & Hidi, S. (2011). Revisiting the conceptualization, measurement, and generation of interest. *Educational Psychologist*, *46*, 168-184. doi:10.1080/00461520.2011.587723

Rhodes, M., & Leslie, S.-J. (2017). *Children’s media communicates essentialist views of science and scientists.* Unpublished manuscript. doi:10.31234/osf.io/s6chb

Rhodes, M., Leslie, S. -J., & Tworek, C. M. (2012). Cultural transmission of social essentialism. *Proceedings of the National Academy of Sciences*, *109*, 13526-13531. doi:10.1073/pnas.1208951109

Rhodes, M., Leslie, S.-J., Yee, K. M., & Saunders, K. (2019). Subtle linguistic cues increase girls' engagement in science. *Psychological Science*, *30*, 455-466. doi:10.1177/0956797618823670

Riegle-Crumb, C., King, B., Grodsky, E., & Muller, C. (2012). The more things change, the more they stay the same? Prior achievement fails to explain gender inequality in entry into STEM college majors over time. *American Educational Research Journal, 49,* 1048-1073. doi:10.3102/0002831211435229

Riegle-Crumb, C., & Morton, K. (2017). Gendered expectations: Examining how peers shape female students' intent to pursue STEM fields. *Frontiers in Psychology*, *8*, 329. doi:10.3389/fpsyg.2017.00329

Rogers, L. O., & Meltzoff, A. N. (2017). Is gender more important and meaningful than race? An analysis of racial and gender identity among Black, White, and mixed-race children. *Cultural Diversity and Ethnic Minority Psychology, 23,* 323-334. doi:10.1037/cdp0000125

Romero, C., Master, A., Paunesku, D., Dweck, C. S., & Gross, J. J. (2014). Academic and emotional functioning in middle school: The role of implicit theories. *Emotion, 14,* 227-234. doi:10.1037/a0035490

Rosenthal, L., Levy, S. R., London, B., Lobel, M., & Bazile, C. (2013). In pursuit of the MD: The impact of role models, identity compatibility, and belonging among undergraduate women. *Sex Roles*, *68*, 464-473. doi:10.1007/s11199-012-0257-9

Rosenzweig, E. Q., & Wigfield, A. (2016). STEM motivation interventions for adolescents: A promising start, but further to go. *Educational Psychologist, 51,* 146-163. doi:10.1080/00461520.2016.1154792

Rowley, S. J., Kurtz-Costes, B., Mistry, R., & Feagans, L. (2007). Social status as a predictor of race and gender stereotypes in late childhood and early adolescence. *Social Development*, *16*, 150-168. doi:10.1111/j.1467-9507.2007.00376.x

Rozek, C. S., Hyde, J. S., Svoboda, R. C., Hulleman, C. S., & Harackiewicz, J. M. (2015). Gender differences in the effects of a utility-value intervention to help parents motivate adolescents in mathematics and science. *Journal of Educational Psychology, 107,* 195-206. doi:10.1037/a0036981

Ryan, R. M., & Deci, E. L. (2016). Facilitating and hindering motivation, learning, and well-being in schools: Research and observations from self-determination theory. In K. R. Wentzel & D. B. Miele (Eds.), *Handbook of motivation at school* (2nd ed., pp. 96-119). New York, NY: Routledge.

Sansone, C. (2009). What's interest got to do with it?: Potential trade-offs in the self-regulation of motivation. In J. P. Forgas, R. F. Baumeister, & D. M. Tice (Eds.), *Psychology of self-regulation: Cognitive, affective, and motivational processes* (pp. 35-51). New York, NY: Psychology Press.

Sax, L., Blaney, J., Lehman, K., Rodriguez, S., George, K., & Zavala, C. (2018). Sense of belonging in computing: The role of introductory courses for women and underrepresented minority students. *Social Sciences*, *7*, 122. doi:10.3390/socsci7080122

Schmader, T. (2002). Gender identification moderates stereotype threat effects on women's math performance. *Journal of Experimental Social Psychology*, *38*, 194-201. doi:10.1006/jesp.2001.1500

Schmader, T., Johns, M., & Barquissau, M. (2004). The costs of accepting gender differences: The role of stereotype endorsement in women's experience in the math domain. *Sex Roles*, *50*, 835-850. doi:10.1023/B:SERS.0000029101.74557.a0

Schneider, M. (2018). A more systematic approach to replicating research. Retrieved from https://ies.ed.gov/director/remarks/12-17-2018.asp

Seyranian, V., Madva, A., Duong, N., Abramzon, N., Tibbetts, Y., & Harackiewicz, J. M. (2018). The longitudinal effects of STEM identity and gender on flourishing and achievement in college physics. *International Journal of STEM Education*, *5*, 40. doi:10.1186/s40594-018-0137-0

Shin, J. E. L., Levy, S. R., & London, B. (2016). Effects of role model exposure on STEM and non-STEM student engagement. *Journal of Applied Social Psychology, 46,* 410-427. doi:10.1111/jasp.12371

Shnabel, N., Purdie-Vaughns, V., Cook, J. E., Garcia, J., & Cohen, G. L. (2013). Demystifying values-affirmation interventions: Writing about social belonging is a key to buffering against identity threat. *Personality and Social Psychology Bulletin, 39,* 663-676. doi:10.1177/0146167213480816

Simpkins, S. D., Davis-Kean, P. E., & Eccles, J. S. (2006). Math and science motivation: A longitudinal examination of the links between choices and beliefs. *Developmental Psychology, 42,* 70-83. doi:10.1037/0012-1649.42.1.70

Simpkins, S. D., Price, C. D., & Garcia, K. (2015). Parental support and high school students' motivation in biology, chemistry, and physics: Understanding differences among Latino and Caucasian boys and girls. *Journal of Research in Science Teaching, 52,* 1386-1407. doi:10.1002/tea.21246

Smith, J. L., Brown, E. R., Thoman, D. B., & Deemer, E. D. (2015). Losing its expected communal value: How stereotype threat undermines women's identity as research scientists. *Social Psychology of Education, 18,* 443-466. doi:10.1007/s11218-015-9296-8

Smith, J. L., Lewis, K. L., Hawthorne, L., & Hodges, S. D. (2013). When trying hard isn't natural: Women's belonging with and motivation for male-dominated STEM fields as a function of effort expenditure concerns. *Personality and Social Psychology Bulletin, 39,* 131-143. doi:10.1177/0146167212468332

Smith, J. L., & White, P. H. (2001). Development of the domain identification measure: A tool for investigating stereotype threat effects. *Educational and Psychological Measurement, 61,* 1040-1057. doi:10.1177/00131640121971635

State of Computer Science Education. (2019). Retrieved from https://advocacy.code.org/

Steele, C. M. (1997). A threat in the air: How stereotypes shape intellectual identity and performance. *American Psychologist, 52,* 613-629. doi:10.1037/0003-066X.52.6.613

Steele, C. M., Spencer, S. J., & Aronson, J. (2002). Contending with group image: The psychology of stereotype and social identity threat. In M. P. Zanna (Ed.), *Advances in experimental social psychology* (Vol. 34, pp. 379–440). San Diego, CA: Academic Press.

Steele, J. (2003). Children's gender stereotypes about math: The role of stereotype stratification. *Journal of Applied Social Psychology, 33,* 2587-2606. doi:10.1111/j.1559-1816.2003.tb02782.x

Steffens, M. C., Jelenec, P., & Noack, P. (2010). On the leaky math pipeline: Comparing implicit math-gender stereotypes and math withdrawal in female and male children and adolescents. *Journal of Educational Psychology, 102,* 947-963. doi:10.1037/a0019920

Stoet, G., & Geary, D. C. (2012). Can stereotype threat explain the gender gap in mathematics performance and achievement? *Review of General Psychology*, *16*, 93-102. doi:10.1037/a0026617

Stout, J. G., & Blaney, J. M. (2017). "But it doesn't come naturally": How effort expenditure shapes the benefit of growth mindset on women's sense of intellectual belonging in computing. *Computer Science Education*, *27*, 215-228. doi:10.1080/08993408.2018.1437115

Stout, J. G., Dasgupta, N., Hunsinger, M., & McManus, M. A. (2011). STEMing the tide: Using ingroup experts to inoculate women's self-concept in science, technology, engineering, and mathematics (STEM). *Journal of Personality and Social Psychology, 100,* 255-270. doi:10.1037/a0021385

Tai, R. H., Liu, C. Q., Maltese, A. V., & Fan, X. (2006). Planning early for careers in science. *Science, 312,* 1143-1144. doi:10.1126/science.1128690

Tellhed, U., Bäckström, M., & Björklund, F. (2017). Will I fit in and do well? The importance of social belongingness and self-efficacy for explaining gender differences in interest in STEM and HEED majors. *Sex Roles, 77,* 86-96. doi:10.1007/s11199-016-0694-y

Tenenbaum, H. R., & Leaper, C. (2003). Parent-child conversations about science: The socialization of gender inequities? *Developmental Psychology, 39,* 34-47. doi:10.1037//0012-1649.39.1.34

Thoman, D. B., Muragishi, G. A., & Smith, J. L. (2017). Research microcultures as socialization contexts for underrepresented science students. *Psychological Science, 28,* 760-773. doi:10.1177/0956797617694865

Thoman, D. B., Sansone, C., Fraughton, T., & Pasupathi, M. (2012). How students socially evaluate interest: Peer responsiveness influences evaluation and maintenance of interest. *Contemporary Educational Psychology, 37,* 254-265. doi:10.1016/j.cedpsych.2012.04.001

Thoman, D. B., Smith, J. L., Brown, E. R., Chase, J., & Lee, J. Y. K. (2013). Beyond performance: A motivational experiences model of stereotype threat. *Educational Psychology Review, 25,* 211-243. doi:10.1007/s10648-013-9219-1

TIMSS 2007 Assessment. (2009). International Association for the Evaluation of Educational Achievement (IEA). Publisher: TIMSS & PIRLS International Study Center, Lynch School of Education, Boston College.

Tobin, D. D., Menon, M., Menon, M., Spatta, B. C., Hodges, E. V., & Perry, D. G. (2010). The intrapsychics of gender: A model of self-socialization. *Psychological Review*, *117*, 601-622. doi:10.1037/a0018936

Turner, K. L., & Brown, C. S. (2007). The centrality of gender and ethnic identities across individuals and contexts. *Social Development, 16,* 700-719. doi:10.1111/j.1467-9507.2007.00403.x

U. S. Census Bureau. (2018). QuickFacts table. Retrieved from https://www.census.gov/quickfacts/fact/table/US/LFE046217

U.S. Department of Education. (2017). Table 318.30. Bachelor's, master's, and doctor's degrees conferred by postsecondary institutions, by sex of student and discipline division: 2015-16. *National Center for Education Statistics, Integrated Postsecondary Education Data Systems (IPEDS).* Retrieved from https://nces.ed.gov/programs/digest/d17/tables/dt17_318.30.asp

U.S. Department of Education. (2018a). Companion guidelines on replication & reproducibility in education research*. National Science Foundation and the Institute of Education Sciences*. Retrieved from https://ies.ed.gov/pdf/CompanionGuidelinesReplicationReproducibility.pdf

U.S. Department of Education. (2018b). Table 306.10. Total fall enrollment in degree-granting postsecondary institutions, by level of enrollment, sex, attendance status, and race/ethnicity or nonresident alien status of student: Selected years, 1976 through 2017. *National Center for Education Statistics, Higher Education General Information Survey (HEGIS).* Retrieved from https://nces.ed.gov/programs/digest/d18/tables/dt18_306.10.asp

U.S. Department of Education. (2018c). Table 318.45. Number and percentage distribution of science, technology, engineering, and mathematics (STEM) degrees/certificates conferred by postsecondary institutions, by race/ethnicity, level of degree/certificate, and sex of student: 2008-09 through 2016-17. *National Center for Education Statistics, Integrated Postsecondary Education Data System (IPEDS).* Retrieved from https://nces.ed.gov/programs/digest/d18/tables/dt18_318.45.asp

van Veelen, R., Otten, S., Cadinu, M., & Hansen, N. (2016). An integrative model of social identification: Self-stereotyping and self-anchoring as two cognitive pathways. *Personality and Social Psychology Review*, *20*, 3-26. doi:10.1177/1088868315576642

van't Veer, A. E., & Giner-Sorolla, R. (2016). Pre-registration in social psychology—A discussion and suggested template. *Journal of Experimental Social Psychology*, *67*, 2-12. doi:10.1016/j.jesp.2016.03.004

Vincent-Ruz, P., & Schunn, C. D. (2018). The nature of science identity and its role as the driver of student choices. *International Journal of STEM Education*, *5,* 48. doi:10.1186/s40594-018-0140-5

Walton, G. M., & Cohen, G. L. (2007). A question of belonging: Race, social fit, and achievement. *Journal of Personality and Social Psychology, 92,* 82-96. doi:10.1037/0022-3514.92.1.82

Walton, G. M., Logel, C., Peach, J. M., Spencer, S. J., & Zanna, M. P. (2015). Two brief interventions to mitigate a "chilly climate" transform women's experience, relationships, and achievement in engineering. *Journal of Educational Psychology, 107,* 468-485. doi:10.1037/a0037461

Wang, M.-T., & Degol, J. (2013). Motivational pathways to STEM career choices: Using expectancy-value perspective to understand individual and gender differences in STEM fields. *Developmental Review, 33,* 304-340. doi:10.1016/j.dr.2013.08.001

Wang, M.-T., Eccles, J. S., & Kenny, S. (2013). Not lack of ability but more choice: Individual and gender differences in choice of careers in science, technology, engineering, and mathematics. *Psychological Science, 24,* 770-775. doi:10.1177/0956797612458937

Watt, H. M. G., Hyde, J. S., Petersen, J., Morris, Z. A., Rozek, C. S., & Harackiewicz, J. M. (2017). Mathematics—a critical filter for STEM-related career choices? A longitudinal examination among Australian and U.S. adolescents. *Sex Roles, 77,* 254-271. doi:10.1007/s11199-016-0711-1

Weisgram, E. S., & Bigler, R. S. (2007). Effects of learning about gender discrimination on adolescent girls' attitudes toward and interest in science. *Psychology of Women Quarterly, 31,* 262-269. doi:10.1111/j.1471-6402.2007.00369.x

Weisgram, E. S., Bigler, R. S., & Liben, L. S. (2010). Gender, values, and occupational interests among children, adolescents, and adults. *Child Development, 81*, 778-796. doi:10.1111/j.1467-8624.2010.01433.x

Weisgram, E. S., & Diekman, A. B. (2017). Making STEM "family friendly": The impact of perceiving science careers as family-compatible. *Social Sciences*, *6*, 61. doi:10.3390/socsci6020061

Wigfield, A., & Eccles, J. S. (2002). The development of competence beliefs, expectancies for success, and achievement values from childhood through adolescence. In A. Wigfield & J. S. Eccles (Eds.), *Development of achievement motivation* (pp. 91-120). San Diego, CA: Academic Press.

Wigfield, A., Eccles, J. S., Fredricks, J. A., Simpkins, S., Roeser, R. W., & Schiefele, U. (2015). Development of achievement motivation and engagement. In M. E. Lamb & R. M. Lerner (Eds.), *Handbook of child psychology and developmental science* (7th ed., Vol. 3, pp. 657-700). Hoboken, NJ: Wiley.

Wigfield, A., Eccles, J. S., Schiefele, U., Roeser, R., & Davis-Kean, P. (2006). Development of achievement motivation. In W. Damon & N. Eisenberg (Eds.), *Handbook of child psychology* (6th ed., Vol. 3, pp. 933–1002). New York: Wiley.

Wynn, A. T., & Correll, S. J. (2017). Gendered perceptions of cultural and skill alignment in technology companies. *Social Sciences, 6,* 45. doi:10.3390/socsci6020045

Xue, Y., & Larson, R. C. (2015). STEM crisis or STEM surplus? Yes and yes. *Monthly Labor Review, 138,* 1-14. doi:10.21916/mlr.2015.14

Yeager, D. S., Hanselman, P., Walton, G. M., Murray, J. S., Crosnoe, R., Muller, C., ... & Dweck, C. S. (2019). A national experiment reveals where a growth mindset improves achievement. *Nature*, 573, 364–369. doi:10.1038/s41586-019-1466-y

Yeager, D. S., & Walton, G. M. (2011). Social-psychological interventions in education: They're not magic. *Review of Educational Research, 81,* 267-301. doi:10.3102/0034654311405999

Young, D. M., Rudman, L. A., Buettner, H. M., & McLean, M. C. (2013). The influence of female role models on women's implicit science cognitions. *Psychology of Women Quarterly, 37,* 283-292. doi:10.1177/0361684313482109

Zhao, F., Zhang, Y., Alterman, V., Zhang, B., & Yu, G. (2018). Can math-gender stereotypes be reduced? A theory-based intervention program with adolescent girls. *Current Psychology*, *37*, 612-624. doi:10.1007/s12144-016-9543-y