CAN A HARD-WORKING FEMALE ROLE MODEL COUNTER

STEM-REQUIRES-BRILLIANCE STEREOTYPES

AND SPARK GIRLS' ENGAGEMENT WITH STEM?

AN ABSTRACT

SUBMITTED ON THE 4TH OF AUGUST 2021

TO THE DEPARTMENT OF PSYCHOLOGY

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

OF THE SCHOOL OF SCIENCE AND ENGINEERING

OF TULANE UNIVERSITY

FOR THE DEGREE

OF

DOCTOR OF PHILOSOPHY

BY

Sally K. Merritt, M.S.

APPROVED: Laurie O'Brien, Ph.D.

Stacy Overstreet, Ph.D.

Carrie Wyland, Ph.D.

Damian Murray, Ph.D.

Abstract

The gender gap in STEM (Science, Technology, Engineering, and Math) professions results from several factors that deter females from pursuing careers in STEM. Girls' low interest in science and lack of feeling both belonging and efficacy in science, which emerge as early as middle school, are believed to be part of the problem. This study reports on a novel intervention designed to spark middle school girls' engagement in science. A diverse group of middle school girls participating in a science outreach event read about a female Black astronaut whose accomplishments were framed either as a result of hard work (growth mindset) or natural abilities (fixed mindset). Participants responded to an open-ended prompt that asked them if they wanted to be an astronaut like the role model and then answered a series of questions. It was hypothesized that girls in the growth mindset condition would endorse stronger interest, belonging, and efficacy in science, indicate a desire to be an astronaut, and explain that desire in ways that indicated similarity with the role model and alignment with their mindset condition. No significant differences were observed/emerged between the two conditions and exploratory analyses found no interaction between race and condition. Possible reasons for the null findings are discussed, including issues related to mindset manipulation and the strength and specificity of the intervention. Characteristics of the sample were also considered, including participants' above mid-point science interest, and belonging, both of which were positively related to desire to be an astronaut. This research provides insights into the complexities that need to be considered when designing an intervention to increase interest, belonging, and self-efficacy in STEM.

CAN A HARD-WORKING FEMALE ROLE MODEL COUNTER STEM-REQUIRES-BRILLIANCE STEREOTYPES AND SPARK GIRLS' ENGAGEMENT WITH STEM?

A DISSERTATION

SUBMITTED ON THE 4TH OF AUGUST 2021

TO THE DEPARTMENT OF PSYCHOLOGY

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS

OF THE SCHOOL OF SCIENCE AND ENGINEERING

OF TULANE UNIVERSITY

FOR THE DEGREE

OF

DOCTOR OF PHILOSOPHY

BY

Sally K. Merritt, M.S.

APPROVED: Laurie O'Brien, Ph.D.

Stacy Overstreet, Ph.D.

Carrie Wyland, Ph.D.

Damian Murray, Ph.D.

ACKNOWLEDGEMENTS

Foremost, I would like to thank my partner, Ryan, for supporting all my ambitions. I wish to thank my PhD mentor, Dr. Stacy Overstreet, for believing in me, helping me cross the finish line, and showing me what it means to be a great role model. I would also like to thank TAWS and the many supportive friends I made in this writing community. This group motivated me to finish my dissertation and learn self-compassion. To my friends in the department, friends in Women in Science & Engineering, and my lifelong friends, thank you for the kindness that you have always showed me. I would like to thank my children for bringing so much joy to my life and putting up with me during graduate school when "mommy is always working." To my own mother, thank you for always encouraging me, rather than telling me I am doing too much. I am grateful for the many fabulous research assistants who collected, entered, and coded this data, without whom this research would not have been possible and to Dr. Michelle Sanchez who graciously allowed me to try out new ways to try to get kids excited about STEM. Finally, a huge thank you to the many wonderful girls who participated in this study for sharing their thoughts and aspirations.

TABLE OF CONTENTS

LIST OF TABLES

Can a Hard-Working Female Role Model Counter STEM-Requires-Brilliance Stereotypes and Spark Girls' Engagement with STEM?

The STEM (science, technology, engineering, and math) workforce lacks diversity, with low representation of women. This lack of diversity risks missing out on important discoveries (Beede et al., 2011; Parker et al., 2015). Efforts to diversify the field must start very early in the educational pipeline because girls start to lose interest in science as early as middle school (Sadler et al., 2012). Without science role models who look like them, girls may feel that they do not belong in science. In addition to feeling like they do not belong due to a lack of representation, research suggests that girls often see STEM participants as brilliant (Cheryan et al., 2015). Taken together, these factors are believed to contribute to low rates of interest in science early in development and ultimately to a lack of women in the science community. Thus, there is a critical need to develop early interventions that provide role models who counteract the negative stereotypes that girls have about science. Role model interventions have the potential to increase interest in science in the short term and pursuit of science careers in the long term.

Research has shed some light on what makes an effective science role model. For girls, female science role models can be effective in combatting a lack of interest in and identification with science (González-Pérez et al., 2020; O'Brien et al., 2017). Beyond identity attributes, other attributes of science role models may be critical for countering the stereotype of scientists as brilliant individuals whose intelligence is seen as natural or God-given (Binning et al., 2019; Deiglmayr et al., 2019; Lin-Siegler et al., 2016), a phenomenon known as the brilliance trap (Cimpian & Leslie, 2017). This phenomenon may discourage women from pursuing STEM fields, which may be countered by science role models whose success is attributed to the result of hard work and persistence rather than innate ability. In fact, one study found that role models known for their effort were more effective at boosting math performance than those known for their gift, especially among girls (Bagès & Martinot, 2011). This attributional framing falls within mindset research, in which effort is emphasized for a growth mindset and contrasts with a fixed mindset where abilities come naturally, easily, or biologically (Dweck, 2007).

The overall objective of the present study is to determine whether a hard working role model increases science belonging, efficacy, and interest as well as STEM career intentions of middle school girls. The central hypothesis is that girls will benefit the most from a female science role model whose success is attributed to hard work, rather than a female science role model whose success is attributed to brilliance. The rationale is that girls will identify more strongly with a role model who works hard and does not embody stereotypes about STEM than one that is characterized as being naturally brilliant. This role model identification should create feelings of belonging in science. In addition, when a role model's success is attributed to hard work, this should increase efficacy and interest in science. By challenging the brilliance trap with similar role models who rebuke stereotypes about brilliance, girls can be motivated to pursue science.

Women and Girls in STEM

Although women make up half of the population and a greater portion of college graduates, they are underrepresented in many STEM fields. Overall women represent only 29% of all STEM careers, with some fields worse than others, such as engineering with only 14.5% women and math and computer scientists with only 26.4% women (NSF, Science & Engineering Indicators, 2018). Most children's science interest tends to decrease with age (Potvin & Hasni, 2014b); for girls who show academic promise in STEM, decreased interest in pursuing these fields may also be driven by STEM stereotypes (Cheryan et al., 2009; Dasgupta & Stout, 2014; Hill et al., 2010; Master et al., 2016). If STEM continues to be homogenous, these fields risk missing out on important discoveries (Beede et al., 2011; Hill et al., 2010). Evidence suggests gender and racial minorities in STEM produce higher rates of scientific innovation (Hofstra et al., 2020). Therefore, it is important to find ways to diversify STEM fields.

Several systematic reviews have tackled the causes of the gender gap, often using a nature versus nurture framework. For example, Ceci et al. (2009) reviewed findings on innate abilities compared to socialization causes of the gender gap. They reviewed over 400 studies including 20 meta-analyses and found that gender differences in *interest* in STEM, rather than in academic performance, is one factor that leads to this STEM gender gap, a finding that was replicated in another systematic review five years later (Ceci et al., 2014). Although the studies reviewed focused on the problem of the gender gap in STEM among adults, they take a longitudinal approach and find that interest rather than achievement through the life span should be examined further.

The gender gap research has taken a life course approach that covers a developmental span from early childhood experiences through the entire career trajectory. The research has uncovered evidence that shows that girls lose interest in STEM around middle school, and their interest in STEM plummets in comparison to boys as they continue through their academic career (Pajares, 2005; Potvin & Hasni, 2014a, 2014b; Sadler et al., 2012). Although one would surmise that academic achievement would predict interest in STEM careers, it tends to be self-efficacy and interest that predict these STEM choices (Chen & Pajares, 2010; Eccles & Wang, 2016; Tai et al., 2006; Wang & Degol, 2013) Given that interest, rather than academic achievement, is a key factor in the professional STEM gender gap, it is worth considering the early socialization experiences that may shape interest.

In fact, an upward trend in research examining the relationship between socialization processes and the gender gap in STEM has been documented (Chen & Pajares, 2010; Cheng et al., 2017; Kanny et al., 2014). Girls are subject to socialization processes that communicate what is appropriate behavior for their gender (Eccles et al., 1990). These socialization messages can come through passive or active forms of discouragement from participating in STEM academic domains. For example, Crowley et al. (2001) demonstrated passive discouragement from parents, who offered more explanations of science exhibits in a museum to their sons than their daughters. More overt discouragement was also demonstrated by Leaper and Brown (2008), rwho found that more than half of their 600 sample of 12–18-year-old girls reported some form of discouragement away from STEM from another individual. Girls reported on disparaging remarks about their abilities in STEM that were made on the basis of their gender. This discouragement came mostly from boys their age. Socialization messages can have profound impacts on STEM motivation. For example, 13-18-year-old girls' lack of STEM motivation was associated with lack of STEM support from their mothers and peers (Leaper et al., 2012). In conclusion, girls' report discouragement away from STEM by others and this has the potential to lead to girls' disengagement from STEM.

Studies with children are emerging as research points to middle school as a period of academic and career interest development that could lead to gender gaps in STEM.

These studies theorize that socialization processes lead to divergent interests among girls and boys as they develop. For example, in a longitudinal survey with a nationwide sample of over 7,000 students, Legewie and DiPrete (2011) found that boys in middle school are more than twice as likely as girls to say they want to work in STEM when they grow up (9.5% for boys vs. 4.1% for girls). Similarly, Barmby, Kind, and Jones (2008) surveyed nearly 1,000 middle school students in five different schools in the UK and found that all students tended to lose interest in science, but the loss was most drastic for girls (Barmby et al., 2008). These studies suggest that middle school is an optimal time to intervene to try to prevent STEM disengagement, especially among girls.

Decreases in STEM interest beginning in middle school are alarming and, if uninterrupted, could lead to decreased interest in STEM careers in later years. Unfortunately, evidence suggests that the declines first observed in middle school are relatively stable through adolescence (Legewie & DiPrete, 2011; Potvin & Hasni, 2014a; Sadler et al., 2012). For example, a longitudinal study by Legewie and DiPrete (2011) demonstrated that interest in STEM during 8th grade predicted interest in STEM during 12th grade, but interest tended declined over time. Specifically, only 27.9% of girls who were interested in STEM in 8th grade showed interest in 12th grade. It was rare for girls to demonstrate an opposite trend of increasing interest; only 5.8% of girls who were not interested in STEM in 8th grade showed interest in 12th grade. Similar results were found in a large nationally representative sample of 6,000 students (Sadler et al., 2012), which showed that from the first year of high school to high school completion, four times as many boys as girls maintained an interest in STEM, even after controlling for math achievement. Taken together, these findings indicate that the gender gap in interest in

STEM begins in middle school and widens as students progress through high school, independent of their achievement in STEM.

To date, research consistently shows that even though some girls never express interest in STEM, others who may report early STEM interest do not maintain it over time (Barmby et al., 2008; Legewie & DiPrete, 2011; Sadler et al., 2012). Several studies have uncovered substantial evidence to support the idea that socialization factors such as stereotypes about STEM and lack of female representation in STEM are responsible for this emerging lack of interest in STEM in early adolescence (Cheryan et al., 2017; Dasgupta & Stout, 2014; Hill et al., 2010).

STEM Stereotypes

While there are a myriad of stereotypes that exist about STEM, the two that have had the most impact on children's interest in pursuing science are that 1) STEM is for males and 2) STEM requires brilliance or natural abilities (Cheryan et al., 2015). These stereotypes are persistent and are embraced widely by Western culture. For example, the gender stereotypes held by a sample of college students in 1980 remained stable over a 35-year period (Haines et al., 2016). Children are highly susceptible to these stereotypes that permeate Western culture and girls are negatively impacted by the STEM-is-for-males and STEM-requires-brilliance stereotypes more than boys (Bian, 2017; Bian et al., 2017; Cvencek et al., 2011; Leaper et al., 2012). As described in the sections that follow, for girls these stereotypes can lead to loss of interest in STEM, feelings of not belonging in STEM, and a sense of decreased efficacy in their ability to be academically successful in STEM.

STEM-is-for-Males Stereotype

One harmful and pervasive STEM stereotype is that STEM fields are for males (Cheryan et al., 2015; Garriott et al., 2016; McGuire et al., 2020). The Implicit Association Test (IAT) has been used to confirm the existence of this stereotype in Western culture. In one study using an IAT with over 5,000 participants, both men and women showed strong implicit stereotypes associating math with male gender (Nosek & Smyth, 2011). These implicit beliefs about STEM-is-for-males start with boys and girls at early ages (Bian, 2017; Bian et al., 2017). Among 247 elementary school children who completed a similar IAT, boys had a stronger association between themselves and math than girls and were more likely to pick the male character in a vignette about child who likes to do math more (Cvencek et al., 2011). In another IAT study, 5th grade girls held more negative implicit math attitudes and more negative math self-concept attitudes than boys (Cvencek et al., 2021). These IAT studies suggest implicit STEM-is-for-males stereotyping exists even in young children.

Using another method to uncover implicit beliefs in youth aged 6 to 18, a meta-analysis of the past 50 years of studies, the draw-a-scientist task, found that the male-science stereotype has weakened over time (Miller et al., 2018). However, the male-science stereotype still exists as studies with older children were more likely to draw a male scientist than studies with younger children. These and other studies (Chatard et al., 2007; Kurtz-Costes et al., 2014; Kurtz-Costes et al., 2008; McGuire et al., 2020) suggest that young children have internalized the STEM-is-for-males stereotype. For example, in a sample of nearly 1,000 5-18 year old children boys believed their gender “should be” good at STEM, but this in-group favoritism did not exist for girls (McGuire et al., 2020).

These studies suggest that even children endorse the STEM-is-for-males stereotypes.

The STEM-is-for-males stereotype can have negative impacts on women and girls. For example, it has been shown that for women, strong endorsements of the stereotype is associated with weaker math self-efficacy, negative attitudes towards math, and less past, present, and future anticipated participation in math (Nosek & Smyth, 2011). In a large cross-cultural study of youth, Nosek et al. (2009) showed that countries where implicit STEM-is-for-males stereotype is strong have wider gender gaps in middle school science and math academic achievement compared to countries where the stereotype is weak.

Such academic achievement gaps may be influenced by lack of interest and low self-efficacy resulting from the STEM-is-for-males stereotype. For example, high endorsement of the STEM-is-for-males stereotype was associated with gender differences of expected success in STEM for 880 middle school students in Croatia (SelimbegoviД‡, 2019). Specifically, high STEM-is-for-males stereotype endorsement was associated with lower STEM self-efficacy for girls but higher STEM self-efficacy for boys. This suggests that although girls may be harmed by the STEM-is-for-males stereotype, boys may benefit from this stereotype. Another study of 300 middle school children from the UK examined sixth and seventh grade students separately measuring STEM-is-for-males stereotypes alongside STEM self-efficacy and STEM academic achievement (Pennington, 2021). Consistent with the findings of SelimbegoviД‡ (2019), stronger endorsement of the STEM-is-for-males stereotype was associated with worse science grades for girls in the sixth grade. One possible, although untested explanation for this is that girls who endorse the STEM-is-for-males stereotype may not be putting forth as much effort in STEM, which is exhibited by lower grades. However, by seventh grade, endorsement of the STEM-is-for-males stereotype was not predictive of science and math grades for girls. Interestingly, while girls rated themselves as having less self-efficacy in science and math than boys, they were achieving better grades than boys in math. Although results in this research varied by grade, they demonstrate that the STEM-is-for-males stereotype is impactful and being a girl can impact STEM self-efficacy regardless of academic achievement (Pennington, 2021).

STEM-Requires-Brilliance Stereotype

In addition to the STEM-is-for-males stereotype, one of the most pervasive STEM stereotypes is that success in STEM requires brilliance (Deiglmayr et al., 2019; Dweck & Master, 2009; Rattan, Savani, et al., 2012; Stipek & Gralinski, 1996). According to this STEM stereotype, a person who is successful in STEM is naturally very intelligent and therefore belongs in STEM. The idea that success in STEM requires brilliance is believed to be a product of socialization processes that repeatedly suggest and reinforce the idea that only very intelligent people are successful in STEM (Bian et al., 2018; Cimpian & Leslie, 2017; Deiglmayr et al., 2019), which ultimately leads to more deeply internalized beliefs about the fixed nature of one's abilities in STEM (Hill et al., 2010; Thébaud & Charles, 2018). Individuals who endorse the STEM-requires-brilliance stereotype accept that people in STEM are naturally very intelligent, and if they do not consider themselves to be naturally intelligent in STEM, they are more likely to disengage from STEM, a phenomenon known as the "brilliance trap" (Cimpian & Leslie, 2017). The brilliance trap can be defined as the propensity to endorse the belief that a certain field requires brilliance (i.e., STEM-requires-brilliance stereotype), thus leading to disengagement with this particular field.

Women and underrepresented racial minorities are more likely to fall into the brilliance trap and disengage from STEM because although race is not inherently tied to intelligence, the group most often stereotyped as intelligent are White males (Cimpian & Leslie, 2017; Storage et al., 2020). As is the case with all stereotypes, these ideas get reinforced through socialization processes, such as in the media depictions of scientists. For example, White men are more frequently portrayed than women or people of color in introductory biology textbooks (Wood et al., 2020), as well as science trade books for children (Kelly, 2018). Thus, the "brilliance trap" subtly traps females and people of color into maladaptive thinking that only (White) men are brilliant, which is discouraging to diverse pursuers of STEM (Leslie et al., 2015).

The belief that brilliance is innate can be understood in the context of mindsets. According to Dweck, people tend to have either a fixed mindset or a growth mindset about certain traits, like intelligence (Dweck, 2006, 2007; Dweck & Leggett, 1988). Those with fixed mindsets believe traits like intelligence are stable, biological, and difficult to change, while those with growth mindsets believe traits like intelligence are malleable, nurtured, and capable of change (Dweck, 2017). Individuals can have different mindsets about different traits or areas of intelligence. For example, mindsets about STEM intelligence are unique to other areas of intelligence such as general intelligence or intelligence related to liberal arts (Dweck & Master, 2009). The presence of a fixed mindset about STEM intelligence as a stable, unchanging trait may lead children into the brilliance trap, whereas the presence of a growth mindset may help them avoid it.

Even children are susceptible to particular mindsets. Bian (2017) conducted a series of studies on the development of the “brilliance trap” with children between the ages of five and seven that suggest that the intersectional stereotype STEM-requires-brilliance emerges early and impacts children’s interest depending on their gender. In two separate studies, Bian provided evidence that children are susceptible to the stereotype that males are brilliant and females are not. In these two studies, boys and girls as young as six years old were more likely to choose a male adult character versus a female adult character when trying to figure out who was “really, really smart.” In another study using random assignment to different games, girls were less likely to want to play games for “smart children.” However, there were no significant differences between girls’ and boys’ interest in games for hard-working children, which shows that there is something particular about games for “smart children” that may be unappealing to girls. Stereotypic beliefs about who is brilliant mediated the relationship between children’s gender and their interest in these games. In a final study, girls as young as six were less likely to select members of their own gender to play a team game for “really really smart” children. These studies suggest that even young children have internalized the stereotype that brilliance is for males and these stereotypes impact girls’ interests and interactions.

In Bian’s (2017) study, girls interest in “hard working” games is believed to come from their avoidance of games for smart children. Their selection is believed to imply that they endorse the brilliance trap stereotype and do not believe they will do well in games for smart children. A similar mechanism may be at play with the STEM-requires-brilliance stereotype. Believing that STEM requires innate abilities discourages girls from engaging in STEM is by fostering a sense of not-belonging (Dweck & Master, 2009). In other words, if students do not believe they have this innate STEM ability, they do not feel they belong. Girls are particularly susceptible to these mindsets because they are stereotyped as not being as "naturally good" at STEM than boys (Cheryan et al., 2009; Kurtz-Costes et al., 2008; McGuire et al., 2020).

Growth mindset has been deemed as one strategy for combatting the STEM-requires-brilliance stereotype. However, the extent to which mindset interventions work, and in which contexts they work best to address the gender disparities in STEM has received mixed empirical support (Sisk et al., 2018; Walton & Yeager, 2020). The factors that have been researched that lead to STEM pursuit are STEM interest, STEM belonging and STEM self-efficacy. While middle school is the time period during which socialization is likely to have the greatest influence on the gender gap in STEM interest, it is also a period during which children's career interest and career self-efficacy are influenced by their academic self-efficacy, or the belief that one has what it takes to succeed school (Bandura et al., 2001). Self-efficacy is the belief that one has what it takes to succeed in a specific domain. Growth mindsets are aligned with stronger self-efficacy in STEM (Komarraju & Nadler, 2013; Rattan, Good, et al., 2012). A growth mindset would attribute success in STEM to hard work, an attribute one can learn to grow, making their success in STEM seem plausible. On the other hand, a fixed mindset suggests that one must have natural gifts in order to succeed in STEM. Therefore, it is important to understand how a growth mindset can help with the persistence in STEM.

The Benefits of Growth Over Fixed Mindsets

Growth mindset is associated academic success in children (Blackwell et al., 2007; Dweck & Yeager, 2019; Nix et al., 2015; Romero et al., 2014; Yeager et al., 2016). Several studies have documented the association between a STEM growth mindset and

STEM interest and self-efficacy in children. For example, in a study of 416 middle school students, growth mindset was positively associated with academic self-efficacy (Mofield & Parker Peters, 2018). In a cross-sectional study of 2,476 US students in grades 6-12 (with 85% from middle school), students who had a growth mindset reported greater STEM interest and STEM self-efficacy than students with a fixed mindset (Marriott, 2019). The differences in STEM self-efficacy between students with a growth mindset and those with a fixed mindset were statistically significant and meaningful; students with a growth mindset rated their STEM self-efficacy above 80 out of 100 possible points whereas students with a fixed mindset rated their STEM self-efficacy between 50 and 60 out of 100. Other research indicates these associations seem to hold over time. In a 10-year longitudinal study of 14,320 high school students, a math growth mindset and math self-efficacy in 10^{th} grade positively predicted their STEM career outcomes more than 10 years later (Seo et al., 2019). These studies demonstrate that a growth mindset in STEM has a strong influence on STEM interest and self-efficacy for all students, but there are often times when either a growth or fixed mindset can be more impactful for females.

STEM Mindset Impact on Females

A growth mindset is important for all learners in STEM subjects, but there is growing consensus in the literature that it is particularly relevant for females (Wang & Degol, 2013). Growth mindset may be particularly helpful to females because they face the challenge in STEM of combatting STEM-is-for-males stereotypes (Casad et al., 2018). For girls to overcome such pervasive stereotypes, adopting a mindset that STEM skills can be fostered, rather than seeing them as innate abilities of another gender, could help girls increase their self-efficacy, interest, and belonging in STEM.

Mindset and Self-Efficacy. Studies have suggested that the relationship between mindsets and self-efficacy is stronger for girls than for boys. For example, in a study of 870 tenth graders in Germany, a fixed mindset about math ability was associated with lower self-efficacy in math among girls, but not boys (Heyder et al., 2021). A study with 152 US middle school students found that girls', but not boys', growth mindset in STEM was associated with math self-efficacy (Huang et al., 2019). This relationship between STEM growth mindset and STEM self-efficacy can have important implications for STEM academic performance (Sisk et al., 2018). For example, in a longitudinal study examining the relations between mindset, STEM self-efficacy, and math achievement in 1,449 high school students (Degol et al., 2018), girls with a growth mindset during the fall and winter of their academic year outperformed boys in math, as measured by their final math grades. Additionally, the relationship between girls' growth mindset and math grades was mediated by STEM self-efficacy. These findings suggest that promoting a STEM growth mindset in girls might be one way to increase self-efficacy, enhance STEM performance, and begin to diminish the gender gap in STEM.

Mindset and Belonging. A growth mindset has the potential to create greater belonging in STEM for girls. Individuals with a growth mindset attribute STEM intelligence to hard work and perseverance (Dweck & Master, 2009; Dweck & Yeager, 2019). Students who feel they have the capacity to engage in the hard work necessary for STEM success/achievement may be more likely to feel they belong in STEM because they possess similar attributes as those successful in STEM. Although there is no known work on the relationship between mindset and STEM belonging in children, there are several studies with young adults that shed light on the impact mindset has on STEM belonging.

The importance of growth mindset to STEM belonging was demonstrated in a longitudinal study of students in a college calculus class (Good et al., 2012). Women who perceived their class environment as conveying a fixed mindset of math ability and a math-is-for-males stereotype reported low feelings of belonging in math. By contrast, women who perceived their class conveyed a growth mindset felt a greater sense of belonging in math, even when they perceived that math-is-for-males stereotyping was high (as measured by the perceptions of environmental stereotyping test). This suggests that growth mindset environments may be protective against STEM-is-for-males stereotyping.

Mindset and Interest. Interest is an important factor to examine for girls because interest is more likely to lead to the pursuit of STEM careers in the future. One study in Germany found that tenth grade girls with a fixed mindset about math ability had lower interest in math, but this relationship did not exist for boys (Heyder et al., 2021). Studies like these suggest that a fixed mindset for girls is particularly harmful to their interest in STEM. A growth mindset may not be enough to counter these effects for girls. For example, middle school girls with a growth mindset did not have greater interest in STEM than girls with a fixed mindset (Huang et al., 2019). It could be that other factors need to be examined to see a broader picture of how mindset may impact STEM interest. For example, Degol et al. (2018) found that middle schoolers with a growth mindset had greater STEM career interest but this relationship was mediated by math value. In this case, the middle schoolers who thought that it is important to learn math could have been as influential to their greater interest in STEM as their growth mindset, or their positive thinking about math could have influenced their growth mindset.

As previously described, fixed mindsets about success in STEM can lead to lowered belonging, less STEM efficacy, and loss of interest in STEM for girls. These variables often interact with one another, so it is important to examine how STEM interest, efficacy and belonging are related when testing predictions about the impact of mindsets in STEM. It may be that interventions that include mindset need to utilize other effective methods of delivery, such as role models.

Role Models

One effective method that researchers have used to counter stereotypes and negative attitudes towards STEM is exposure to STEM role models (e.g., Cheryan et al., 2015; Master et al., 2016; Olsson & Martiny, 2018). Early research in child development has demonstrated that children readily mimic an adult role model displaying particular behaviors and children mimic best with same-gender role models (Bandura, 1965). Out of this body of research, social learning theory was developed, which proposes that new behaviors, attitudes, and emotions can be acquired by first observing others and then imitating them (Bandura & McClelland, 1977). This theory suggests that children tend to imitate same-gender role models because they convey that the behavior is appropriate for their gender. Same-gender role models may also be effective because children are more likely to imitate people similar to themselves, through the process of identification. This identification has been theorized to be an important tenet of getting aspirants to enact the behavior of role models (Buck et al., 2008; Olsson & Martiny, 2018). In particular, adult role models are believed to be effective for helping people achieve their academic goals by demonstrating pathways to success (Morgenroth et al., 2015), which can increase the likelihood of enacting their goals.

Other researchers believe that the decision to mimic a role model is a higher cognitive process that relies on the expectancy-value theory of achievement motivation (Eccles & Wang, 2016; Eccles & Wigfield, 2020; Wigfield & Eccles, 2000). This theory suggests that motivation to achieve a goal is mediated through a cognitive process that weighs the pros, cons, and probabilities of effort and achievement. Theoretically, when individuals are confronted with a task, they assess the level of expected success as well as the personal value of the task to them, and through this process, they arrive at a certain level of motivation to achieve the task. Role models facilitate this cognitive process by demonstrating pathways to success (i.e., aspirants identify with the role model and *expect* that they can accomplish the same task that the role model accomplishes). In addition, aspirants adopt the value that role models demonstrate in accomplishing a specific task (i.e., if the role model appears to place a high value on the task, the aspirant may also be influenced to see the task as more valuable). Role models are especially important in demonstrating pathways to success in domains that may be unfamiliar to aspirants. This theory suggests that aspirants who are unfamiliar with a particular domain, such as chemistry, will look to a role model to understand what chemists do and look like.

Personifying the people that work in a particular domain via role modeling has been shown to be effective at boosting interest in careers (Gibson, 2004; Morgenroth et al., 2015). For example, Wyss et al. (2013) presented a series of ten- to fifteen-minute videos of scientists describing their jobs to middle school students. Students who viewed the videos increased their consideration of careers in science as compared to a control group who did not view the videos. Although this was a small sample, this type of study demonstrates how simple role model interventions can boost interest in STEM.

Other research has demonstrated that the role modeling effect works particularly well when the aspirant and role model share some valued identity (Buck et al., 2008; Dasgupta, 2011). This shared identity does not need to be well-represented in the larger field or discipline. For example, female role models in STEM (where women are underrepresented) have been shown to be effective in boosting STEM interest among women and girls (Lawner et al., 2019; Lockwood, 2006; Olsson & Martiny, 2018). Therefore, some suggest utilizing female role models to get girls interested in STEM (Casad et al., 2018) and there is a rich literature on the most effective female role models in STEM.

Female Role Models in STEM

According to the stereotype inoculation model, female role models in STEM may be particularly effective for combatting stereotypes because role models who share similar attributes help aspirants better identify with the role model and persist in domains that may be academically challenging (Dasgupta, 2011). The stereotype inoculation model theorizes that female role models in academic domains are effective because they increase feelings of social belonging and self-efficacy for female aspirants. Although the stereotype inoculation model was developed from research with adults, research from others who use female role models for girls in STEM suggest this theory can be applied to children.

To illustrate, a meta-analysis of forty-five STEM role model studies confirms that gender-matched and race-matched role models have a significant positive effect for aspirants, especially in field studies (Lawner et al., 2019). This meta-analysis was conducted on studies with adults and children, suggesting that gender matching can be successful with children because of shared attributes with the role model that creates a sense of connection and challenges stereotypical views of scientists (Buck et al., 2008).

O'Brien et al. (2017) demonstrated the effectiveness of female science role models for girls who participated in a study during a STEM outreach event. A diverse group of 175 middle school girls was randomly assigned to write about a leader from the STEM workshops they attended or one of their friends. Girls who wrote about a workshop leader (a female adult STEM role model) reported an increase in their perceived fit with science. Fitting in with science is similar to measures of STEM belonging (i.e., I feel like I belong in science class) and STEM efficacy (i.e., I'm bad when it comes to science). Girls who wrote about a STEM role model were more highly identified with her than girls who wrote about a friend and higher role model identification was related to greater sense of fit in science. The authors argued that providing an opportunity for girls to reflect on their impressions of the role model may have enhanced the impact of their role model intervention.

In a follow up study, Merritt and colleagues explored whether selecting a favorite role model might be more effective than being assigned a role model to write about (Merritt et al. in press). This mechanism of choice was tested by randomly assigning a different sample of girls at the STEM outreach event to write about the first workshop leader (no choice) or to choose a favorite workshop leader to write about. Girls in this study identified highly with the role models, regardless of condition. Additionally, role model identification was associated with increases in science identity, a measure used to indicate how much someone feels their identity overlaps with science. Without differences among conditions on these measures, it tentatively suggests that role models who are assigned may be just as effective as role models who are freely chosen by girls.

Effective Counter-Stereotypical STEM Female Role Models

Without interventions or experiences with female STEM role models, children are likely to view STEM fields as places for White males (Garriott et al., 2016; McGuire et al., 2020; Miller et al., 2018; Wood et al., 2020). As noted, science trade books for children are more likely to depict scientists as White and male (Kelly, 2018), suggesting that effective role models for girls need counter the standard and common STEM-is-for-males stereotype. Female role models have been particularly useful in combatting stereotypes about who belongs in STEM (e.g., Lawner et al., 2019; O'Brien et al., 2017; Olsson & Marrtiny, 2018). In these studies, engaging with female role models has led to a greater sense of belonging among aspirants, suggesting that countering the STEM-is-for-males stereotype is important for engaging girls with STEM.

Adult women serving as STEM role models have successfully been used to encourage girls to pursue STEM (González-Pérez et al., 2020). For example, Gonzalez-Perez and colleagues studied the impact of female role model visits to classrooms of 300 girls in public and private middle schools and high schools in Spain. Each class was visited by three different female role models who talked to the girls about their jobs as scientists or engineers. The study measured the degree to which the girls' enjoyed, valued, and expected success in math before and after the role model's visit. Role model exposure increased ratings from girls on all these measures as well as their overall expectations of success in STEM. Importantly, this study also measured stereotypes about STEM. Role models also had a significant impact on decreasing girls' negative stereotypes about STEM by dismantling these STEM stereotypes in their presentation. The content was rated as counter-stereotypical if the role model mentioned that her job required any of the following three items: teamwork, social skills, and communication. The greater the counter-stereotypical content conveyed by the role model, the stronger the relationship between expectations of math success and the choice of future STEM career. This study demonstrates the impacts female role models who share counter-stereotypical content can have on young aspirants in STEM.

Female role models who demonstrate counter-stereotypic STEM behavior may be especially useful to non-traditional STEM aspirants (i.e., females). A recent review of the literature demonstrates that exposure to counter-stereotypic role models can reduce gender stereotyping of young girls (Olsson & Martiny, 2018). This review of the literature suggests that exposure to counter-stereotypical female role models is particularly important for getting girls interested in STEM. For example, one study showed that girls were less likely to picture a scientist as a man after participating in a 10-day summer camp led by female scientists (Leblebicioglu et al., 2011). Olsson and Martiny (2018) suggest highlighting similarities between girls and STEM role models while giving plenty of opportunities for multiple exposures to role models.

Role Model Mindset

While female STEM role models seem to help counteract the STEM-is-for-males stereotype, gender matching alone may not be an effective counter for the STEM-requires-brilliance stereotype. One relatively new path of inquiry is whether role models' mindsets impact aspirants. Role models who convey growth mindsets may be effective for combatting the STEM-requires-brilliance stereotype. A role model who has achieved success through hard work may dispel myths that STEM requires innate brilliance. In addition, a role model that coveys her success as a product of hard work, rather than innate ability, may demonstrate pathways to success that seem achievable for young aspirants. Thus, exposing girls to role models with a growth mindset for STEM may be one mechanism to enhance their interest, belonging, and performance in STEM areas.

A common role model that students are exposed to on a daily basis is their teacher. Heyder et al. (2020) examined the impact of teacher mindset on their students. Findings indicated that fourth grade teachers with a fixed mindset about math were demotivating to students. Similar findings have been found in young adult samples with college students. Muenks et al. (2020) found that college students whose STEM professors who espoused a growth mindset reported a greater sense of belonging in STEM than students whose professors espoused a fixed mindset or no particular mindset (Muenks et al., 2020). They also found that increased feelings of belonging in STEM predicted greater interest in STEM. Conversely, another study demonstrated that subjecting students to a fixed mindset STEM professor led to lower interest in taking the STEM course (LaCosse, 2020). Taken together, these findings indicate that being exposed to STEM role models with a growth mindset can lead to positive changes in student STEM outcomes.

Another common role model for students is peers and there is some evidence that a growth mindset in peer role models can have a positive influence on girls' performance in STEM. For example, Bages et al. (2016) examined the impact of a peer role model whose success in math was attributed to hard work or giftedness on math self-efficacy. Girls who read about a hard-working peer were more likely to identify with the role model than girls who read about a gifted peer or one without explanation. Stronger identification with the hard working role model, not the gifted role model, was associated with increased self-efficacy in math (Bagès et al., 2016). In a similar study, girls performed better on a difficult math test when they read about a hard-working role model rather than a gifted one (Bagès & Martinot, 2011). Taken together these studies demonstrate how a simple manipulation of a role model's mindset can impact children's identification with that role model, which in turn can impact other STEM-related outcomes.

Beyond Gender Diversity in STEM

In addition to the lack of STEM gender diversity, STEM also suffers from a lack of ethnic and racial diversity. NSF has categorized African American, Latinx, and Native Americans as Underrepresented Minorities (URM) in STEM because the percentage of people from these groups obtaining STEM degrees and in the STEM workforce is lower than their representation in the U.S. population (NSF, 2019). The lack of diversity is even lower at the intersection of gender and ethnicity; Black women only make up about 2.5% of the science and engineering workforce (National Science Foundation, 2018), which means that Black girls have very few same-gender same-race role models. Thus, Black girls have even less similar-looking STEM role models to admire than White girls.

Exposure to more Black female STEM role models has the potential to increase interest in STEM among Black girls and improve the racial gap in STEM, but few studies have tested interventions aimed to improve the ethnic and racial diversification of STEM. When examining a myriad of studies on the effects of role models in STEM, the authors observe that there has been no known experimental research testing whether same-race role models are more effective at recruiting URMs into STEM (Drury et al., 2011). Theoretical work under the stereotype inoculation model suggests that same-race role models should be effective at increasing STEM interest among URM children (Dasgupta, 2011) and common mechanisms of change within role model interventions have found that identity, interest, self-efficacy, and support are important factors in the experiences of Black women and girls in STEM (Ireland et al., 2018). Still, it is unclear if role model research could be more effective for girls of color by making use of a woman of color as the role model.

To date, most studies that have examined the effect of female role models on women or girls have either tested the impact of White female role models or have not specified the race of the female role model (e.g., Bages & Martinot, 2011; O'Brien et al., 2017; Plant et al., 2009). For example, Merritt et al. (in press) described above, had a diverse sample of girls write about a STEM workshop leader and their results showed that URM girls identified more with role models than White or Asian girls, despite the lack of race-matching. The current study examines the impact of a Black female role model with growth or fixed mindset on a diverse group of adolescent girls and specifically offers an opportunity to explore if the growth mindset role model will have a greater impact on Black girls relative to White girls.

Study Overview

This present study integrated the mindset and role model literature to examine the impact of the mindset of a Black female role model on girls' interest in STEM. Middle-school girls participated in a science outreach event and were randomly assigned to read about a Black female astronaut whose success was attributed to either brilliance or hard work. The mindset and role model literatures tend to use White role models; this current study attempts to replicate and extend effects using a Black role model. Following their exposure to the science role model, girls responded to an open-ended prompt asking them if they would like to be an astronaut like the role model and to explain their answer. Girls then completed measures to assess science belonging, efficacy, and interest. The first aim of this field experiment was to determine the impact of a Black female science role model whose success is attributed to hard work (growth mindset) over a Black female role model whose success is attributed to brilliance (fixed mindset). More specifically, the first hypothesis was that girls who read about a growth mindset role model would report higher science efficacy, belonging, and interest than girls who read about a fixed mindset role model.

The second aim of the current study was to identify whether the growth versus fixed mindset of a role model would impact themes girls' mention in their open-ended responses. Therefore, the second hypothesis was that girls who read about a growth mindset role model would be more likely to report that they wanted to be an astronaut, that they wished to be similar to the role model, and that they liked her more than the girls in the fixed mindset condition. This was based on research that showed children identified more with growth mindset role models than fixed mindset role models and the measure of role model identification includes items related to similarity (Bagès et al., 2016). As part of the second hypothesis, it was predicted that girls in the growth mindset condition would be more likely to mention the positive aspects of hard work in their open-ended response compared to girls in the fixed mindset condition, who would be more likely to mention not having abilities or intelligence.

One novel element of the current study was the racial and ethnic diversity of the participants, which allowed for an exploratory aim to examine the impact of a Black female role model on Black girls compared to White girls. Few studies have examined this, although the limited findings do suggest the potential importance of examining race (Ireland et al., 2018; Lawner et al., 2019; Riegle-Crumb et al., 2011). For example, past research with a sample of adolescent girls at a science outreach program found that underrepresented minority girls identified more with the workshop leader role models at the outreach event (Merritt et al., in press). Although the current study design did not allow for a test of matching effects (e.g., whether the Black role model had more of an impact for Black girls than a White role model would, and vice versa), exploratory analyses examined if mindset condition interacted with race on levels of belongingness, efficacy, and interest. More specifically, an interaction was hypothesized where the mindset manipulation would have a greater impact on Black[1] girls (and any multiracial girl who at identifies Black or African American as one of their racial identities) than non-Hispanic White girls. Social identity theory suggests that sharing an identity with the role model would allow Black girls to identify more with the role model than White girls (Tajfel et al., 1979). It is less clear from the literature if any girl of color (e.g. Asians or Latinas) would identify more with the role model than White girls, only girls of color who identified as Black were included in this analysis. In the open-ended responses, analyses explored if the growth mindset condition resulted in more mentions of themes

[1] For the sake of brevity and inclusiveness, this category is referred to as Black. The author acknowledges that some may prefer the term African American. However, the term Black is more inclusive as not all people who identify as Black also identify as African American.

related to the role model (i.e., role model intelligence, similarity, liking, gender, and race) among Black girls compared to White girls. It was predicted that Black girls in the growth mindset condition would be more likely to mention hard work and intellectual curiosity and less likely to write about lack of ability and disinterest in space than White girls in the growth mindset condition.[2]

Method

Participants

One hundred and ninety-one girls participated in the study as part of a science outreach event known as GiST (Girls in STEM at Tulane). No girl refused to take the survey, but one group left the GiST event before the third workshop so they did not participate in the study. Of those that participated, 150 girls' had parental consent (M = 11, SD = 1.00, *range* = 9 - 14). Participants selected their ethnic background using the following response choices: White/European American = 34.7%; Black/African American = 31.3%; Hispanic/Latino American = 10.7%; Asian American = 4.7%; Native American = 2.7%; and Other = .7%. Thirteen percent of girls were categorized as Multiracial based on the selection of more than one response choice or a written-in response.

For exploratory analyses examining differences between Black girls and non-Hispanic White girls, additional categorizations were made. All girls who self-identified as Black/African American by selecting that response choice or by writing in a response of African American or Black as their ethnic category were categorized as Black,

---

[2] There were no specific predictions regarding the themes of alternative career, fear/danger, and family because they were added as a result of themes that emerged from looking at the open-ended responses.

resulting in 59 Black girls. For the European American/White category, all girls who checked European American or wrote in an ethnicity consistent with this (e.g., Italian) were included, resulting in 52 White girls. Girls who selected European/American/White and Hispanic/Latino American response choice or wrote in Hispanic were not included in this analysis.

Procedures

Participants were recruited as part of a science outreach event known as GiST (Girls in STEM at Tulane). Parental permission forms were mailed to parents along with registration packets for the GiST event. Girls arrived at the GiST event on a Saturday and participated in two workshops on a variety of STEM topics led by either Tulane professors, graduate students, or advanced undergraduates. Research assistants either administered the study protocol before or after the third workshop of the day. The timing of the survey administration was by the GiST organizers. Research assistants trained to administer the survey passed out the survey and the assent form. All research assistants were women.

The survey packet was randomly distributed and consisted of a short biography of Stephanie Wilson, a Black female astronaut. None of the workshop facilitators were astronauts and none of the workshop topics focused on space or astronomy. In past studies, girls were able to select a favorite workshop leader, suggesting they may like some more than others just based on their short interactions (Merritt et al., in press). Therefore, the use of an astronaut role model controlled for potential contamination of interpersonal interactions that occurred over the course of the event. Girls read the fixed or growth mindset biography to themselves and answered the open-ended prompt, "Would you like to be an astronaut like Stephanie? Why or why not?" Once they completed the open-ended response, girls completed the self-report measures in the following order: belonging in science, science efficacy, and science interest. The last portion of the survey was demographic questions. Research assistants collected the completed surveys, which took about fifteen minutes to complete.

Manipulation

The framing of the astronaut's biography was manipulated so that participants were randomly assigned to either a fixed or growth mindset. Participants read a short bio of a science role model and her accomplishments, framed either as a result of working hard (growth mindset) or natural abilities (fixed mindset). In the fixed mindset condition, participants read the following biography:

> *Stephanie Wilson is a NASA astronaut with the most hours in space of any African American astronaut. Her* ***superior intelligence gained her entry*** *to Harvard University. Her* ***talent for understanding*** *space along with her* ***natural abilities*** *in math and science led her to study aerospace engineering. Stephanie went on to do brilliant research with NASA's Jet Propulsion Laboratory. Stephanie has flown on 3 space shuttle missions and* ***received honors and awards for her research and abilities****.*

In the growth mindset condition, participants read the following biography:

> *Stephanie Wilson is a NASA astronaut with the most hours in space of any African American astronaut. Her* ***long hours studying earned her a spot*** *at Harvard University. Her* ***interest in*** *space along with her* ***love*** *of math and science led her to study aerospace engineering. Stephanie went on to do conduct research with*

> *NASA's Jet Propulsion Laboratory. Stephanie has flown on 3 space shuttle missions and* ***received honors for her hard work and years of service****.*

In both conditions, girls saw the same photo of the role model. For the complete survey see Appendix A.

Dependent Variables

Future Astronaut

After reading about the role model, girls responded to the following open-ended questions: *Would you like to be an astronaut like Stephanie? Why or why not?* A research assistant coded their response to the first question with three possibilities: No = 1 (I do not want to be an astronaut), Maybe = 2 (I might want to be an astronaut), and Yes = 3 (I want to be an astronaut).

Open-Ended Themes

The girls' open-ended responses to this prompt were coded using a variety of themes related to the reasons that the role model may or may not have been effective. All these open-ended themes were coded as yes =1 (the theme is present) or no = 0 (the theme was not present). Many themes were identified ahead of coding based on the role model and mindset literatures. According to the stereotype inoculation model, sharing some component of the role model's identity or attributes facilitates the process of role model identification (Dasgupta, 2011). For this reason, mentions of the role model's gender (e.g., *Yes because she is a* ***woman*** *and she shows that there are not just male astronauts*) and race (e.g. *I would not like to be an astronaut because it seems scary and I would not like to be away from my family but I am super thankful for this brave* ***Black*** *woman*) were coded as distinct themes. The process of role model identification often involves liking or admiration so likability (e.g. N*o because space isn't really for me.* ***She seems like a cool person*** *and that would be a good job, but I think I want to be a veterinarian or a dermatologist when I grow up*) and desired similarity (e.g. *Yes* ***I would like to be like Stephanie*** *because I want to be a Black astronaut*) were included as separate themes.

A growth mindset may influence one to think about hard work but hard work can be seen positively or negatively. Therefore, mentions of hard work were coded as a positive theme (e.g. *I would like to be an astronaut like Stephanie because* ***she spent her hard work studying*** *and going up to space and doing missions. She is an inspiration*) or a negative theme (e.g., *Not really,* ***being an astronaut seems like a lot of hard work*** *and time*). Any mentions of lack of abilities, talent, or intelligence were also coded as a theme (e.g. *No because going into space would mean I have to leave my family. Also* ***I am not cut out for all the training I know that they have to do***). Additionally, any mentions of the role model's intelligence were coded as a separate theme (e.g., *I can tell she is successful and* ***smart****, but I am not particularly interested in being an astronaut*).

There are a variety of reasons girls may or may not want to be an astronaut that are unrelated to the role model, and it is important to understand these other reasons because researchers need to take these reasons into account when designing future STEM interventions. One of the reasons girls may choose to be an astronaut is their interest in space or science, which was coded as science interest (e.g., *Maybe because then* ***I can explore space and study and find unknown things in the universe***). The opposite may be true for some girls, so expressions of disinterest in space or science were coded as disinterest (e.g., *No because* ***my passion is not space***).

In examining girls' open-ended responses, the following themes were identified through the process of coding. For example, some girls expressed an interest in pursuing careers different than an astronaut, which were coded under the theme of alternative career (e.g., *No, I would not like to be an astronaut like Stephanie because* ***I really want to be a chef***). One unanticipated theme that emerged was fear, with some girls expressing feelings of fear or loneliness about being in space (e.g., *I would not because* ***I don't want to die in space***). Finally, some girls expressed not wanting to be away from their families (e.g., *No****, I do not like the idea of being away from my family***). For the complete code book, refer to Table 1.

Belonging in Science

Four questions assessed girls' feelings of belonging in science. These questions were adapted from the membership subscale of belonging from Good, Rattan, & Dweck (2012). These same four items in the membership subscale were previously used with adolescent girls to measure belonging in a computer science classrooms and had high internal reliability with α that ranged from .87 to .94 in two different experiments (Master et al., 2016). The four questions included in this study were: *I feel that I belong to the science community, I consider myself a member of the science world, I feel like I am part of the science community,* and *I feel a connection with the science community.* Participants responded on an eight-point scale with labels ranging from 1 (*Strongly Disagree)* to 8 (*Strongly Agree)*. A composite score was calculated by averaging the items, with higher scores indicating greater belonging. In the current study, α =.91.

Science Self Efficacy

These items were created based on face validity with items that assessed girls' agreement with whether they believed they could be successful in science. These items were similar to other STEM self-efficacy measures, but they focus more on the future and less on social comparison (see Degol et al., 2018 for example). Girls responded on a five-point scale from 1 (*Strongly Disagree*) to 5 (*Strongly Agree*) to the following three statements: *If I work hard enough, I could become a scientist when I grow up; If I wanted to, I could become a scientist when I grow up; I have what it takes to become a scientist when I grow up.* A composite score was calculated by averaging the items, with higher scores indicating greater science efficacy. In the current study, $\alpha = .78$.

Science Interest

This scale was developed based on the State Authenticity as Fit to Environment (SAFE) theory, which holds that environmental cues such as social fit and goal fit often lead people to approach or avoid a certain area, like STEM (Schmader & Sedikides, 2018). The scale was created on face validity with five items that tap into how much participants like science as well as their future orientation to continue engaging with science. The degree to which participants liked science was measured by asking them to rate their dislike or like on a scale from 1 (I hate science) to 8 (I love science) for the following questions: *How much do you like science?* and *Do you think science is fun?* The degree to which participants wanted to engage in science in the future was measured by asking them to rate their disagreement or agreement on a scale from 1 (Strongly Disagree) to 8 (Strongly Agree) for the following statements: *I am interested in trying out more science experiments* and *I want to learn more about science.* Additionally, the question, *How much would you like to be a scientist?* measured on a 1 (not at all) to 5 (very much) scale was used in the composite score for this measure.

Since not all items appeared on the same response scale, the items were standardized first and then averaged. Higher scores indicate greater interest in science. The α for this scale was .87.

Personal Demographics

Participants completed demographic information on their age, race, and the name of the school they attended on the last page of the survey.

Data Screening and Cleaning

All statistical analyses were conducted using SPSS version 27 software. Confidence intervals were calculated using Karl Wuensch's SPSS plugin (2021) with the guidance of Lakens (2014). Prior to conducting analyses, data were screened to identify missing values and outliers as well as assess assumptions using the procedures suggested by Tabachnick and Fiddell (2012).

Data were screened for missing values. There were thirteen total items missing a value; four participants were missing only one item; two participants were missing two items (one of them had two missing items from the same scale and one of them had two missing items from different scales); and one participant was missing five items across two different scales. No participants were missing an entire scale. For participants with missing items, the mean of the other items were used to calculate a score on the measure. Mean scores for the three main dependent variables were able to be calculated for every participant despite missingness.

Z-scores were calculated for each of the three composite scores in order to examine the data for outliers. Only one participant had an efficacy score more than 3.00 standard deviations below the mean, indicating an outlier. This score was winsorized.

The main analyses involved multivariate analysis of variance so it was important to test for violations of multicollinearity, homogeneity of variance, and normality. In terms of the assumption of normality, skew and kurtosis of the dependent variables of interest, efficacy, and belonging were assessed and found to be within acceptable ranges. However, the Q-Q plot and histogram for the dispersion of interest was slightly negatively skewed. No transformation of this variable occurred because MANOVA is robust to violations of the normality assumption. Box's Test of Equality of Covariance Matrices was non-significant, indicating homogeneity of variance and covariance assumptions were met ($p > .05$). The homogeneity of variance at the univariate level was tested using Levene's test of equality of error variances and met the assumption (*p's* > .05).

The assumption of multicollinearity was tested by correlating the three dependent variables: interest, efficacy and belonging. These variables were highly correlated but no two variables violated the assumption of multicollinearity by being correlated above the .90 level. The correlation matrix for the main dependent variables can be found in Table 2.

All but one participant provided a written response to the prompt. Data were created from the open-ended responses by a primary and a secondary coder. The primary and secondary coder initially independently coded a random sample of 10% of the data. The coding from this first round was used to establish understanding of the themes and guidelines for how to code responses. Disagreements in this first round were discussed and resolutions were reflected in the coding guidelines. Next the primary coder coded the remaining data while the secondary coder randomly selected one-third of the data to code. Reliability was calculated on the one-third of data coded by both coders. There was one error found in which the primary coder overlooked coding a particular theme on one entry. Their coding was compared using Kappas, which ranged from .73—1.00 (perfect agreement). The Kappa that corresponded to each theme can be found in Table 1. The primary coders' coding of the complete dataset was used for the analysis of themes in this study.

The mean number of themes present for each girl was 1.34; number of themes per response ranged from 0 (uncodeable) to 4. One assumption of a chi-square analysis is that no more than twenty percent of the expected cell counts are less than 5. When screening the data to make sure this assumption was met, the following seven coded themes violated this assumption: role model intelligence, similarity, gender, race, lack of ability, positive hard work, and negative hard work. For example, only 2% of participants mentioned the role model's intelligence, 2% mentioned gender, and 2.7% mentioned race (For the overall presence of themes coded as yes, refer to Table 1). These coded themes were so rarely present that they violated this assumption and were therefore not included in any further analyses.

For exploratory analysis using logistic regression, all Hosmer and Lemeshow Tests were non-significant (*p's* > .05).

Results

Descriptive Statistics

Descriptive statistics on the three primary dependent variables were consistent with prior research conducted in the context of the GiST program. Prior research with girls at GiST has generally found that participants tend to be higher than the mid-point on science-related scales such as science identity and fit in science (Merritt et al., in press; O'Brien et al., 2017). Participants, on average, agreed that they felt a sense of belonging in science with the mean belonging in science score of 5.44 on a 1 to 8 scale. Efficacy in science was also above the mid-point of the scale with an average score of 3.96 on a 1 to 5 scale, indicating participants felt between a 'medium amount' and 'pretty much' self-efficacious in science. The mean of the four items on the Science Interest scale 6.96 indicating agreement that they were interested in science (scale range 1 to 8). The single item, *How much would you like to be a scientist?*, was on a 1 to 5 scale with an average of 3.11. This indicates that the average participant indicated that they would like to become a scientist at least "a medium amount." Efficacy, interest, and belonging were significantly positively correlated with each other suggesting a strong relationship among these variables. A correlation matrix of these three dependent variables with means and standard deviations can be found in Table 3.

When asked if they wanted to be an astronaut, 12.8% of participants said they wanted to be an astronaut, and 14.9% of participants said they might like to be an astronaut. The highly specific question and profession likely led to 72.3% of participants saying they did not want to be an astronaut. Desire to be an astronaut was significantly positively correlated with interest in science and belonging in science, but there was no relationship with science efficacy. Desire to be an astronaut was also significantly correlated with themes generated from the open-ended responses, specifically, participants who expressed a greater desire to be an astronaut were more likely to indicate liking the role model and being interested in space and less likely to indicate fear and disinterest in space.

The full list of coded themes as well as the percentage of participants that mentioned each theme can be found in Table 1. The most frequent themes included fear of space (26.8%), disinterest in space (24.2%), alternative career (20.8%), family (12.1%), and liking the role model (7.4%). Many of the themes were significantly correlated with the three main dependent variables of interest. Participants with greater interest in science and a greater sense of belonging were more likely to express interest in space and less likely to be concerned about separation from family, but they were also more likely to express interest in alternative careers. Belonging in science was also positively correlated with liking the role model. The only theme science efficacy was significantly correlated with was interest in space, which indicated that participants with greater science efficacy had greater interest in space.

Many of the themes generated from the open-ended responses were significantly correlated with each other. Many of the themes had negative correlations with one another suggesting that participants typically gave one type of reason for either wanting or not wanting to be like the role model. Mentioning an alternative career path was negatively associated with not wanting to be separated from family. This suggests that paritcipants either mentioned wanting a different career or not wanting to be separated from family. Disinterest in space was negatively correlated with fear of space, separation from family, and interest in space. Again, these negative correlations suggest that if participants were to mention being disinterested in space, then they were less likely to mention fear, family, or interest in space.

Mentioning an alternative career was negatively associated with age suggesting that the younger participants were more to mention an alternative career. The only other significant correlation with age was disinterest in space, suggesting that the older participants were more likely to mention disinterest in space. Race was not significantly correlated with any other variable in the study.

Hypothesis testing

The first hypothesis was that participants who read about a growth mindset role model would report higher science efficacy, belonging, and interest than girls who read about a fixed mindset role model. This hypothesis was tested using a Multivariate Analysis of Variance (MANOVA) on the dependent variables of belonging in science, science efficacy, and science interest and revealed no significant difference between conditions, F (3, 146) = .04, p =.991; *Wilk's* Λ = .99, η^2 = .00, 90% CI [.00, .00]. For the means, standard deviations and results of the individual ANOVAs refer to Table 4.

Open-ended responses

The second hypothesis made the prediction that participants in the growth mindset would be more likely to say they wanted to be an astronaut than participants in the fixed mindset condition. There was not a significant difference between conditions on whether participants said they wanted to be an astronaut, F (1, 146) = .08, p = .783, η^2 = .00, 90% CI [.00, .02].[3] The mean of the participants in the fixed condition was 1.39 while the mean of the participants in the growth condition was 1.42. For the complete results refer to Table 5. Of the participants in the growth condition, 14.5% indicated they wanted to be an astronaut, 13.2% indicated they might be interested in being an astronaut, and 72.4% indicated that they did not want to be an astronaut. Of the participants in the fixed

[3] This was also analyzed with chi-square and the results were not significant, χ^2 (2, N = 148) = .63, p = .729

condition, 11.1% indicated they wanted to be an astronaut, 16.7% indicated they might want to be an astronaut, and 72.2% indicated they did not want to be an astronaut.

Although the second hypothesis laid out specific predictions for which themes would be more likely to occur in the growth versus fixed mindset condition, no differences emerged between conditions other than one. The theme of family was the only significant difference to emerge with 18.1 % participants in the fixed condition more likely to write about missing their family if they were to become an astronaut than 6.5% of participants in the growth mindset condition, χ^2 (1, *N* = 149) = 4.68, *p* = .030. See Table 6 for complete results from the open-ended coding.

Exploratory results

Exploratory analyses examined if there was an interaction between condition and race of the participant on several different dependent variables. First, a 2 × 2 MANOVA with race (Black vs. White) and condition (fixed vs. growth) was run with the dependent variables of science belonging, science efficacy, and science interest. There was not a significant main effect of condition (*F* (3, 105) = .79, *p* = .500*, Wilk's* Λ = .98, η^2 = .02, 90% CI [.00, .24], or race, *F* (3, 105) = .37, *p* = .776*, Wilk's* Λ = .99, η^2 = .01, 90% CI= [.00, .12]. There was a marginally significant interaction between race and condition *F* (3, 105) = 2.64, *p* = .054*, Wilk's* Λ = .93, η^2 = .07, 90% CI= [.00, .51]). None of the univariate ANOVAs were significant for this exploratory analyses, but they can be found in Table 7.

The first question the participants were asked was whether they wanted to be an astronaut. A 2 × 2 ANOVA with race (Black vs. White) and condition (fixed vs. growth) was run with the dependent variable of the coded response to the astronaut question. There was no main effect of condition, F (1, 107) = .06, p = .804, η^2 = .01, 90% CI= [.00, .27], or race F (1, 113) = .01, p =.939, η^2 = .00, 90% CI= [.00, .00]. There was also no significant interaction, F (1, 107) = .94, p = .334, η^2 = .01, 90% CI= [.00, .27]. Refer to Table 8 for complete univariate results.

The remaining themes were coded with either a yes (the theme is present) or no (the theme is not present), therefore logistic regression tested the effect of condition, race, and the interaction on these coded themes. There were no significant results for these exploratory analyses. For the complete logistic regression results, refer to Table 9.

Discussion

The present study examined whether role model mindset impacted girls' interest, belonging, and efficacy in science as well as whether role model mindset inspired girls to follow in the role models' career path by saying that they wanted to become an astronaut. The theorized mechanism behind imitating a role model is through role model identification (Morgenroth et al., 2015). Based on this theory and past research, it was predicted that girls in the growth mindset would want to mimic the role models' behavior because they identified with her and understood that the pathway to success was via hard work. Alternatively, it was predicted that girls in the fixed mindset role model condition would not identify with this "genius" and not want to be like her. This prediction is consistent with other studies that show a professor's mindset impacted students' interest, engagement, and belonging in their STEM course, over and above their own mindset (LaCosse, 2020). The experiment did not find evidence to support these predictions but there is value in contemplating why no significant results emerged.

Hypothesis 1: Does Mindset Matter for STEM engagement?

Contrary to prediction, girls who read about a growth mindset role model were not more likely to report higher science efficacy, science belonging, nor interest in science than girls who read about a fixed mindset role model. One possible reason for this outcome could be that mindset was not manipulated as intended. Generally, experimental studies in social psychology include a manipulation check to ensure the independent variables are being manipulated as they are intended. This study, however, did not include a manipulation check to ensure that the girls understood the difference between fixed and growth mindset attributions. There are two reasons a manipulation check was not included in this study. First, a pre-post method for manipulation check was not practical given the time constraints of the study. Second, a prior study suggests it was not necessary as children as young as fifth grade are capable of distinguishing between attributions of a hard-working role model (growth mindset) versus a gifted role model (fixed mindset; Bagès & Martinot, 2011). Despite rationale for not needing to include a manipulation check, the study methodology makes it impossible to know if the mindset manipulation was successful.

Even if the mindset manipulation was successful, there are several additional reasons why the current study may have yielded null results. Walton and Yeager (2020) suggest in their review that at-risk students benefit the most from interventions. This suggestion has also been empirically supported in a meta-analysis that shows academically at-risk students benefit the most from mindset interventions (Sisk et al., 2018).

Although middle school girls are considered at-risk of losing interest in STEM, the girls in the present sample may not face this risk. For the most part, the girls that attend GiST self-select to attend a hands-on science event. This means that they likely start out with strong interest, efficacy, and feelings of belonging in science. It is therefore possible that girls in this study have strong initial levels of science interest, efficacy, and belonging that are unlikely to be increased further by a subtle mindset intervention. In fact, previous studies using samples of girls from the GiST event show higher-than-midpoint levels of comparable variables such as science identity and fit in science (Merritt et al., in press; O'Brien et al., 2017). This suggests that girls in this study might not be the "at-risk" sample that may benefit from this relatively simple and brief intervention.

A second point Walton and Yeager (2020) is that the context within which the intervention takes place is an important consideration (Walton & Yeager, 2020). These authors argue that growth mindset interventions do not work in contexts that continue to endorse fixed mindsets. For example, a growth mindset intervention is less likely to be effective in a school where teachers praise students for outcomes such as grades rather than processes like hard work. Ideally, the GiST event is not such a context. In fact, GiST is designed to expose girls to female role models who provide ample cues that they belong in science and that the process of hard work is rewarded. One explanation for the null results is that contexts that clearly and consistently reinforce growth mindsets may be more influential than any single mindset intervention, thus nullifying the effects of the intervention. The current intervention was likely not powerful enough of a STEM intervention over what the girls were already experiencing throughout the day to be able to create differences between the growth and fixed mindset conditions.

Another possibility for the null effects is that the role model should have been a part of a more robust growth mindset intervention. Studies that have delivered multi-session mindset interventions that included role models have demonstrated positive effects (Binning et al., 2019; Blackwell et al., 2007; Burnette et al., 2020). For example, one mindset intervention used a series of classroom training sessions delivered via young adult research assistants dubbed "mentors," and found that academic motivation in male and female middle school students increased in the growth mindset condition compared to a control condition (Blackwell et al., 2007). Another study had computer science college students watch a series of growth mindset videos throughout the semester, one of which featured a role model in order to emphasize the importance of hard work (Burnette et al., 2020). This intervention was effective at creating greater interest in computer science careers in the growth mindset condition. Finally, a study had ninth and tenth grade students in the experimental condition read about a series of science role models that included the struggles experienced by each role model, while students in the control condition read standard depictions of science role models (Lin-Siegler et al., 2016). Findings indicated that students in the intervention condition identified more with the scientists and had better grades than students in the control condition. Taken together, these studies suggest that role models in mindset interventions may work best to further emphasize ongoing teachings on growth mindsets, rather than as a single point of delivery for a one-time mindset intervention.

However, one study that took place in France did find positive effects of a one-time mindset intervention delivered through a peer role model (Bagès et al., 2016). The study utilized vignettes that attributed a peer role model's success in math to either hard work, giftedness, or no attributional explanation and then student academic performance was measured via a math test. Girls performed significantly better on the math test when they read about a hard working role model than when they read about a gifted one or one without explanation (Bagès et al., 2016). One possibility is that the intervention served to motivate girls' persistence on the math test that immediately followed, but this type of single intervention might be harder to shift attitudes or beliefs. A performance component might be a necessary piece for a growth mindset role model to be effective. It could also be that a peer role model is more relatable and therefore more powerful than an adult role models. In summary, although the current study shares many features with Bagès et al. (2016), where it deviates may be a crucial piece to an effective intervention.

Relatability of the role model could be another issue in the current study in that a Black female astronaut may be too exceptional to be relatable. The astronaut was described as an exceptional woman who worked hard (in the growth mindset condition). Although working hard suggests having struggles and overcoming obstacles, this is implied and may not have been obvious to the participants. It could be that girls in both conditions did not feel strong role model identification because she was so exceptional and not relatable enough without the added information about her struggles. More information about the astronaut's struggles in the growth mindset condition, may have led to higher role model identification in the growth mindset condition, which in turn may have led to significant differences between conditions on the primary dependent variables.

In summary, there are several possibilities for why this intervention may not have impacted interest, belonging, and efficacy. Without a manipulation check, it is uncertain that the manipulation worked, but even if it did, the strength of the intervention may not have been enough, given the sample and the context. It is also possible that the role model wasn't relatable. More research is needed to identify the qualities of an effective role model and the ideal "dose" of mindset intervention for different contexts and different students. In order to create more effective interventions, researchers should include more components in their mindset manipulation and include measures of role model identification to determine what qualities and levels of role model exposure may be most effective.

Hypothesis 2: Does Mindset Matter for Career Interest?

The second hypothesis predicted that girls who read about a growth mindset role model would be more likely to report that they wanted to be an astronaut and that their reasons for making that decision would be related to mindset condition. Although 27.7% of girls indicated that they might like or would like to become an astronaut, the majority of girls did not want to be an astronaut (72.3%) and responses did not significantly differ by condition. As noted above, the mindset manipulation may not have been strong enough to achieve the hypothesized results. In fact, regardless of mindset condition, desire to be an astronaut was significantly positively correlated with the main dependent variables of interest in science and belonging in science. This finding is consistent with past research suggesting girls' interest and belonging in science are indicators as to whether they will pursue a career in STEM (Master et al., 2016; Tai et al., 2006). A stronger mindset intervention that increased interest and belonging may have also led to more girls in the growth mindset condition indicating an interest in becoming an astronaut.

An additional possibility that could have given way to null results is the specificity of the first question prompt. The first question asked girls if they wanted to be an astronaut like Stephanie. Asking girls about whether they wanted to be an astronaut like the role model likely led them to focus on her specific profession rather than the attributions made about her success. In other words, one possibility for the lack of difference in the themes girls mentioned may have stemmed from the question directing girls to focus on the role model's profession, rather than her path to success. A broader question such as, "How are you similar to or different from Stephanie?," or " Do you want to be a scientist like Stephanie?," may have elicited more differences in that girls in the growth mindset condition may have identified more with the role model than girls in the fixed mindset condition.

It is also possible that the specificity and uniqueness of being an astronaut contributed to the null findings. For example, 26.8% of girls mentioned being afraid of space, which was negatively correlated with desire to be an astronaut, regardless of condition. Based on participants' common negative response to this profession, girls may have preconceived notions about being an astronaut. After reflecting on the manipulation materials, the passage reads that the role model was notable for being the African American astronaut with the most hours in space. This wording of "the most hours in space" may have been troubling and brought up issues of isolation or a fear response. Developmentally, girls in middle school place high importance on social connections such as friendships so a job that appears to keep them from those social connections is not ideal (Belsky, 2006; Kiuru et al., 2020; LaFontana & Cillessen, 2010).

An additional developmental issue with focusing on only one specific profession is that girls at this age may have already developed stable ideas about their future careers. Research has shown that middle school is a time when children begin to develop realistic and often concrete views of their future careers (Hartung et al., 2005). The current study was designed with the assumption that students would have more malleable views about potential science careers. With 20.8% of girls in this study spontaneously mentioning having already decided on a career different than an astronaut, program developers trying to encourage girls into specific STEM careers should consider devising programming where STEM can be incorporated into children's pre-existing career goals.

In addition to not seeing a predicted pattern of results between growth and fixed mindsets on their desire to be an astronaut, there was also no significant results between conditions regarding similarity and liking of the role model, positive aspects of hard work, or mentions of not having abilities or intelligence. Girls' open-ended responses of admiring the role model and being interested in space were positively correlated with their desire to be an astronaut. Not surprisingly, the more girls were interested in being an astronaut, the less likely they were to be afraid of or disinterested in space. Therefore, a desire to be an astronaut is related to variables it should theoretically be related to, but the manipulation did not affect girls' career interest in the predicted direction. This suggests that the main dependent variables are important to measure as they do relate to the pursuit of STEM, but the mindset manipulation does not appear to have an impact.

The only open-ended response that varied by condition was concern about family separation. Girls in the fixed mindset condition mentioned concerns about family separation significantly more often than girls in the growth mindset condition. A likely explanation is that a Type I error occurred because multiple chi-square analyses were conducted on the open-ended data.

In summary, there was no effect of condition on career interest or reasons explaining that interest (with the exception of family). The weakness of the intervention could be responsible for the null effect, but there is also evidence to suggest that the astronaut profession and the narrative used led to preconceived notions that may have had unintended consequences within the present sample.

Exploratory Results: Does Participant Race Matter?

The third set of analyses explored whether there were any interactions between participant race and the mindset condition. It was predicted that the use of a Black role model would result in a greater impact of the growth mindset condition for Black girls than for White girls, but this was not supported. There was a marginal multivariate interaction between race and condition on the dependent variables of science interest, science efficacy, and science belonging. Although very small and non-significant, for belonging there was a negative difference between fixed and growth for Black girls and a positive difference for White girls; the opposite pattern occurred for efficacy. Because the magnitude of these differences is not meaningful, they are not discussed. Exploratory analyses that examined interactions between race and mindset condition on the desire to be an astronaut and the open-ended themes girls wrote about were also non-significant.

The non-significant race by condition interactions suggest that Black and White girls responded in similar ways to the mindset manipulation, which was not effective for either group. It is possible that the Black role model did not enhance the mindset manipulation for Black girls because Black girls identified (or did not identify) with the role model based on characteristics other than race. This process may have been similar to the way White girls identified, or did not identify, with the role model. For example, Black and White girls reported similar rates of likeability of the role model and similar levels of belonging in science, suggesting similar levels of identification with the role model. On the other hand, Black and White girls also reported similar rates of disinterest in space and fear of being an astronaut, suggesting similar levels of non-identification with the role model.

Although social identity theory suggests that sharing an identity with the role model would allow Black girls to identify more with the role model than White girls (Tajfel et al., 1979), but the findings in the current study did not support this. In fact, meta-analyses indicate a lack of support for race-matching (Lawner et al., 2019; Sisk et al., 2018)) and other research has found that underrepresented students benefit from interventions with role models even when role models are White (Lin-Siegler et al., 2016; Merritt et al., in press). For example, URM girls identified more with female STEM role models than White and Asian girls even though the role models were overwhelmingly White (Merritt et al., in press), suggesting that gender may have been more salient than race.

It is also possible that a race by condition interaction would have been observed with a stronger mindset intervention. A study by Lin-Siegler et al. (2016) demonstrated that students in the 9th and 10th grades had better science grades after a role model mindset intervention that utilized White scientists whose biography featured a story of struggle. Another study explored this role model mindset phenomenon with more diverse scientists (e.g., Thomas Edison, Neil DeGrasse Tyson) and celebrities (e.g., Oprah Winfrey, Walt Disney) and found that growth mindset interventions along with role models stories of struggle benefitted Black students with high expectations for their education more than it benefitted White students with high expectations for their education (Binning et al., 2019). This intervention utilized diverse role models and had a larger impact on Black students with high academic expectations, but the design of the study did not allow for a specific test of the benefits of race-matching. Although one might like to speculate that race-matching between Black students and Black role models leads to higher role model identification than would be expected with White role models, findings from the current study do not support this theory. Other research suggest that there are likely many other intervention components that must be considered in studies examining race-matching of role models, including non-race-based similarities and the nature of the mindset trainings.

Limitations & Future Directions

Although the present study featured some novel components such as a role model of color and a diverse sample of girls, there were several limitations that should be addressed in future research to potentially improve the outcomes of similar studies. Limitations will be discussed along three main themes: methodological issues, sampling limitations, and contextual issues.

As previously mentioned, one methodological issue is that there was no manipulation check to be able to determine if the manipulation itself was effective. An additional issue is whether the participants were at all impacted by this intervention. A more effective way to determine this is through pre and post design to determine girls' baseline levels of science interest, efficacy and belonging before the intervention. An alternate solution to this issue is using a control group in which girls are *not* exposed to the role model to test if the role model is more effective at boosting girls' interest, efficacy, and belonging in science than no role model. Future studies should consider incorporating a control group that will not be exposed to a role model or use pre post design to measure changes on these variables as a result of the intervention.

Another methodological issue is the questionable strength of the intervention. Unfortunately, as others have pointed out, a one-off short intervention may not be powerful enough to induce change in attitudes or performance (Sisk et al., 2018). Others have been more successful with mindset and role modeling interventions that combine multiple approaches, such as standard mindset training and tutorials along with role models (Binning et al., 2019; Blackwell et al., 2007; Todd & Zvoch, 2019) or that deliver the intervention over a longer series of time (Lin-Siegler et al., 2016; Yeager et al., 2016). Still there is the possibility that these types of interventions may not be enough to reverse pervasive stereotypes about STEM or preconceived notions about a particular profession (in this case, an astronaut). Therefore, it seems plausible that if future researchers hope to see a significant impact on children, they will want to consider building out their interventions to be more powerful by combining more empirically-backed practices rather than trying to isolate the effect of one.

Methodologically, the dependent variables that were selected in the study have been shown to be indicative of girls' persistence in STEM, but mindset interventions as short as this one may work best on performance variables like academic achievement (Bagès & Martinot, 2011; Bagès et al., 2016; Sisk et al., 2018; for exception, see Burnette et al., 2020). Future researchers may want to consider whether their mindset intervention is powerful enough to move an attitude measure or whether a performance component may be a necessary aspect to the role model mindset intervention.

One last methodological issue is that hypotheses regarding the race by condition interactions were unable to be rigorously tested because of a lack of a comparison group that was exposed to a White role model. In this particular study, it would have been difficult to randomly assign girls to a Black or White role model within their workshop group because participants would have been able to easily detect that there were two different conditions because girls would be able to see that other girls had received a packet with a role model of a different race. The current manipulation only alters the biographical text which is more difficult to detect when viewing someone else's paper. Of course, hierarchical linear modeling could be used if girls were assigned to condition within workshop. Adding a White role model for comparison and using nested modeling all requires a much greater sample size than the one obtained. Future researchers that wish to isolate the role model race-matching effect will need to use a Black and White role model, a different methodological approach, and a larger sample.

The sample in this current study poses a limitation because girls that attend GiST generally self-select to attend a science event, so they tend to have higher than mid-point scores on measures related to science. Girls with higher than mid-point scores on science measures may be more difficult to persuade with subtle one-time interventions. Future researchers will want to consider conducting similar research with a more average sample of children that may not already have a predisposition to science or match the intensity of the intervention to the nature of the sample.

Lastly, there are contextual limitations to conducting a study like this one. The context of a STEM outreach event like GiST offers both opportunities and drawbacks.

Working with organizers of a STEM outreach event has its benefits in that this study was able to draw on a diverse sample of girls at no cost. However, recruiting at this outreach event means that girls have already interacted with many female STEM role models and are hearing positive STEM messaging throughout the day. An ideal time for data collection would be the morning of the event before girls have been exposed to any STEM messaging or female role models. However, the organizers requested that this study be conducted during the third workshop. Future researchers who partner with STEM outreach organizations will also have to weigh the pros and cons of conducting a field study at a STEM outreach event and may want to consider an intervention that is less redundant with the experiences girls have at STEM outreach events.

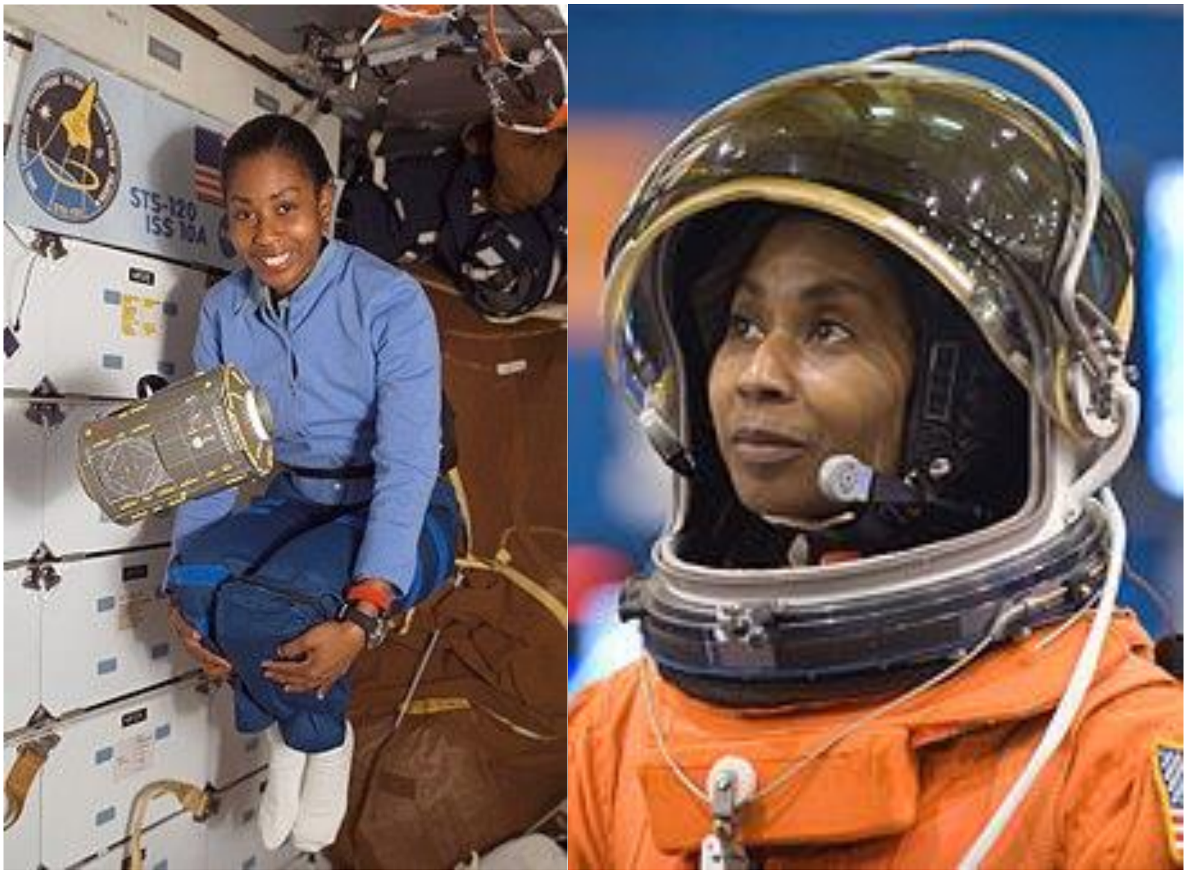
In the current study, the girls came from different school contexts, and information about these school contexts was not collected. Therefore, another possibility for the null results is that the context of the girls' different school environments may be playing a greater role in the current study than either the manipulation or the context of the outreach event. For example, the girls' schools may emphasize growth or fixed mindsets in STEM. Most intervention studies that were reviewed to address this issue of context took place in a school setting, comparing school environments that embrace tenets of the interventions versus those that do not (Walton & Yeager, 2020). It is possible and likely that the school context may be more powerful than a short intervention or a one-day science outreach event on girls' interest, efficacy, and belonging in science. Future researchers will want to carefully consider the impacts of the collection site context and the school context when designing a mindset intervention study.

Conclusion

The present study drew on theory and past research on role models and mindset to attempt to build an intervention that could help boost girls' interest, belonging, and efficacy in science. Girls' sense of belonging in science, interest in science, and efficacy in science were highly correlated with one another but the intervention itself did not produce significant differences between the growth and fixed mindset conditions. Additionally, although the sample allowed for testing interaction effects between Black and White girls, race was not a contributing factor to any of the study variables. It is important that researchers keep testing interventions in order to ensure implementations are empirically sound. The current study suggests more factors than just a role model's mindset should be considered when trying to create an intervention to spark girls' engagement in STEM.

Appendix A

Stephanie D. Wilson



Stephanie Wilson is a NASA astronaut with the most hours in space of any African American astronaut. Her long hours studying earned her a spot at Harvard University. Her interest in space along with her love of math and science led her to study aerospace engineering. Stephanie went on to do conduct research with NASA's Jet Propulsion Laboratory. Stephanie has flown on 3 space shuttle missions and received honors for her hard work and years of service.

Would you like to be an astronaut like Stephanie? Why or why not?

____

____

____

Please answer the question before turning the page.
Tulane University

SURVEY

This is a survey designed by the Social Perception Lab at Tulane University for the GIST workshop. We are interested in finding out what opinions you have about science. No one will see your answers, and we do not put anyone's name on any reports.

If you have any questions, please raise your hand and ask!

Instructions: Please answer these questions about how you feel about science. There are no right or wrong answers, and this is not a test.

1. I feel that I belong to the science community.

Strongly Disagree							Strongly Agree
1	2	3	4	5	6	7	8

---

2. I consider myself a member of the science world.

Strongly Disagree							Strongly Agree
1	2	3	4	5	6	7	8

---

3. I feel like I am part of the science community.

Strongly Disagree							Strongly Agree
1	2	3	4	5	6	7	8

---

4. I feel a connection with the science community.

Strongly Disagree 1	2	3	4	5	6	7	Strongly Agree 8

5. How much would you like to be a scientist?

1	2	3	4	5
Not at all	A little bit	A Medium amount	Pretty much	Very much

6. If I work hard enough, I could become a scientist when I grow up.

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree

7. If I wanted to, I could become a scientist when I grow up.

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree

8. I have what it takes to become a scientist when I grow up.

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree

9. How much do you like science?

I Hate Science 1	2	3	4	5	6	7	I Love Science 8

10. Do you think science is fun?

Science is Boring 1	2	3	4	5	6	7	Science is Super Fun 8

11. I am interested in trying out more science experiments.

Strongly Disagree 1	2	3	4	5	6	7	Strongly Agree 8

12. I want to learn more about science.

Strongly Disagree 1	2	3	4	5	6	7	Strongly Agree 8

Your initials (e.g., Mary Smith is MS): ____________________
Birthday: Please write the day, month, and year you were born (e.g., July 12, 1999):
____
SCHOOL NAME: _______________________________________
What color is your GiST wristband? ________________________
What is your race? (check all that apply)
___ Asian American
___ Black/African American
___ Hispanic/Latino American
___ Native American
___ White/European American
___ Other (please specify) _____________________________
How many times have you participated in GiST before?
____ This is my first time/I have never participated before today.
____ I participated in GiST once before today.
____ I participated in GiST two or more times before today.
Did you participate in GIST last November?
____ Yes
____ No
____ I don't know

THANKS!!!!

Table 1. Coding for open-ended responses

Coding theme	**Question**	**% yes**
Astronaut K=.96	Did the participant say they want to be an astronaut?	12.8%
Similarity K=.64	Did the participant mention being similar to the role model? Or wanting to be similar in some way?	6.0%
Liking K=.73	Did the participant mention liking the role model (e.g., thinking she's cool, inspiring)	7.4%
Gender K=1.00	Did the participant mention gender?	2.0%
Race K=1.00	Did the participant mention race?	2.7%
Role Model Intelligence K=1.00	Did the participant mention that the role model was smart, intelligent, or talented?	2.0%
Hard Work + K= 1.00	Did the participant talk about working hard in a positive way? (e.g. Stephanie works hard)	2.0%
Hard Work – K=1.00	Did the participant talk about working hard in a negative way? (e.g. I don't want to work hard)	1.3%
Lack Ability K=1.00	Did the participant mention their lack of ability, talent, or intelligence?	3.4%
Interest in space K=.74	Did the participant mention being interested in discovery or space?	23.5%
Disinterest K=.94	Did the participant mention being disinterested in space?	24.2%
Alternative Career K=.90	Did the participant mention having a different career plan than astronaut?	20.8%
Fear K=1.00	Did the participant mention a fear of space or that the job was dangerous?	26.8%
Family K=.90	Did the participant mention not wanting to be separated from family?	12.1%

Note. Responses were coded yes as to whether the theme was present. The right-hand column is the percentage of girls’ responses that were coded as yes for that theme. Astronaut was the only theme that had three options, with 14.9% of participants saying they might want to be an astronaut.

Table 2.

Means, Standard Deviations, and Correlations for Dependent Variables

	M	SD	Efficacy	Interest
Belonging (α=.91)	5.44	1.79	.52**	.70**
Efficacy (α=.78)	3.96	.83		.62**
Interest (α=.87)	-.01	.83		

Note. * $p < .05$, ** $p < .01$.
Belonging is on a 1-8 scale. Efficacy is on a 1-5 scale. Interest is standardized.

Table 3.

Bivariate Correlations among dependent variables, age, race, and open-ended coding.
Note. Items 1-3 are DV scale items. Items 4-9 are dummy-coded (1 = presence of a theme, 0 = absense of the theme) from open-ended resopnses. *$p \leq .05$. **$p < .01$.

	1	2	3	4	5	6	7	8	9	10	11
1. Interest	--										
2. Belonging	.70**	--									
3. Efficacy	.62*	.52**	--								
4. Role Model Liking	.13	.18*	.10	--							
5. Alternative Career	.24**	.19*	.12	-.02	--						
6. Fear	.03	.01	.06	-.06	-.20*	--					
7. Family	-.31**	-.24**	-.15	-.03	-.19*	-.13	--				
8. Interest in Space	.24**	.25**	.23**	-.10	-.09	-.09	-.16	--			
9. Disinterest in Space	-.14	-.14	-.05	-.04	-.10	-.34**	-.16*	-.20*	--		
10. Age	-.07	-.03	-.06	.08	-.27**	-.02	.08	.07	.19*	--	
11. Race	-.05	-.09	-.09	-.05	-.03	.06	.03	-.06	.07	.09	--
12. Astronaut	.27**	.24**	.15	.31**	-.13	-.20*	-.16	.47**	-.28**	-.01	.01

Table 4.

Means, Standard Deviations, and Univariate F Tests

	Condition					
	Fixed	Growth	*F (1,148)*	*p*	η^2	90% CI
Interest	.01 (.87)	-.03 (.80)	.09	.767	.00	[.00, .02]
Efficacy	3.98 (.82)	3.94 (.84)	.09	.767	.00	[.00, .02]
Belonging	5.48 (1.88)	5.41 (1.71)	.05	.820	.00	[.00, .01]

Note. There were no significant results with $p < .05$.

Table 5. *Conditional Means, Standard Deviations, and Univariate F Tests*

	Condition					
	Fixed (n=72)	Growth (n=76)	*F (1, 146)*	*p*	η_p^2	90% CI
Astronaut	1.39 (.08)	1.42 (.08)	.08	.783	.00	[.00, .02]

Note. Astronaut was a coded theme so this theme was set on a scale to the degree that participants wanted to be an astronaut. Higher scores indicate more likely to want to be an astronaut. CI = Confidence Interval

Table 6.

Percentage of Responses Coded as "Yes" by Condition

Coding Category	Fixed (n=72)	Growth (n=77)	χ^2	*p*	OR	95% CI
Role model likability	8.3%	6.5%	.18	.668	.76	.22, 2.62
Interest in space	19.4%	27.3%	1.27	.260	1.55	.72, 3.35
Disinterest in space	22.2%	26.0%	.29	.593	1.23	.58, 2.61
Alternative Career	22.2%	19.5%	.17	.680	.85	.38, 1.87
Fear	26.4%	27.3%	.02	.903	1.05	.51, 2.16
Family	18.1%	6.5%	4.68*	.030	0.32	.11, .94

Note. OR = Odds ratio, CI = Confidence Interval. The table indicates the percentage of participants in each condition who wrote open-ended responses that were categorized in each category. *Note.* The number in the row indicates the percentage of participants in each condition who had a particular theme present in their open-ended responses. *χ^2 significant at $p < .05$.

Table 7.

Interaction means and standard deviations for exploratory analyses

	Condition			
	Fixed		Growth	
	Black	White	Black	White
Interest	-.07 (.15)	.11 (.19)	-.11 (.18)	-.08 (.16)
Efficacy	3.77 (.15)	4.13 (.19)	4.10 (.18)	4.01 (.16)
Belonging	5.49 (.29)	5.43 (.38)	4.95 (.35)	5.65 (.31)

Table 8.

Effect of mindset condition and race on interest, efficacy, and belonging in science

Variable	*F*	*p*	η^2	90% CI
Interest				
condition	.45	.504	.00	[.00, .15]
race	.39	.536	.00	[.00, .13]
interaction	.20	.655	.00	[.00, .07]
Efficacy				
condition	.41	.524	.00	[.00, .14]
race	.67	.416	.01	[.00, .21]
interaction	1.78	.185	.02	[.00, .41]
Belonging				
condition	.22	.642	.00	[.00, .08]
race	.93	.337	.01	[.00, .27]
interaction	1.29	.259	.01	[.00, .34]

Note. There were no significant results with $p < .05$.

Table 9.

Results of Logistic Regression on the coded open-ended themes

	B	SE	*p*	Exp(B)	95% CI
Role Model Likability					
Condition	.02	.96	.985	1.02	(.16, 6.68)
Race	-.55	1.04	.596	.58	(.08, 4.43)
Interaction	.39	1.41	.784	1.47	(.09, 23.52)
Science Interest					
Condition	.55	.68	.417	1.74	(.46, 6.62)
Race	.06	.70	.931	1.06	(.27, 4.17)
Interaction	-.50	.95	.596	.60	(.10, 3.87)
Disinterest					
Condition	1.20	.85	.159	3.30	(.63, 17.45)
Race	1.34	.83	.109	3.80	(.74, 19.42)
Interaction	-1.61	1.05	.126	.20	(.025, 1.58)
Family					
Condition	-1.51	.89	.091	.22	(.04, 1.27)
Race	-.22	.66	.737	.80	(.22, 2.94)
Interaction	.50	1.23	.686	1.65	(.15, 18.48)
Alternative Career					
Condition	-.07	.67	.918	.93	(.25, 3.46)
Race	-.41	.68	.545	.66	(.17, 2.52)
Interaction	.55	.93	.558	1.73	(.28, 10.75)
Fear					
Condition	-.54	.63	.393	.58	(.17, 2.01)
Race	-.37	.60	.542	.69	(.21, 18.66)
Interaction	1.26	.85	.136	3.54	(.67, 18.66)

Note. There were no significant results. Condition is coded as 0 = fixed and 1 = growth. Race is dummy coded as White = 0 and Black = 1.

References

Bagès, C., & Martinot, D. (2011). What is the best model for girls and boys faced with a standardized mathematics evaluation situation: A hardworking role model or a gifted role model? *British Journal of Social Psychology*, *50*(3), 536-543. https://doi.org/10.1111/j.2044-8309.2010.02017.x

Bagès, C., Verniers, C., & Martinot, D. (2016). Virtues of a hardworking role model to improve girls' mathematics performance. *Psychology of Women Quarterly*, *40*(1), 55-64. https://doi.org/10.1177/0361684315608842

Bandura, A. (1965). Influence of models' reinforcement contingencies on the acquisition of imitative responses. *Journal of Personality and Social Psychology*, *1*(6), 589. https://doi.org/10.1037/h0022070

Bandura, A., Barbaranelli, C., Caprara, G. V., & Pastorelli, C. (2001). Self-Efficacy Beliefs as Shapers of Children's Aspirations and Career Trajectories. *Child development*, *72*(1), 187-206. https://doi.org/https://doi.org/10.1111/1467-8624.00273

Bandura, A., & McClelland, D. C. (1977). *Social learning theory* (Vol. 1). Englewood cliffs Prentice Hall.

Barmby, P., Kind, P. M., & Jones, K. (2008). Examining Changing Attitudes in Secondary School Science. *International Journal of Science Education*, *30*(8), 1075-1093. https://doi.org/10.1080/09500690701344966

Beede, D. N., Julian, T. A., Langdon, D., McKittrick, G., Khan, B., & Doms, M. E. (2011). Women in STEM: A gender gap to innovation. *Economics and Statistics Administration Issue Brief*(04-11). https://dx.doi.org/10.2139/ssrn.1964782

Belanger, A. L., Joshi, M. P., Fuesting, M. A., Weisgram, E. S., Claypool, H. M., & Diekman, A. B. (2020). Putting belonging in context: Communal affordances signal belonging in STEM. *Personality and Social Psychology Bulletin*, 0146167219897181. https://doi.org/10.1177/0146167219897181

Belsky, J. (2006). *Experiencing the lifespan*. Macmillan.

Bian, L. (2017). *The roots of gender gaps: Investigating the development of gender stereotypes about intelligence* University of Illinois at Urbana-Champaign]. http://hdl.handle.net/2142/97324

Bian, L., Leslie, S.-J., & Cimpian, A. (2017). Gender stereotypes about intellectual ability emerge early and influence children's interests. *Science*, *355*(6323), 389-391. DOI: 10.1126/science.aah6524

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. https://doi.org/10.1016/j.jesp.2017.11.006

Binning, K. R., Wang, M.-T., & Amemiya, J. (2019). Persistence mindset among adolescents: Who benefits from the message that academic struggles are normal and temporary? *Journal of Youth and Adolescence*, *48*(2), 269-286. https://doi.org/10.1007/s10964-018-0933-3

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*(1), 246-263. https://doi.org/10.1111/j.1467-8624.2007.00995.x

Buck, G. A., Clark, V. L. P., Leslie-Pelecky, D., Lu, Y., & Cerda-Lizarraga, P. (2008). Examining the cognitive processes used by adolescent girls and women scientists in identifying science role models: A feminist approach. *Science education*, *92*(4), 688-707. https://doi.org/10.1002/sce.20257

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*(1), 107-116. https://doi.org/10.1177/1948550619841631

Casad, B. J., Oyler, D. L., Sullivan, E. T., McClellan, E. M., Tierney, D. N., Anderson, D. A., Greeley, P. A., Fague, M. A., & Flammang, B. J. (2018). Wise psychological interventions to improve gender and racial equality in STEM. *Group Processes & Intergroup Relations*, *21*(5), 767-787. https://doi.org/10.1177/1368430218767034

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*(3), 75-141. https://doi.org/10.1177/1529100614541236

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*(6), 1017-1024. https://doi.org/10.1016/j.jesp.2006.10.024

Chen, J. A., & Pajares, F. (2010). Implicit theories of ability of Grade 6 science students:

Relation to epistemological beliefs and academic motivation and achievement in science. *Contemporary educational psychology*, *35*(1), 75-87. https://doi.org/10.1016/j.cedpsych.2009.10.003

Cheng, A., Kopotic, K., & Zamarro, G. (2017). Can Parents' Growth Mindset and Role Modelling Address STEM Gender Gaps? http://dx.doi.org/10.2139/ssrn.2920623

Cheryan, S., Master, A., & Meltzoff, A. N. (2015). Cultural stereotypes as gatekeepers: increasing girls' interest in computer science and engineering by diversifying stereotypes [Hypothesis and Theory]. *Frontiers in psychology*, *6*(49). https://doi.org/10.3389/fpsyg.2015.00049

Cheryan, S., Plaut, V. C., Davies, P. G., & Steele, C. M. (2009). Ambient belonging: how stereotypical cues impact gender participation in computer science. *J Pers Soc Psychol*, *97*(6), 1045-1060. https://doi.org/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), 1. https://doi.org/10.1037/bul0000052

Cimpian, A., & Leslie, S.-J. (2017). The brilliance trap. *Scientific American*, *317*(3), 60-65. https://doi.org/10.1038/scientificamerican0917-60

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*(3), 258-261. https://doi.org/10.1111/1467-9280.00347

Cvencek, D., Brečić, R., Gaćeša, D., & Meltzoff, A. N. (2021). Development of Math Attitudes and Math Self-Concepts: Gender Differences, Implicit–Explicit Dissociations, and Relations to Math Achievement. *Child development*.

Cvencek, D., Meltzoff, A. N., & Greenwald, A. G. (2011). Math–gender stereotypes in elementary school children. *Child development*, *82*(3), 766-779. https://doi.org/10.1111/j.1467-8624.2010.01529.x

Dasgupta, N. (2011). Ingroup experts and peers as social vaccines who inoculate the self-concept: The stereotype inoculation model. *Psychological Inquiry*, *22*(4), 231-246. https://doi.org/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*(1), 21-29. https://doi.org/10.1177/2372732214549471

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*(5), 976-990. https://doi.org/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. https://doi.org/10.3389/fpsyg.2019.01114

Diekman, A. B., Steinberg, M., Brown, E. R., Belanger, A. L., & Clark, E. K. (2017). A goal congruity model of role entry, engagement, and exit: Understanding communal goal processes in STEM gender gaps. *Personality and Social Psychology Review*, *21*(2), 142-175. https://doi.org/10.1177/1088868316642141

Drury, B. J., Siy, J. O., & Cheryan, S. (2011). When do female role models benefit women? The importance of differentiating recruitment from retention in STEM.

Psychological Inquiry, *22*(4), 265-269. https://doi.org/10.1080/1047840X.2011.620935

Dweck, C. S. (2006). *Mindset: The new psychology of success*. Random House. http://search.ebscohost.com/login.aspx?direct=true&AuthType=ip,sso&db=psyh&AN=2006-08575-000&site=ehost-live&scope=site&custid=s8978822

Dweck, C. S. (2007). Is Math a Gift? Beliefs That Put Females at Risk. In S. J. Ceci & W. M. Williams (Eds.), *Why aren't more women in science?: Top researchers debate the evidence.* (pp. 47-55). American Psychological Association. https://doi.org/10.1037/11546-004

Dweck, C. S. (2017). The journey to children's mindsets—and beyond. *Child Development Perspectives*, *11*(2), 139-144. https://doi.org/10.1111/cdep.12225

Dweck, C. S., & Leggett, E. L. (1988). A social-cognitive approach to motivation and personality. *Psychological Review*, *95*(2), 256. https://doi.org/10.1037/0033-295X.95.2.256

Dweck, C. S., & Master, A. (2009). Self-theories and motivation: Students' beliefs about intelligence. In K. R. Wenzel & A. Wigfield (Eds.), *Handbook of motivation at school.* (pp. 123-140). Routledge/Taylor & Francis Group. http://search.ebscohost.com/login.aspx?direct=true&AuthType=ip,sso&db=psyh&AN=2009-24219-007&site=ehost-live&scope=site&custid=s8978822

Dweck, C. S., & Yeager, D. S. (2019). Mindsets: A View From Two Eras. *Perspect Psychol Sci*, *14*(3), 481-496. https://doi.org/10.1177/1745691618804166

Eccles, J. S., Jacobs, J. E., & Harold, R. D. (1990). Gender role stereotypes, expectancy effects, and parents' socialization of gender differences. *Journal of Social issues*, *46*(2), 183-201.

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*(2), 100-106. https://doi.org/10.1177/0165025415616201

Eccles, J. S., & Wigfield, A. (2020). From expectancy-value theory to situated expectancy-value theory: A developmental, social cognitive, and sociocultural perspective on motivation. *Contemporary educational psychology*, *61*, 101859. https://doi.org/https://doi.org/10.1016/j.cedpsych.2020.101859

Garriott, P. O., Hultgren, K. M., & Frazier, J. (2016). STEM Stereotypes and High School Students' Math/Science Career Goals. *Journal of Career Assessment*, *25*(4), 585-600. https://doi.org/10.1177/1069072716665825

Gibson, D. E. (2004). Role models in career development: New directions for theory and research. *Journal of Vocational Behavior*, *65*(1), 134-156. https://doi.org/10.1016/S0001-8791(03)00051-4

González-Pérez, S., Mateos de Cabo, R., & Sáinz, M. (2020). Girls in STEM: Is It a Female Role-Model Thing? *Frontiers in psychology*, *11*, 2204. https://doi.org/10.3389/fpsyg.2020.02204

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*(4), 700-717. https://doi.org/10.1037/a0026659

Haines, E. L., Deaux, K., & Lofaro, N. (2016). The Times They Are a-Changing … or Are They Not? A Comparison of Gender Stereotypes, 1983–2014. *Psychology of Women Quarterly*, *40*(3), 353-363. https://doi.org/10.1177/0361684316634081

Hartung, P. J., Porfeli, E. J., & Vondracek, F. W. (2005). Child vocational development: A review and reconsideration. *Journal of Vocational Behavior*, *66*(3), 385-419. https://doi.org/https://doi.org/10.1016/j.jvb.2004.05.006

Heyder, A., Weidinger, A. F., & Steinmayr, R. (2021). Only a burden for females in math? Gender and domain differences in the relation between adolescents' fixed mindsets and motivation. *Journal of Youth and Adolescence*, *50*(1), 177-188. https://doi.org/10.1007/s10964-020-01345-4

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

Hofstra, B., Kulkarni, V. V., Galvez, S. M.-N., He, B., Jurafsky, D., & McFarland, D. A. (2020). The diversity–innovation paradox in science. *Proceedings of the National Academy of Sciences*, *117*(17), 9284-9291. https://doi.org/10.1073/pnas.1915378117

Huang, X., Zhang, J., & Hudson, L. (2019). Impact of math self-efficacy, math anxiety, and growth mindset on math and science career interest for middle school students: The gender moderating effect. *European Journal of Psychology of Education*, *34*(3), 621-640. https://doi.org/10.1007/s10212-018-0403-z

Ireland, D. T., Freeman, K. E., Winston-Proctor, C. E., DeLaine, K. D., McDonald Lowe, S., & Woodson, K. M. (2018). (Un) hidden figures: A synthesis of research examining the intersectional experiences of Black women and girls in STEM education. *Review of Research in Education*, *42*(1), 226-254. https://doi.org/10.3102/0091732X18759072

Kanny, M. A., Sax, L. J., & Riggers-Piehl, T. A. (2014). INVESTIGATING FORTY YEARS OF STEM RESEARCH: HOW EXPLANATIONS FOR THE GENDER

GAP HAVE EVOLVED OVER TIME. *20*(2), 127-148. https://doi.org/10.1615/JWomenMinorScienEng.2014007246

Kelly, L. B. (2018). An analysis of award-winning science trade books for children: Who are the scientists, and what is science? *Journal of Research in Science Teaching*, *55*(8), 1188-1210. https://doi.org/10.1002/tea.21447

Kiuru, N., Wang, M.-T., Salmela-Aro, K., Kannas, L., Ahonen, T., & Hirvonen, R. (2020). Associations between adolescents' interpersonal relationships, school well-being, and academic achievement during educational transitions. *Journal of Youth and Adolescence*, *49*(5), 1057-1072. https://doi.org/10.1007/s10964-019-01184-y

Komarraju, M., & Nadler, D. (2013). Self-efficacy and academic achievement: Why do implicit beliefs, goals, and effort regulation matter? *Learning and individual differences*, *25*, 67-72. https://doi.org/10.1016/j.lindif.2013.01.005

Kurtz-Costes, B., Copping, K. E., Rowley, S. J., & Kinlaw, C. R. (2014). Gender and age differences in awareness and endorsement of gender stereotypes about academic abilities. *European Journal of Psychology of Education*, *29*(4), 603-618. https://doi.org/10.1007/s10212-014-0216-7

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 (1982-)*, 386-409. http://www.jstor.org/stable/23096251

LaCosse, J. (2020). The role of STEM professorsвЂ™ mindset beliefs on studentsвЂ™ anticipated psychological experiences and course interest. *Journal of Educational*

Psychology. https://doi.org/10.1037/edu0000620 10.1037/edu0000620.supp

LaFontana, K. M., & Cillessen, A. H. (2010). Developmental changes in the priority of perceived status in childhood and adolescence. *Social development*, *19*(1), 130-147. https://doi.org/10.1111/j.1467-9507.2008.00522.x

Lawner, E. K., Quinn, D. M., Camacho, G., Johnson, B. T., & Pan-Weisz, B. (2019). Ingroup role models and underrepresented students' performance and interest in stem: A meta-analysis of lab and field studies. *Social Psychology of Education: An International Journal*. https://doi.org/10.1007/s11218-019-09518-1

Leaper, C., & Brown, C. S. (2008). Perceived experiences with sexism among adolescent girls. *Child development*, *79*(3), 685-704.

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. *J Youth Adolesc*, *41*(3), 268-282. https://doi.org/10.1007/s10964-011-9693-z

Leblebicioglu, G., Metin, D., Yardimci, E., & Cetin, P. S. (2011). The effect of informal and formal interaction between scientists and children at a science camp on their images of scientists. *Science Education International*, *22*(3), 158-174.

Legewie, J., & DiPrete, T. A. (2011). High school environments, stem orientations, and the gender gap in science and engineering degrees. https://doi.org/10.7916/D84Q84HX

Leslie, S.-J., Cimpian, A., Meyer, M., & Freeland, E. (2015). Expectations of brilliance underlie gender distributions across academic disciplines. *Science*, *347*(6219), 262-265. https://doi.org/10.1126/science.1261375

Lin-Siegler, X., Ahn, J. N., Chen, J., Fang, F.-F. A., & Luna-Lucero, M. (2016). Even Einstein struggled: Effects of learning about great scientists' struggles on high school students' motivation to learn science. *Journal of Educational Psychology*, *108*(3), 314.

Lockwood, P. (2006). 'Someone like me can be successful': Do college students need same-gender role models? *Psychology of Women Quarterly*, *30*(1), 36-46. https://doi.org/10.1111/j.1471-6402.2006.00260.x

Marriott, L. K. (2019). Opposing effects of impulsivity and mindset on sources of science self-efficacy and STEM interest in adolescents. *PloS one*, *14*(8), 1-23. https://doi.org/10.1371/journal.pone.0201939

Merritt, S. K., Hitti, A., Van Camp, A. R., Shaffer, E., Sanchez, M. H., & O'Brien, L. T. (2021). Maximizing the impact of exposure to scientific role models: Testing an intervention to increase science identity among adolescent girls. *Journal of Applied Social Psychology*. doi: 10.1111/jasp.12774

Master, A., Cheryan, S., & Meltzoff, A. N. (2016). Computing whether she belongs: Stereotypes undermine girls' interest and sense of belonging in computer science. *Journal of Educational Psychology*, *108*(3), 424. https://doi.org/10.1037/edu0000061

McGuire, L., Mulvey, K. L., Goff, E., Irvin, M. J., Winterbottom, M., Fields, G. E., Hartstone-Rose, A., & Rutland, A. (2020). STEM gender stereotypes from early childhood through adolescence at informal science centers. *Journal of Applied Developmental Psychology*, *67*, 101109. https://doi.org/https://doi.org/10.1016/j.appdev.2020.101109

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 US Draw-a-Scientist studies. *Child development*, *89*(6), 1943-1955. https://doi.org/10.1111/cdev.13039

Mofield, E. L., & Parker Peters, M. (2018). Mindset Misconception? Comparing Mindsets, Perfectionism, and Attitudes of Achievement in Gifted, Advanced, and Typical Students. *Gifted Child Quarterly*, *62*(4), 327-349. https://doi.org/10.1177/0016986218758440

Morgenroth, T., Ryan, M. K., & Peters, K. (2015). The Motivational Theory of Role Modeling: How Role Models Influence Role Aspirants' Goals: [research-article]. *https://doi.org/10.1037/gpr0000059*. https://doi.org/10.1037_gpr0000059

Muenks, K., Canning, E. A., LaCosse, J., Green, D. J., Zirkel, S., Garcia, J. A., & Murphy, M. C. (2020). Does my professor think my ability can change? Students' perceptions of their STEM professors' mindset beliefs predict their psychological vulnerability, engagement, and performance in class. *Journal of Experimental Psychology: General*, *149*(11), 2119-2144. https://doi.org/10.1037/xge0000763 10.1037/xge0000763.supp (Supplemental)

National Science Foundation, National Center for Science and Engineering Statistics. (2019). *Women, minorities, and persons with disabilities in science and engineering: 2019.* Special Report NSF 19-304. https://www.nsf.gov/stati stics/ wmpd

Nix, S., Perez-Felkner, L., & Thomas, K. (2015). Perceived mathematical ability under challenge: a longitudinal perspective on sex segregation among STEM degree fields. *Frontiers in psychology*, *6*, 530. https://doi.org/10.3389/fpsyg.2015.00530

Nosek, B. A., Smyth, F. L., Sriram, N., Lindner, N. M., Devos, T., Ayala, A., Bar-Anan, Y., Bergh, R., Cai, H., Gonsalkorale, K., Kesebir, S., Maliszewski, N., Neto, F., Olli, E., Park, J., Schnabel, K., Shiomura, K., Tulbure, B. T., Wiers, R. W., Somogyi, M., Akrami, N., Ekehammar, B., Vianello, M., Banaji, M. R., & Greenwald, A. G. (2009). National differences in gender-science stereotypes predict national sex differences in science and math achievement. *Proc Natl Acad Sci U S A*, *106*(26), 10593-10597. https://doi.org/10.1073/pnas.0809921106

Nosek, B. A., & Smyth, F. L. (2011). Implicit Social Cognitions Predict Sex Differences in Math Engagement and Achievement. *American Educational Research Journal*, *48*(5), 1125-1156. https://doi.org/10.3102/0002831211410683

O'Brien, L. T., Hitti, A., Shaffer, E., Camp, A. R. V., Henry, D., & Gilbert, P. N. (2017). Improving girls' sense of fit in science: increasing the impact of role models. *Social Psychological and Personality Science*, *8*(3), 301-309. https://doi.org/10.1177/1948550616671997

Olsson, M., & Martiny, S. E. (2018). Does Exposure to Counterstereotypical Role Models Influence Girls' and Women's Gender Stereotypes and Career Choices? A Review of Social Psychological Research [Review]. *Frontiers in psychology*, *9*(2264). https://doi.org/10.3389/fpsyg.2018.02264

Pajares, F. (2005). *Gender differences in mathematics self-efficacy beliefs*. Cambridge University Press.

Parker, R., Pelletier, J., & Croft, E. (2015). WWEST's Gender Diversity in STEM: A briefing on women in science and engineering.

https://dx.doi.org/10.14288/1.0384523

Pennington, C. R. (2021). Do gender differences in academic attainment correspond with scholastic attitudes? An exploratory study in a UK secondary school. *Journal of Applied Social Psychology*, *51*(1), 3-17. https://doi.org/10.1111/jasp.12711

Plant, E. A., Baylor, A. L., Doerr, C. E., & Rosenberg-Kima, R. B. (2009). Changing middle-school students' attitudes and performance regarding engineering with computer-based social models. *Computers & Education*, *53*(2), 209-215. https://doi.org/10.1016/j.compedu.2009.01.013

Potvin, P., & Hasni, A. (2014a). Analysis of the decline in interest towards school science and technology from grades 5 through 11. *Journal of Science Education and Technology*, *23*(6), 784-802. https://doi.org/10.1007/s10956-014-9512-x

Potvin, P., & Hasni, A. (2014b). Interest, motivation and attitude towards science and technology at K-12 levels: a systematic review of 12 years of educational research. *Studies in science education*, *50*(1), 85-129. https://doi.org/10.1080/03057267.2014.881626

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*(3), 731-737. https://doi.org/10.1016/j.jesp.2011.12.012

Rattan, A., Savani, K., Naidu, N., & 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*(5), 787. https://doi.org/10.1037/pspi0000130

Riegle-Crumb, C., Moore, C., & Ramos-Wada, A. (2011). Who wants to have a career in science or math? exploring adolescents' future aspirations by gender and race/ethnicity. *Science education*, *95*(3), 458-476. https://doi.org/10.1002/sce.20431

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*(2), 227. https://doi.org/10.1037/a0035490

Sadler, P. M., Sonnert, G., Hazari, Z., & Tai, R. (2012). Stability and volatility of STEM career interest in high school: A gender study. *Science education*, *96*(3), 411-427. https://doi.org/10.1002/sce.21007

Schmader, T., & Sedikides, C. (2018). State authenticity as fit to environment: The implications of social identity for fit, authenticity, and self-segregation. *Personality and Social Psychology Review*, *22*(3), 228-259. https://doi.org/10.1177/1088868317734080

SelimbegoviД‡, L. (2019). The independent contributions of gender stereotypes and gender identification in predicting primary school pupils' expectancies of success in STEM fields. *Psychology in the Schools*, *56*(10), 1614-1633. https://doi.org/10.1002/pits.22296

Seo, E., Shen, Y., & Alfaro, E. C. (2019). Adolescents' Beliefs about Math Ability and Their Relations to STEM Career Attainment: Joint Consideration of Race/ethnicity and Gender. *J Youth Adolesc*, *48*(2), 306-325. https://doi.org/10.1007/s10964-018-0911-9

Sisk, V. F., Burgoyne, A. P., Sun, J., Butler, J. L., & Macnamara, B. N. (2018). To what extent and under which circumstances are growth mind-sets important to academic achievement? Two meta-analyses. *Psychological Science*, *29*(4), 549-571. https://doi.org/10.1177/0956797617739704

Smyth, F. L., & Nosek, B. A. (2015). On the gender-science stereotypes held by scientists: explicit accord with gender-ratios, implicit accord with scientific identity. *Front Psychol*, *6*, 415. https://doi.org/10.3389/fpsyg.2015.00415

Stipek, D., & Gralinski, J. H. (1996). Children's beliefs about intelligence and school performance. *Journal of Educational Psychology*, *88*(3), 397.

Storage, D., Charlesworth, T. E., Banaji, M. R., & Cimpian, A. (2020). Adults and children implicitly associate brilliance with men more than women. *Journal of Experimental Social Psychology*, *90*, 104020. https://doi.org/10.1016/j.jesp.2020.104020

Su, R., & Rounds, J. (2015). All STEM fields are not created equal: People and things interests explain gender disparities across STEM fields. *Frontiers in psychology*, *6*, 189.

Tai, R. H., Liu, C. Q., Maltese, A. V., & Fan, X. (2006). Planning early for careers in science. *Life sci*, *1*(0.2). https://www.gwern.net/docs/science/2006-tai.pdf

Tajfel, H., Turner, J. C., & Austin…, W. G. (1979). An integrative theory of intergroup conflict.

Thébaud, S., & Charles, M. (2018). Segregation, stereotypes, and STEM. *Social Sciences*, *7*(7), 111.

Todd, B. L., & Zvoch, K. (2019). The effect of an informal science intervention on middle school girls' science affinities. *International Journal of Science Education*, *41*(1), 102-122. https://doi.org/10.1080/09500693.2018.1534022

Walton, G. M., & Yeager, D. S. (2020). Seed and soil: Psychological affordances in contexts help to explain where wise interventions succeed or fail. *Current Directions in Psychological Science*, *29*(3), 219-226. https://doi.org/10.1177/0963721420904453

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. *Dev Rev*, *33*(4). https://doi.org/10.1016/j.dr.2013.08.001

Wigfield, A., & Eccles, J. S. (2000). Expectancy–Value Theory of Achievement Motivation. *Contemporary educational psychology*, *25*(1), 68-81. https://doi.org/https://doi.org/10.1006/ceps.1999.1015

Wood, S., Henning, J. A., Chen, L., McKibben, T., Smith, M. L., Weber, M., Zemenick, A., & Ballen, C. J. (2020). A scientist like me: demographic analysis of biology textbooks reveals both progress and long-term lags. *Proceedings of the Royal Society B*, *287*(1929), 20200877. https://doi.org/10.1098/rspb.2020.0877

Wyss, V. L., Heulskamp, D., & Siebert, C. J. (2013). Increasing middle school student interest in STEM careers with videos of scientists. *International Journal of Environmental and Science Education*, *8*(1), 501-522. http://libproxy.tulane.edu:2048/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=psyh&AN=2013-21829-010&login.asp&site=ehost-live&scope=site

Yeager, D. S., Romero, C., Paunesku, D., Hulleman, C. S., Schneider, B., Hinojosa, C., Lee, H. Y., O'Brien, J., Flint, K., & Roberts, A. (2016). Using design thinking to improve psychological interventions: The case of the growth mindset during the transition to high school. *Journal of Educational Psychology*, *108*(3), 374. https://doi.org/10.1037/edu0000098

BIOGRAPHY

Sally K. Merritt received her PhD in Social Psychology from Tulane University in 2021 and her Master's degree in 2019. Sally has three main areas of research: understanding prejudice through offensive communication, examining issues of discrimination in the workplace, and belonging/persistence in STEM for underrepresented groups. She is currently an Assistant Professor of Psychology at Georgia Southwestern State University. Sally stays busy raising her two sons, Fischer and Remi as well as her two dogs, Diego and Olive, with her partner, Ryan.