

Gender Stereotypes Influence Children’s STEM Motivation

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Abstract

Children's memberships in social groups have profound effects on their motivation. Stereotypes about social groups shape children's beliefs about what is expected for their group members. These beliefs can influence children's developing beliefs about themselves (self-perceptions). In this article, I review research on how gender stereotypes influence children's motivation in science, technology, engineering, and math (STEM), including ability beliefs and sense of belonging. When children belong to a gender group that is negatively stereotyped in a STEM field, they may doubt their own capabilities and whether they belong in that field, making it harder for them to develop interest over time. Developmentally, the influence of gender stereotypes on motivation begins during preschool and strengthens during late childhood. I also address the consequences of different kinds of stereotypes and why some children are more influenced by stereotypes than others. Understanding this process in childhood will help researchers design effective interventions to remedy educational inequities in STEM.

Keywords: gender, stereotypes, motivation

Membership in social groups profoundly affects children's beliefs and behavior. One way social groups affect children is through stereotypes about their groups, including their gender. Stereotypes are shared beliefs within a society that link groups with certain traits, such as beliefs that boys have more math ability than girls (Bigler & Liben, 2006). Stereotypes can affect people in many ways: They make unique individuals seem like identical copies (Way et al., 2013). Stereotypes make one story ("This boy is good at math") become everyone's story ("I'm a girl, so I must not be good at math"). In this way, stereotypes shape children's beliefs about what is expected for them as a member of their group.

What happens when stereotypes get inside children's heads? In academic domains, these stereotypes can lead them to believe that their group members do not succeed or belong in certain fields. Personally believing in a stereotype is known as endorsement (Cvencek, Nasir et al., 2015); children's endorsement of stereotypes about their group can shape their self-perceptions—how they see themselves (Master & Meltzoff, 2020). These self-perceptions indicate whether they believe *they* can succeed or belong in those fields. In this article, I review how stereotypes shape self-perceptions with a focus on childhood, which is an important time because self-perceptions at this time set the stage for career decisions during adolescence.

First, I review research on how gender stereotypes influence children's motivation in science, technology, engineering, and math (STEM) fields (see Table 1 for definitions and examples). Then I discuss the developmental trajectory of stereotype endorsement and its influence on academic self-perceptions, with a focus on ability beliefs and belonging in STEM fields. I focus on STEM because these fields have strong gender stereotypes favoring boys, which act as barriers that deter girls and women (Master & Meltzoff, 2020). Women are underrepresented in many STEM fields, especially computer science and engineering, so

removing barriers to girls' participation offers a promising route to motivating more students into STEM pathways and careers (Hill et al., 2010). Addressing STEM motivation during childhood is important because positive attitudes about STEM decrease between elementary and middle school, and gender gaps in motivation emerge (Master & Meltzoff, 2020). Throughout this review, I specify when the research focused on a particular field because gender stereotypes and motivation can vary between STEM fields (Master & Meltzoff, 2020). When the research includes several fields or when generalizations can be made, I refer to STEM more generally.

This article represents a novel contribution because few reviews have examined children's gender stereotypes about academic fields (cf. Leaper, 2015; Miller et al., 2006), and none have detailed how they influence STEM motivation through self-perceptions. This novel perspective brings together developmental science (Leaper, 2015; Liben & Bigler, 2002), social psychology research on balanced identity and social identity threat (Cvencek, Kapur, & Meltzoff, 2015; Tobin et al., 2010; Walton & Brady, 2021), and educational psychology (Eccles & Wigfield, 2020), providing a bridge between disciplines. A deeper understanding of when, why, how, and which children are affected by gender stereotypes can inform the design of educational interventions in STEM fields.

Developmental Trajectory of Stereotype Endorsement and Influence

Two relevant developmental trajectories include the development of stereotype endorsement and the development of the process by which endorsement influences self-perceptions. Both trajectories are influenced by relevant cognitive and social developmental processes, individual differences, and external environmental influences. Because of these individual differences and environmental influences, studies do not always find clear developmental patterns, and findings may differ based on which stereotypes are measured,

children's own gender and cultural background, and the time period. Children actively construct their stereotypes and self-perceptions based on their experiences, leading to variation (see the "Looking Ahead" section for more discussion of individual differences). Relevant cognitive processes include improvements in the ability to classify someone in multiple ways (such as by gender and STEM ability) and perceptions of similarities across and differences within groups, with perceptions of the self and others becoming increasingly complex and differentiated by domain (Bigler & Liben, 2006; Levy & Dweck, 1999). Relevant social processes include identity development, such as gender identity, and sensitivity to peer pressure, with young adolescents in particular becoming more concerned with belonging and exploring identity (Rogers & Meltzoff, 2017; Rowley et al., 2007).

In the development of stereotype endorsement, one important early influence may be awareness of stereotypes (see Table 1). From early childhood, many children are "gender detectives," skilled at uncovering preferences and expectations for their gender (Halim & Ruble, 2010). Their awareness that others believe in gender-STEM stereotypes increases from elementary to middle school, and typically correlates moderately with children's own endorsement (Cvencek, Nasir et al., 2015; Kurtz-Costes et al., 2014), although more research examining longitudinal links between awareness and endorsement is needed. During elementary school, some children begin to endorse traditional gender stereotypes about academic fields (Cvencek et al., 2011; Leaper, 2015). However, the type of stereotype matters because ingroup favoritism leads young children to endorse ability stereotypes favoring their own group rather than traditional stereotypes. Because younger elementary school children typically show ingroup favoritism when asked which group is "better" (Martinot & Désert, 2007; Master & Meltzoff, 2020; Miller et al., 2006), endorsement of ability stereotypes may differ by gender, particularly

for younger children (Kurtz-Costes et al., 2014). When averaging across genders, children overall appear to endorse stereotypes about *interest* favoring boys earlier by mid-elementary school (Cvencek et al., 2011; Master et al., 2021), and stereotypes about *ability* favoring boys later by late elementary school or adolescence (Martinot & Désert, 2007; Passolunghi et al., 2014). Some young adolescents' STEM stereotypes match traditional adult stereotypes (Cvencek, Nasir et al., 2015), although they may hold counterstereotypical beliefs favoring girls for math (Kurtz-Costes et al., 2014; Martinot & Désert, 2007; Passolunghi et al., 2014; Rowley et al., 2007). Not all students begin to endorse traditional stereotypes: During this period, some students become egalitarian "truth tellers" who openly reject gender stereotypes (Way et al., 2013).

We know less about the development of the link between stereotypes and self-perceptions, although some evidence suggests this link may strengthen during late childhood. Even very young children in preschool can make category-based inferences involving gender when reasoning about others (Halim & Ruble, 2010). This may extend to self-perceptions in basic ways during early childhood through simple gender schemas (Liben & Bigler, 2002; Rhodes & Brickman, 2008). Emphasizing gender can increase preschoolers' stereotype endorsement and gendered play preferences (Hilliard & Liben, 2010), giving them a sense that, for example, "This is our group, and these are the things for us."

During middle childhood, children become more adept at reasoning about groups and traits, and more motivated to compare themselves with others (Miller et al., 2006). In elementary school, endorsement of stereotypes begins to correlate with self-perceptions and interest (Cvencek et al., 2011; Master & Meltzoff, 2020). For example, many girls feel a lower sense of belonging for an activity that they believe boys enjoy more than girls (Master et al., 2021).

Children's gender stereotypes about technology ability are also correlated with their ability beliefs and interest in technology by this age (Master et al., 2017).

The influence of stereotypes can become more complex as older children develop improved cognitive processing skills. Children may not possess the deductive reasoning skills to solve a logic problem such as, "Girls are not good at math; I am a girl, therefore I am _____ at math" until approximately age 11, around entry to middle school (Patterson & Bigler, 2018). At this point, stereotypes may become more closely linked to young adolescents' self-perceptions as youth become more efficient at balancing these complex representations of themselves and others (Kurtz-Costes et al., 2008). However, as suggested by balanced identity theory, the influence of gender stereotypes (links between *gender group* and *trait*) on self-perceptions (links between *self* and *trait*) should be cognitively balanced with gender identity (links between *gender group* and *self*), so this pattern may be weaker for adolescents who identify less with their gender (Tobin et al., 2010).

How Stereotype Endorsement Influences Motivation

Why might stereotypes influence children's self-perceptions? From an early age, children search for information to help them understand and predict the social world. Social categories offer a natural way for children to do so (Bigler & Liben, 2006). Children use social categories to judge how others will think, feel, and act. At the same time, children are motivated as individuals with personal beliefs and attitudes. They use social information to guide expectations for themselves, too (Master & Meltzoff, 2020), asking questions such as "Do people like me belong here?" and "Can people like me succeed?" If the answers are no, children may question whether they will belong or succeed.

Stereotypes about academic fields are often relative between gender groups. Believing one group is “good at math” may imply indirectly that the other group is not (Cvencek, Nasir et al., 2015). Across ages and cultures, success in STEM fields and natural brilliance are typically seen as more for boys than girls (Bian et al., 2017; Cvencek, Kapur, & Meltzoff, 2015). Success in school and language/reading are seen as more for girls than boys (Cvencek et al., 2011; Heyder & Kessels, 2013). As students proceed through school, they experience stereotype cues and patterns that create awareness of and strengthen the endorsement of these links (Bigler & Liben, 2006; see Table 1). Once they endorse a stereotype, cognitive biases may reinforce that belief when children preferentially attend to and remember information that confirms the stereotype (Liben & Bigler, 2002). Ironically, many children can be affected by stereotypes even if they do not believe the stereotypes are true. Awareness of others’ stereotypes can affect academic performance through stereotype threat (Flore & Wicherts, 2015). Stereotype threat refers to the fear of confirming a negative stereotype about one’s group and can be activated merely through awareness (Cohen et al., 2006; Huguet & Régner, 2009).

When children internalize stereotypes, this endorsement can influence two particularly meaningful self-perceptions: their ability beliefs and their sense of belonging (see Table 1). I focus on these because of their central importance for motivation, but stereotypes may also affect motivation through other pathways. First, stereotypes may affect motivation through children’s beliefs about their ability. *Ability beliefs* is a broad term meant to include beliefs about current ability, self-efficacy to succeed at upcoming tasks, and expectations of success, which tend to be strongly related (Eccles & Wigfield, 2020). Children in negatively stereotyped groups, such as girls in STEM classes, may see many stereotype-relevant cues that their group has less ability, such as differential treatment from teachers (Rubie-Davies & Peterson, 2010). If children believe

members of their group have less ability, they may assume they are also less capable. Indeed, in studies, children as young as 6 who believed their gender had less ability in math or technology rated their own ability lower than children who believed their gender had more ability (Master et al., 2017; Plante et al., 2013). When gender stereotypes are made salient, stereotype endorsement is linked to ability beliefs even more strongly (Martinot & Désert, 2007).

Second, endorsement can influence children's motivation through their sense of belonging. Sense of belonging indicates how much students see themselves as fitting in and having a positive relationship with the people or environment around them (Walton & Brady, 2021). By middle school, many girls feel a lower sense of belonging than boys in STEM activities and classes (Master et al., 2021). Stereotype endorsement may lower girls' feelings of *social* belonging when they see that girls are not well represented in a field or do not typically enjoy that field; it may lower their *academic* belonging when they feel boys have abilities they lack. When stereotypes are salient, many girls feel a lower sense of belonging in STEM activities and courses (Master et al., 2016, 2021), although this may depend on the type of stereotype, girls' gender identification, and how much girls endorse that stereotype. The more girls endorse gender stereotypes, the lower their sense of belonging in STEM courses in elementary and middle school (Master et al., 2021).

Can Self-Perceptions Influence Stereotypes?

Children are not just passive recipients of information about the social world; they actively construct their understanding (Liben & Bigler, 2002). They make deductive inferences from their group to themselves (*group-stereotype-to-self*), while they make inductive inferences from themselves to their group (*self-to-group-stereotype*; see Table 1). Endorsement of

stereotypes may influence self-perceptions, while self-perceptions also influence endorsement (Liben & Bigler, 2002; Tobin et al., 2010). A girl who likes math may assume other girls like math, too. Empirical evidence suggests that the group-stereotype-to-self pathway develops earlier than the reverse in terms of academic stereotypes. Many children begin to endorse gender stereotypes about math before gender differences in self-perceptions are evident (Cvencek et al., 2011), although both pathways strengthen as children progress through elementary school (Cvencek, Kapur, & Meltzoff, 2015; Cvencek, Nasir et al., 2015). The group-stereotype-to-self pathway may be especially strong when a group has lower status as a result of negative stereotypes because members of these groups tend to be more identified with their group (Latrofa et al., 2010). In addition, young girls may identify more strongly with their gender group than do boys (cf. Rogers & Meltzoff, 2017; Turner & Brown, 2007).

Looking Ahead

Research on gender stereotypes and STEM motivation is connected to many topics in developmental psychology, social psychology, and education. Interdisciplinary collaborations are important for gaining a more thorough understanding of when, why, how, and for whom stereotype endorsement influences academic motivation. In particular, researchers should explore the consequences of different kinds of stereotypes and individual differences in how much endorsement influences motivation.

Distinguishing Among Stereotypes

Stereotypes are complex, and subtle differences in how they are measured may affect links to self-perceptions. Stereotypes can be measured in many ways: explicitly through self-report, or indirectly through implicit associations or assumptions about a person with a certain

characteristic, although consideration of differences between implicit and explicit stereotypes is outside the scope of this review (see Bigler & Liben, 2006; Leaper, 2015). They can be analyzed in terms of awareness of others' stereotypes or personal endorsement. They may involve beliefs about adults or other children. They can describe the prevalence of features within a group or prescribe how group members should act. All these distinctions may be meaningful, although few studies have compared them systematically (cf. Cvencek, Kapur, & Meltzoff, 2015).

One important distinction may involve whether the stereotype involves ability or interest. Most research in this area has involved stereotypes about which groups have more ability, especially math ability. Yet gender-interest stereotypes (about who is interested, likes, or enjoys a field) may have stronger links to children's STEM interest and academic choices than do ability stereotypes (Master et al., 2021). Interest stereotypes may strengthen children's beliefs that they will not belong or enjoy that field themselves, reducing their interest.

A second important distinction for research is to examine STEM stereotypes that are not explicitly related to gender but that affect girls and boys differentially. These include stereotypes about being a "nerd," "genius," or "brilliant" (Bian et al., 2017; Master et al., 2016). The associations of these traits with STEM may have a stronger negative influence on girls' motivation than boys' because these traits are not associated with girls, leaving girls to feel that they do not fit the prototype of a STEM person (Starr & Leaper, 2019). If many girls do not incorporate these traits into their self-concept, this may further reduce their perceptions that they fit the prototype of someone who will succeed or belong in STEM fields (McPherson et al., 2018). Similarly, beliefs that STEM fields do not afford the pursuit of communal goals may deter girls more than boys (Weisgram & Diekmann, 2017). Most relevant studies in this area have been

conducted with adolescents (cf. Bian et al., 2017), meaning that we need research exploring these stereotypes and their influence among children.

A third distinction is to explore consequences of endorsement versus awareness of stereotypes because many studies have not distinguished these. Although endorsement and awareness are empirically correlated (Kurtz-Costes et al., 2014), children can be aware of stereotypes without personally endorsing them, as seen in gender-egalitarian children (Leaper, 2015). Awareness alone can have negative consequences, as in stereotype threat. In one study, being reminded of a negative stereotype had a small impact on girls' math, science, and spatial performance (see Flore & Wicherts, 2015). However, the limited empirical evidence available suggests that endorsement may be more influential than awareness when it comes to self-perceptions (Liben & Bigler, 2002; Martinot & Désert, 2007; Master & Meltzoff, 2020).

Moreover, endorsement and awareness may influence self-perceptions in different ways. For example, sense of belonging represents a multifaceted representation of the self in relation to a field and the people in that field. It includes both social and academic fit, and may be linked to social cues from people inside and outside the field (Banchefsky et al., 2019). Knowing that someone believes a negative stereotype about their group is related to many girls' anticipation of gender discrimination and feelings of being devalued, which are linked to more negative self-perceptions (Robnett, 2016). Awareness of stereotypes may also influence sense of belonging indirectly through endorsement, as occurs when girls feel they do not fit the image of a prototypical scientist (Master et al., 2021). These are important empirical questions that point to different targets for interventions.

Individual Differences in How Much Endorsement Influences Motivation

The process by which stereotypes influence motivation is not all or none. Many students resist endorsing stereotypes (Way et al., 2013), and links between stereotype endorsement and motivation are sometimes found only for certain groups (e.g., Kurtz-Costes et al., 2008). A critical part of understanding why stereotype endorsement influences motivation involves understanding when and why it does not. Two potential moderators of this process involve group identification and mindsets, although research involving causal mechanisms and long-term interventions is needed.

First, stereotypes may influence motivation more when children identify more closely with their group (Leaper, 2015). According to balanced identity theory, both the group-stereotype-to-self and self-to-group-stereotype processes should be stronger when children identify more strongly with their group (Cvencek, Kapur, & Meltzoff, 2015). The more children identify with their gender, the more they internalize their expectations of the group (Tobin et al., 2010). Conversely, if group membership is not central to their sense of self, children may feel less need to conform to group attitudes (Rogers & Meltzoff, 2017). Thus, one source of differences in susceptibility to stereotypes may lie in the centrality of children's gender identity. Other aspects of their identity or self-concept may also be relevant, including how much they feel they fit the prototype of a STEM person (McPherson et al., 2018).

Second, motivation may be influenced more by stereotypes when children believe personal characteristics are fixed and unchangeable. This fixed mindset is contrasted with a growth mindset, belief that characteristics can change through effort (Dweck & Master, 2009). Children with a fixed mindset may focus more on unchangeable links between groups and traits, and less on situational or individual influences on behavior (Leaper, 2015). In one study, middle school students with a fixed mindset more readily endorsed and acted on stereotypes about others

than did those with a growth mindset (Levy & Dweck, 1999). These beliefs can also be applied to the self: For children with a fixed mindset, the group stereotype becomes their individual destiny. In one study, adolescent girls who endorsed a fixed mindset about math had lower expectations of success, which predicted lower math achievement (Degol et al., 2018).

Conclusions

As children get older, they develop an increasingly sophisticated understanding of the social world. At the same time, they develop a sense of their own identity, including properties that tie them to and set them apart from others. Group membership plays a role in both tasks. Beliefs in stereotypes about their group can guide children's expectations for what they can do and where they belong. These stereotypes can shape their academic self-perceptions (including ability beliefs and sense of belonging) in STEM fields. These processes emerge during preschool and strengthen as children progress through elementary and middle school.

Numerous questions remain for efforts to develop effective interventions to improve equity in STEM fields. While some experimental evidence reviewed here supported causal effects of stereotype endorsement on motivation (e.g., Hilliard & Liben, 2010; Latrofa et al., 2010; Master et al., 2016, 2021; Miller et al., 2006), other experiments failed to show effects of group stereotypes on self-perceptions (Patterson & Bigler, 2018), indicating that we need more experiments and longitudinal studies. Although I have focused on gender stereotypes in this review, racial/ethnic stereotypes may influence children's academic self-perceptions through similar processes. Intersectional identities should also be explored, including stigmatized identities other than race/ethnicity and gender. In addition, while research cited here came from European (Heyder & Kessels, 2013; Huguet & Régner, 2009) and Asian (Cvencek, Kapur, &

Meltzoff, 2015) countries as well as the United States, cross-cultural studies would provide more information about generalizability.

Many educational inequities in STEM are rooted in stereotypes (Leslie et al., 2015). Although structural changes in education are necessary, stereotypes can compound the effects of structural disadvantages to further reduce girls' motivation in STEM classes and activities. Girls receive less encouragement and support to pursue STEM interests than boys (Leaper, 2015), and internalizing gender stereotypes can push them further away. Understanding how stereotypes influence children's motivation across development is critical for remedying educational inequities.

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Table 1*Key Terms and Definitions*

Construct	Definition	Examples
Stereotype-Related Constructs:		
Stereotypes	Shared beliefs that link groups with certain traits or characteristics, held by a particular society or culture and transcending beliefs within an individual (Bigler & Liben, 2006; see also Master & Meltzoff, 2020)	“Boys are better than girls at math,” “Girls are better than boys at reading,” “Scientists are brilliant”
Stereotype cues	Cues, messages, and signals of stereotypes expressed through patterns within many aspects of a culture, including physical objects, media representations, social interactions, and language use (Master & Meltzoff, 2020)	A math teacher always calls on boys first to solve math problems; images of male engineers are more common than female engineers; science kits are in a store aisle labeled “boys’ toys”
Stereotype endorsement	Personally reporting the belief that a stereotype is true (Cvencek, Nasir et al., 2015)	“I believe boys are more interested than girls in coding”
Stereotype awareness (or knowledge)	Belief that other people endorse a particular stereotype (Cvencek, Nasir et al., 2015)	“I think most people believe that boys are more interested than girls in coding”
Group-stereotype-to-self inferences	The process by which stereotype endorsement influences self-perceptions, when students make deductive inferences from their group’s traits and characteristics to their own traits and characteristics (Liben & Bigler, 2002; Tobin et al., 2010)	“Girls are not good at math (and I’m a girl), so I must not be good at math”
Self-to-group-stereotype inferences	The process by which self-perceptions influence stereotype endorsement, when students make inductive inferences from their own traits and characteristics to their group’s traits and characteristics (Liben & Bigler, 2002; Tobin et al., 2010)	“I like science (and I’m a girl), so girls must like science”
Motivation-Related Constructs:		
Motivation	A pattern of cognitions (self-perceptions, beliefs, and goals), affective responses (interest), and behaviors (persistence and academic choices) that energizes students in school (Dweck & Leggett, 1988)	Self-perceptions, beliefs, goals, interest, persistence, academic choices like elective course enrollment
Academic self-perceptions	Beliefs that involve the self’s relation to an academic domain (Master & Meltzoff, 2020)	Ability beliefs (“I am good at math,” “I will succeed in math”), sense of belonging (“I belong in math class,” “I fit in with the students in my math

		class”), identification (“math is important to me,” “I value math”)
Ability beliefs	A student’s perception of how good she is in a domain and her expectations for success on tasks in that domain (Eccles & Wigfield, 2020)	“I’m good at math,” “I will do well on my math test,” “I am confident in math,” “I will succeed in math”
Sense of belonging	A student’s beliefs about how much she fits in with others and has a positive relationship with the people or environment around her (Walton & Brady, 2021)	“I belong in math class,” “I fit in with the students in my math class”
Interest	The state of engaging with or the enduring tendency to engage with a particular domain over time (Eccles & Wigfield, 2020)	“He is very interested in math; he does extra math problems just for fun”