STARTING YOUNG: HOW EARLY ROLE MODELS IMPACT YOUNG GIRLS' PERSISTENCE IN SCIENCE

A Thesis

Submitted to the College of Human Ecology, Department of Human Development

in Fulfillment of the Requirements of the Undergraduate Honors Research Program

Elyse M. Ganss

Cornell University

May 2021

Abstract

Women are significantly underrepresented in certain science, technology, engineering, and mathematics (STEM) careers, and this underrepresentation has roots in early childhood. To help mitigate the early emergence of gender gaps in STEM, our study devised a novel role model intervention targeting young girls. Children (N =229, 122 boys, 107 girls) aged 4-7 years participated in either a Baseline, Exposure, or Roleplay condition. Across all conditions, children participated in a science game and were asked questions about their self-efficacy and motivation in science. In the Exposure and Roleplay conditions, children were introduced to a gender-matched role model who was described as successful and persistent. Specific to the Roleplay condition, children were also asked to imagine they were the role model during the science game. Girls in the Roleplay condition (but not in the Exposure condition) persisted significantly longer than girls in the Baseline condition, such that their persistence was equivalent to that of boys. Furthermore, girls' self-efficacy was higher in both the Exposure and Roleplay conditions as compared to the Baseline condition. In contrast, boys' persistence and self-efficacy was not affected by either the Exposure or Roleplay conditions. Our study shows that introducing girls to a woman role model, and particularly—asking them to imagine to be the role model through a pretend play activity—can increase their persistence and self-efficacy in science. By doing so, our study provides a novel strategy to help reduce gender gaps in science from their developmental roots.

ACKNOWLEDGEMENTS

I would like to express my gratitude to the members of the Little Thinkers Lab who provided support during this project and aided in data collection: Lindsay Tuttle, Yuchen Tian, Natalie Cayon, Kimberly Victor, Amisha Singh, and Alexandra Li. A sincere and heartfelt thank you to Reut Shachnai for offering me the opportunity to collaborate on the Role Model project. Your support and mentorship during every part of the research process has been invaluable. Most of all, a tremendous thank you to my advisor, Dr. Lin Bian, for her encouragement and guidance during my honors thesis journey. Thank you to Dr. Tamar Kushnir for taking time out of her busy schedule and being my second reader for my honors thesis. I am grateful for Dr. Felix Thoemmes, Director of the Honors program, for creating a welcoming community in our honors seminar and providing helpful feedback on my writing. Thank you to my older brothers, CJ and JJ, for inspiring me during this project and being excellent listeners during my endless conversations about the research I was working on. A special thank you to my personal role model, my mother: Elizabeth Ganss, who has always believed I can achieve anything I put my mind to. I am incredibly grateful that I was able to spend my undergraduate years at Cornell University, where I began to cultivate my research interests and passions.

TABLE OF CONTENTS

Introduction

Females account for 56% of college students in the United States today, but remain significantly underrepresented in certain science, technology, engineering, and mathematics (STEM) fields such as physics and computer science (Funk & Parker, 2018; NCES, 2020). Furthermore, women who are STEM majors as undergraduates are less likely than their male peers to work in STEM fields following graduation. When women do work in these fields, they often receive lower wages than their equally qualified male peers—commonly referred to as the gender wage gap (Beede et al., 2011; Funk & Parker, 2018). Why does women's underrepresentation in STEM persist despite their increasing rates of college enrollment? Although a myriad of factors come into play, one prominent explanation is the negative feedback loop created by the lack of female representation and visibility in science careers driving a reduction in women identifying with science and pursuing scientific careers (Hazari et al., 2013). Importantly, this phenomenon is rooted in childhood: As early as the elementary school years, children associate science with men (Miller et al., 2018) and acquire gender stereotypes about intellectual abilities (Bian et al., 2017; Cheryan et al., 2013). The acquisition of negative stereotypes about females' abilities hinders young girls' identification and motivation in STEM (Bian et al., 2017; Beilock et al., 2010; Rhodes et al., 2019). What can be done to mitigate these early-emerging gender gaps? Past research with adults suggests that exposing women to female role models boosts their self-efficacy and sense of belonging in science, thereby increasing science persistence and engagement (Buunk et al., 2007; Stout et al., 2011). Similarly, developmental research has explored the positive effects of pretend play on girls' engagement in learning (Hoffman & Russ, 2012). Despite evidence that gender gaps in STEM emerge in early childhood, no research (to our knowledge) has explored whether role model interventions could be used to foster science engagement among young girls (Dasgupta, 2011; Lips, 2004). To help fill this gap, our study devised a novel role model intervention for 4–7-year-old children, exploring its effectiveness in reducing early-emerging gender gaps in science.

Developmental roots of gender stereotypes

Children acquire gender stereotypes about brilliance (i.e., high-level intellectual ability) at a young age (Bian et al., 2017). Bian et al. (2017) found that children as young as six years old begin to associate brilliance with men more than women. Similarly, Cvencek et al. (2011) found that boys in the second grade identify with math more than girls, and that both boys and girls associate math with boys. This phenomenon stems from children's internalization of a stereotypical portrayal of scientists and mathematicians (Cheryan et al., 2013). In the 1960's, the inaugural study of the Draw-A-Scientist Test, found a troubling pattern—in a sample of over 4,000 children—almost every single child who participated in the study drew a male scientist (Chambers, 1983). A meta-analysis of the last five decades of research involving the Draw-A-Scientist Test found that before ages 7-8, most boys and girls drew a picture of a scientist matching their own gender—a significant change from Chambers' initial study (Miller et al., 2018). However, when children grew older, both girls and boys tended to draw more male scientists (Miller et al., 2018).

The age-related differences found in the studies discussed suggest that gender stereotypes about STEM develop throughout childhood and influence children's beliefs about who can succeed in STEM (Bian et al., 2017; Cvencek et al., 2011; Miller et al., 2018). Stereotypes shape children's aspirations and are likely to limit their range of future careers, thus contributing to the underrepresentation of women in STEM fields (Bian et al., 2017). Exploring interventions to reduce gender stereotypes about STEM is therefore a logical next step in the current direction of developmental research. Possible solutions to the early development of stereotypes include exposing children to scientists with diverse identities and fostering science identities in children and adolescents from stigmatized groups (Cheryan et al., 2013; Hazari et al., 2013).

Social influences on identity formation and children's motivation in STEM

Children's self-concepts (i.e., beliefs about oneself) are established in their early years (Cvencek et al., 2011). Children during early to middle childhood show evidence of developing self-concepts (i.e., with different levels of abstractness) and this trend of continues with growing experience (Cimpian et al., 2017). Societal messages regarding what children should be interested in are learned through their daily interactions and media representations (Alexander et al., 2012; Cheryan et al., 2013; Steinke, 2017). Children's self-concepts and interests, as previously discussed, can be greatly affected by gender stereotypes (Alexander et al., 2012; Steinke, 2017). The type of language children hear in daily conversations is extremely important for children's development and certain linguistic cues can strengthen children's early science engagement (Rhodes et al., 2019). Along with language heard in conversations, the lack of diversity of scientists in TV shows and movies (e.g., scientists typically being portrayed in the media as White male characters) can also negatively affect interest and motivation in science among children whose social identities and self-concepts do not adhere to this prototype (Cheryan et al., 2013). Stereotypical media representations of men in science have perpetuated stereotypes in STEM careers by characterizing male scientists as the norm and consequently leading to the perception that science careers are unattainable for women (Steinke, 2017). Such perceptions lead to diminished identification with science and limit girls' desired career paths (Hazari et al., 2013; Riegle-Crumb et al., 2011). Enhancing diversity in media portrayals is an important step in increasing girls' identification and self-efficacy in science (Cheryan et al., 2015).

Children's appreciation of science and motivation to pursue science are critical to their sustained interest in the subject (Riegle-Crumb et al., 2011). A longitudinal study followed children from preschool to middle childhood, finding that their early science interests predicted later opportunities to participate in science activities and informal science learning (Alexander et al., 2012). The evolution of scientific interests in children depends on children's sense of belonging in science, which later fosters beliefs in one's ability to succeed in science (Trujillo & Tanner, 2014). In particular, self-efficacy (i.e., one's perception of how well one can accomplish a task) plays an important role in children's motivations and identity formation (Bandura et al., 2001; Trujillo & Tanner, 2014). Bandura et al. (2001) argues that self-efficacy—above and beyond current academic ability—influences children's career goals. Studies show no evidence of gender differences in STEM achievement and instead, results reflect that boys and girls display similar aptitude in STEM fields (Hyde et al., 2008; Leslie et al., 2015). Furthermore, there is no clear evidence that women possess less innate talent; rather, a more likely explanation are women's constant experiences of stereotype threat (e.g., the concept that when a stereotyped group is emphasized, people who are members of that group perform worse on a given task), discrimination, and other structural and psychological obstacles (Dar-Nimrod & Heine, 2006; Leslie et al., 2015). Lack of self-efficacy in science among children can limit their possible selves (Markus & Nurius, 1986) and their ideas about what their future may look like, including their potential career trajectories (Oyserman et al., 2006). If young girls develop low self-efficacy in science, they may shy away from the field and may not pursue higher-level science courses in school that serve as a gateway to science majors in college (Dasgupta, 2011). Thus, boosting self-efficacy and motivation in science are crucial to girls' retainment in science.

Ingroup role models increase identification with science

Past research suggests that men will not be affected by the introduction of role models because they are already confident in their science abilities due to having been exposed to positive stereotypes about their gender ingroup (Dasgupta, 2011). Conversely, a considerable body of work suggests that exposing women to female role models increases their identification with science (Dasgupta, 2011; Herrmann et al., 2016). Exposure to a relevant social comparison target (i.e., a role model figure) has been shown to inspire identification and inspiration in women (Buunk et al., 2007). In a study observing high school and college-aged girls' self-efficacy and career aspirations, women rated their current abilities as equivalent to men's in mathematics and science, yet they did not envision themselves as pursuing mathematics and science in the future (Lips, 2004). Specifically, whereas girls in high school may have considered a wider variety of careers, college women expressed low interest in STEM careers (Lips, 2004). Riegle-Crumb et al. (2011) found diminished interest in STEM careers among girls as early as middle school: Girls in eighth grade were substantially less likely to aspire to have careers in science or math and reported enjoying science significantly less than boys. Prior research suggests that introducing a role model figure can have a protective effect on women's STEM performance and longevity in these fields (Lips, 2004; Marx & Roman, 2002). For example, Herrmann et al. (2016) found that when college-aged women were exposed to a woman role model, their academic performance and persistence in science courses improved. As previously discussed, women's lower motivation in science can be explained by negative gender stereotypes of their abilities (Trujillo & Tanner, 2014). The integration of role models into science may boost girls' confidence and provide a sense of belonging (Dasgupta, 2011). Being exposed to female role models can even inspire positive implicit attitudes as well as stronger implicit identification with STEM among women (Stout et al., 2011). However, for the intervention to be successful, it is crucial that the presented role model will be viewed by girls as similar to themselves—representing a future they could one day obtain. It is important in the presentation of a role model figure that they are perceived as accomplished and well-regarded in the chosen career field, but are not impossible to emulate (Dasgupta, 2011; Herrmann et al., 2016).

Much of the current research on role model interventions focuses on adolescents and adults. However, research on role model interventions during earlier stages of development is missing. The present study aims to fill this gap in the literature by examining the effectiveness of a role model intervention among 4–7-year-old children.

Pretend play and the imaginative capabilities of children

Pretend play (e.g., the act of engaging in an imaginative activity) has the ability to cognitively transform children's behavior. There is evidence of pretend play being used as a teaching tool for children as they are able to reason what information they should take back to reality (Weisberg, 2015). The interactive nature of pretend play has been shown to improve emotional and attentional control in children (Goldstein & Lerner, 2018) and has been used to introduce new possibilities to children (Harris, 2021). Taylor et al. (2013) discovered that children who utilized roleplaying, via invisible friends, personified objects or pretend identities, were able to create imaginary phone conversations easier than children who did not roleplay. Thus, supporting the concept that roleplaying has the power to allow children to explore and possibly persist more in new activities and environments. Pretend play enhances girls' engagement in learning through increased creativity and emotional regulation (Hoffmann &

Russ, 2012). For example, Karniol et al. (2011) found that children who were encouraged to display positive characteristics of a superhero were able to exhibit increased delay of gratification. Likewise, in White et al. (2017), children who were told to imagine they were someone else (e.g., Batman, Bob the Builder, etc.) in a task were able to persist longer. Furthermore, relating this information to the present study, children who imagine themselves to be famous scientists may identify and engage with science more and thus, persist for a longer period of time in the science task.

The present study

The present study investigated girls' and boys' motivation and persistence in science and examined if whether pretending to be a woman role model (i.e., beyond being merely exposed to her) will boost young girls' persistence, motivation, and self-efficacy in science. This study addressed the following questions: (1) Will the introduction of role models to 4–7-year-old children increase their persistence and engagement in a science task? (2) Will mere exposure to a role model figure suffice to boost girls' persistence? (3) Will the Roleplay condition be necessary to maximize girls' persistence in the science task? The Roleplay condition draws on the imaginative capabilities of children to act as if they are someone else. Children imagining themselves as famous scientists may allow them to identify and engage with science and thus, motivate them to continue for a longer period of time.

Our main hypotheses were:

(1) The introduction of role models to young girls, but not boys, will increase their persistence and engagement in the science task as well as their self-efficacy and motivation.

(2) The Exposure condition will boost girls' persistence in the science task.

(3) However, the Roleplay condition will be the most effective in maximizing girls' persistence in the science task.

To test these hypotheses, we told children about scientists and had them participate in a science game, after assigning them to one of two experimental conditions (Exposure, Roleplay), or a control condition (Baseline).

Method

Participants

Participants included 229 children (107 girls, 122 boys) ranging from ages 4 to 7 years (M_{age} = 5.96 years old; range 4.03 to 7.95), such that about 60 children at each age were tested in all. Children were tested via Zoom, with most children participating in the United States (51% Northeast, 21% South, 14.6% Midwest, 11.1% West) and a few in Canada (1.5%). Children came from predominately upper-middle class backgrounds. Specific demographics of the sample are as follows: 75.1% White, 9.7% Asian or Pacific Islander, 8.7% Multiracial, 4.6% Latino/Hispanic, 1.3% Other, and .4% African American.

Procedure and Materials

We adapted Rhodes et al.'s (2019) procedure detailing the scientific method by telling children they were going to play a science game, and explaining that first they were going to learn about scientists. Children were then told about scientists and how they make predictions. The experimenter asked if the child knew what a prediction was, and a definition (i.e., "a guess that you think a lot about first—a thoughtful guess") was given by the experimenter no matter their response. Children were then randomly assigned to one of three conditions: Baseline, Exposure or Roleplay. In the Baseline condition after the introduction about scientists and predictions, children were told they were going to play a science game and make predictions about whether objects would sink or float when dropped in water.

In the Exposure condition, children also learned about scientists and making predictions, but were then told about a gender-matched role model figure. Girls were asked if they had ever heard of Dr. Marie Curie, while boys were asked about Dr. Isaac Newton. A brief explanation was given by the experimenter telling the child (1) Dr. Marie Curie/Dr. Isaac Newton was a scientist that discovered really important things (2) She/he always worked really hard even when things got tricky (3) When she/he made mistakes or her/his predictions were wrong, she/he kept on trying. Children were then asked two brief comprehension check questions: *Does Dr. Marie/Dr. Isaac work hard or not work hard? When Dr. Marie/Dr. Isaac makes mistakes does he/she give up, or does he/she keep on trying?* The experimenter corrected or confirmed the child's responses after each question. Children then began the Sink-or-Float game.

In the Roleplay condition, children were given identical prompts to those in the Exposure condition about either Dr. Marie Curie or Dr. Isaac Newton and were asked the same comprehension questions. However, they were then told they were going to imagine they were the famous scientist previously mentioned. Children were then asked a comprehension question about who they were supposed to be and were corrected if they did not say the scientist's name. Children were then told that they were the scientist—either Dr. Marie or Dr. Isaac—and began the Sink-or-Float game. Children in the Roleplay condition were addressed by the name Dr. Marie or Dr. Isaac during the game (i.e., in contrast, children in the Baseline and Exposure conditions were addressed using their own names).

Children in each condition completed a practice trial and were then asked if they wanted to keep playing the science game or do something else. If they wanted to keep playing, another trial of the Sink-or-Float game was presented, and—following response and feedback—children were again asked if they wanted to keep playing or do something else. This process repeated until children said they wanted to do something else, or reached the maximum amount of 50 trials.

When the game ended, the experimenter asked children a series of questions about their self-efficacy and motivation (Table 1), presented in a randomized order. In the Roleplay condition only, children were also asked whether they felt like they were the scientist—Dr. Marie or Dr. Isaac—during the science game to evaluate whether the roleplaying manipulation was successful. Each Zoom session was recorded, and undergraduate research assistants coded videos for accuracy.

Table 1.

Experimental Questions:

Topic:	**Questions:**
Self-Efficacy:	• *How good do you think you are at the science game: good or not so good?* • *How good do you think you are at being a scientist: good or not so good?*
Motivation:	• *If you had the chance to do something tomorrow: would you play the science game or do something else?* • *Do you want to be a scientist when you grow up?* • *How did playing the science game make you feel: happy or sad?* • *Do you like the science game, or do you not like it?*

Results

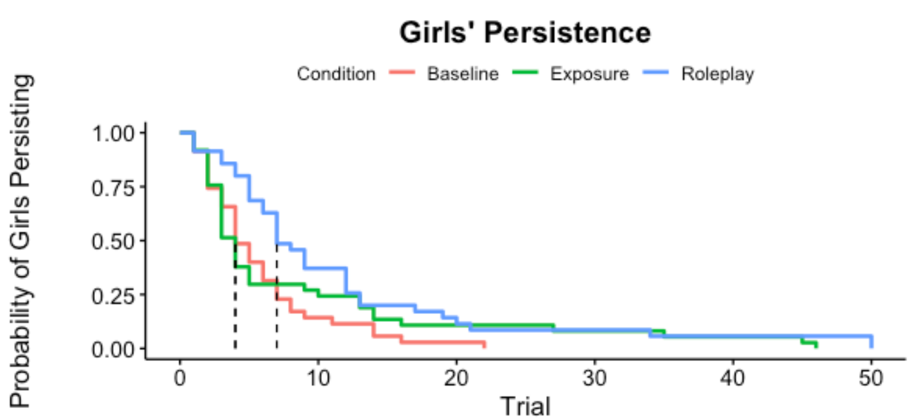
Persistence

To study how children's persistence was affected by condition and gender, we utilized a survival curve analysis. This analysis is typically used in health-related studies to see how long a given population will survive, but for our purposes we used it to analyze how long children persisted throughout the science game. With the maximum being fifty trials, we observed, separately for girls and boys, how long they persisted in the science game in the experimental conditions (Exposure, Roleplay) as compared to the Baseline condition, while controlling for overall accuracy rate. The data shows that in the science game, boys completed more trials overall (Table 2). Similarly, the main effect of gender was significant on persistence while controlling by accuracy rate (β= .29, SE = 1.3, z = 2.1 p = .033). In the Baseline condition, boys completed more than two times the trials than girls. The average number of trials boys completed did not differ significantly across conditions (Boys: Baseline = 13.96, Exposure = 9.32, Roleplay = 12.0). Table 2 shows that the average number of trials girls completed differed across conditions, with girls progressively completing more trials from the Baseline to Exposure to Roleplay conditions. Despite this descriptive increasing trend for girls' persistence, only the Roleplay condition significantly differed from the Baseline condition (β= .63, SE = .24, z = 2.6, p = .025). When looking at boys' and girls' persistence combined, we found that the Exposure and Roleplay conditions were not significant. However, when isolating the gender category to girls', we found that the Roleplay condition became a predictor of improved persistence. This finding was significant as it showed our pretend play manipulation was successful at boosting girls' persistence.

Table 2:
Descriptive statistics of the number of trials completed by boys and girls

Condition	Gender	Median	Mean	SD
Baseline	Boys	6	13.95	15.56
Baseline	Girls	4	5.83	4.71
Exposure	Boys	6	9.32	9.77
Exposure	Girls	4	8.62	11.52
Roleplay	Boys	9	12.0	13.02
Roleplay	Girls	7	11.54	11.73
Overall persistence	Boys	7	11.85	13.15
Overall persistence	Girls	5	8.67	10.08

However, girls in the Exposure condition did not persist longer than in the Baseline condition (β =.22, SE = .24, z = .89, p = .642). As seen in Figure 1, girls' persistence increased in number across the Baseline, Exposure, and Roleplay conditions. However, for boys, persistence did not significantly vary across conditions (i.e., boys' Baseline-Roleplay: β = -.124, SE = .22, z = -.57, p = .836). These trends follow our hypotheses with young girls' persistence increasing in the Roleplay condition, but not varying by condition for boys. However, as hypothesized girls' persistence did not significantly increase in the Exposure condition. In the Roleplay condition, 6% of girls completed the maximum of fifty trials. In the Baseline condition, the most trials girls completed were twenty trials total (accounted for 3% of the sample). This means that total amount of trials completed in the science game significantly increased for girls depending on condition.



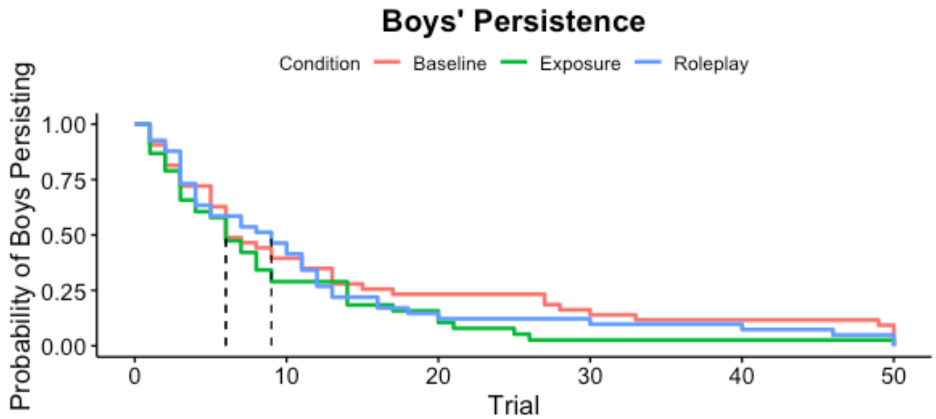


Figure 1: The probability of girls and boys to persist across the 50 trials of the science game by condition. The dotted lines indicate the median number of trials completed for each condition.

Self-Efficacy

Self-efficacy was scored on a 0-5 scale with two questions' (*How good do you think you are at the science game: good or not so good? How good do you think you are at being a scientist: good or not so good?)* responses being averaged to create self-efficacy scores. We then conducted linear regression analyses, separately for girls and boys, predicting their self-efficacy by condition, while controlling for their accuracy rate. Girls' self-efficacy scores were higher in the Exposure (β = .54, SE = .28, t = 1.9, p = .057) and Roleplay (β = .59, SE = .28, t = 2.1, p = .037) conditions than in the Baseline condition. Figure 2 illustrates the difference in self-efficacy scores between girls' responses in the Baseline vs. Exposure/Roleplay conditions. Among boys, there was not an effect of condition on self-efficacy scores (Exposure: β = -.37, SE .28, t = -1.3, p = .185; Roleplay: β = -.29, SE = .28, t = -1.04, p = .299). When combining boys' and girls' self-efficacy scores, we found that conditions were not significant on their own. In contrast, when we isolated girls' scores, we found that the Exposure and Roleplay conditions were predictors of improved self-efficacy.

Figure 2: Boys' and girls' self-efficacy scores displayed by condition. The error bars represent standard errors.

Motivation

Self-reported motivation was scored on a 0-5 scale with four questions' (*If you had the chance to do something tomorrow: would you play the science game or do something else? Do you want to be a scientist when you grow up? How did playing the science game make you feel: happy or sad? Do you like the science game, or do you not like it?)* responses averaged to create a motivation score. We then conducted linear regression analyses, separately for girls and boys, predicting their motivation by condition, while controlling for their accuracy rate. We found the effect of condition for motivation was not statistically significant for girls or boys (i.e., Girls, Roleplay: β = -.19, SE = .18, t = -1.0, p = .305; Boys, Roleplay: β = -.36, SE = .31, t = -1.2, p = .237). The R^2 value for girls and boys was .02, which alludes to a lack of fit of the model. These findings of self-reported scores of motivation contrast with the increased motivation of girls' seen in our persistence measure.

Discussion

To review, our study focused on the underrepresentation of women in STEM and how this phenomenon has roots in early childhood. Specifically, we focused on if pretending to be a woman role model would increase young girls' persistence, self-efficacy, and motivation in a science game. The study included a novel role model intervention where in our experimental conditions (Exposure and Roleplay), boys and girls heard about a gender-matched role model. In the Roleplay condition, boys and girls were then asked to imagine they were the role model during the science game. All children participated in the science game (Sink-or-Float game) and completed as many trials as they wanted. When they decided they wanted to stop playing, we asked them a series of questions about their self-efficacy and motivation. We then conducted data analyses, separately by gender, of participants' persistence, self-efficacy, and motivation.

The present study's results confirm the ability of an implementation of a role model intervention to improve young girls' persistence and self-efficacy in science. As hypothesized, the Roleplay condition was most effective in increasing young girls' persistence and self-efficacy. The Exposure condition yielded similar results for self-efficacy, but not for persistence. This could have occurred because the Exposure condition did not boost girls' identification with science enough. Similarly, as expected, boys' persistence, self-efficacy, and motivation were not affected by the role model intervention. A possible explanation for our results is that presenting girls with a gender-congruent role model reduces the availability of gender stereotypes and results in the confidence to continue in the pursuit of science careers (Olsson & Martiny, 2018) or in the present study's case, the science game. In contrast to our hypotheses, girls' self-reported motivation was not affected by condition. Our results showed that while self-reported motivation did not increase for girls in the Exposure or Roleplay conditions when compared to the Baseline condition, their persistence did increase in the Exposure and Roleplay conditions. As persistence is a form of motivation, it is possible that girls' implicit motivation did not change even though their explicit motivation did. It is possible that although girls have improved self-efficacy (e.g., after being exposed or imagining they are a role model) about what they are personally capable of accomplishing in STEM, they still are not motivated enough to pursue a career in STEM. This disconnect may occur because girls still cannot see a future in which a career in STEM is possible or realistic as a result of lack of long-term role models. To mitigate this and to help foster personal connections, future studies may consider utilizing in-person, real-life role models. However, this could become costly and time intensive when trying to schedule role models to come speak to young girls. Ultimately, this speaks to a strength of our study and the manipulation that we used—in that, it required no outside resources. Another major strength of our study is that it showed that even a brief storytelling method—totaling no more than a paragraph in length—about a woman role model's perseverance in the face of hardship was successful at increasing young girl's persistence and self-efficacy in the science game. Based on the effectiveness of our study and the novelty of our research design, our methods should be replicated in future studies. However, there are some small alterations that could be made to our script to possibly make the manipulation be even stronger.

As Olsson and Martiny (2018) explain, most role model studies do not use a follow up design and consequently, enduring effects of the role model exposure are not measured. An essential next step of developmental research should include a longer-term role model intervention. A low-cost intervention to follow up on our findings could include a storytelling method, similar to the one used in the present study, over several weeks or months. Using a storybook about women in nontraditional occupations, Nhundu (2007) found girls in the intervention group had a preference for traditionally male dominated careers. This study was an effective first step at reducing gender-stereotyping of careers and improving gender equity. Incorporating a longer-term intervention is important for lasting change to occur particularly when considering how to increase girls' desire to one day pursue a career in STEM. The present study provided promising results for the potential of conducting a role model intervention aimed at improving young girls' persistence and self-efficacy. However, this is not indicative of a permanent behavior change as girls may forget what they learned in the study as time goes on. Our findings provide confidence to the effectiveness of introducing young girls to women role models and this could have extremely positive implications. Importantly, our study provides hope for future strategies aimed at reducing the gender gap in STEM, starting with children.

Limitations

One limitation of the present research is that data collection was completed over Zoom as a result of the COVID-19 pandemic. Past research has been conducted in-person and therefore, replication studies must occur to ensure there was no confounding variable relating to the virtual nature of the study. Similarly, another limitation of the study is the sample's median income. As of 2019, the median income in the United States was $68,703 (US Census, 2020). However, the median income of our study was $120,000. Our sample was not necessarily generalizable to children of lower socioeconomic status and therefore, it is unclear if our results would be replicable. This is not a problem specific only to our study as much of developmental research includes participants from the middle class (Rowley & Camacho, 2015). As previously mentioned, our sample was relatively homogenous with 75.1% of participants identifying as White. This is specifically of importance when considering who may benefit the most from a role model intervention. Specifically, follow up studies should incorporate a more diverse sample.

Future directions

Women as a whole are underrepresented in STEM, but women of color in science are severely underrepresented. In 2017, only 11.5% of science and engineering employees were women of color (e.g., 6% Asian women, 2.5% Black women, 2.3% Latinas, and .1% American Indian/Alaska Native women) in the United States (Catalyst, 2020). Women of color face a uniquely difficult experience pursuing a career in STEM. This is because they experience the double-bind problem (e.g., the intersection and oppression of race and gender) combined with a career choice in STEM, which brings unique institutional and structural barriers and discrimination (Alfred et al., 2018). For example, there are early gaps in positive STEM experiences for Black girls as they are less likely to be recommended for advanced courses starting in middle school (Collins et al., 2020). Understanding the specific barriers for women of color is essential for success of future role model intervention work. Specifically, by targeting girls of color in early childhood and exposing them to role models similar to them, the attainability of a career in STEM may seem more possible and help them continue on in these fields. A possible way to integrate our findings into the real-world would be in an educational setting. For example, having elementary and middle school teachers display posters with diverse STEM role models as well as including teaching units on these figures may encourage girls' interests in these fields. Similarly, this would help normalize women's success in these fields and show young girls examples of possible careers to strive for.

Another important factor to be considered in future studies is the role of external influences on children. Parents can be an important component of cultivating children's science interests (Halim et al., 2018) or in unfortunately, disseminating gender stereotypes (Adler et al., 1992). A holistic view in future work that includes children's family, teachers, peers, and other relationships may help lessen gender stereotypes (Adler et al., 1992). The idea being that for a role model intervention to be effective in reducing gender stereotypes and promoting girls' identification with STEM, other aspects of a child's environment would have to similarly support these ideas. When thinking of a role model intervention incorporating children's peers, group membership has been shown to improve preschoolers' engagement in STEM activities including boosting their persistence and interests in the subject (Master et al., 2017). However, future developmental research featuring group membership and improving STEM interests must be careful to foster children's identification with the group. If not, children may perceive themselves as outgroup members, which could negatively affect STEM interests.

As previously discussed, interventions with real-life role models may prove to be too expensive to realistically implement at a large-scale. However, there is an adaptation to the present study that could be implemented in follow up studies that draws on the success of past work with real-life role models. A manipulation with real-life role models that seems to have promising results is having girls reflect on their similarity with the role model after exposure. For example, O'Brien et al. (2017) found that middle school aged young girls who were allowed to pick their favorite role model after a science outreach event and then reflect on their choice through writing showed an increase in sense of fit in science. Likewise, Van Camp et al. (2019) found that college age women displayed less implicit and explicit gender stereotypes about STEM after writing a reflection on role models they had read about. These studies show that having a participant stop and think about the presented role model and the similarity between themselves and role model may help foster science identities and improve identification with science. Drawing on the success of these studies with adult women, we could adapt the present study's methods. This would involve a new experimental condition where after introducing children to a role model, they write a short reflection about the role model and if they consider themselves as being similar to them. This small addition to the present study's methods, when implemented in follow up studies, could be effective in boosting girls' persistence even more than what is currently seen in the Roleplay condition.

Conclusion

Early childhood is an important time for fostering young girls' science interests and sense of belonging in science. Having early interests in STEM subjects may lead to unique experiences that serve as a steppingstone toward later activities and classes. By boosting young girls' persistence and self-efficacy in STEM, a leveling of the gender gap occurs. Presenting girls with a gender-congruent role model has the ability to support their burgeoning STEM interests and persist in the face of any gender stereotypes or social influences they may encounter. An important component of the present study was the finding that introducing young girls to a woman role model can increase their self-efficacy and persistence in science. Of specific importance to the success of the manipulation was asking the girls to imagine to be the role model through a pretend play activity. Imagining to be the role model they had previously learned about allowed girls to perform above and beyond their baseline performance in the science game and this provides insight about best practices when creating role model interventions in the future. Ultimately, the present study provided a novel strategy to help reduce gender gaps in science from their developmental roots.

References

Adler, P. A., Kless, S. J., & Adler, P. (1992). Socialization to gender roles: Popularity among elementary school boys and girls. *Sociology of Education*, *65*(3), 169–187. https://doi.org/10.2307/2112807

Alexander, J. M., Johnson, K. E., & Kelley, K. (2012). Longitudinal analysis of the relations between opportunities to learn about science and the development of interests related to science. *Science Education*, *96*(5), 763–786. https://doi.org/10.1002/sce.21018

Alfred, M. V., Ray, S. M., & Johnson, M. A. (2019). Advancing women of color in STEM: An imperative for U.S. global competitiveness. *Advances in Developing Human Resources*, *21*(1), 114–132. https://doi.org/10.1177/1523422318814551

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/10.1111/1467-8624.00273

Beede, D. N., Julian, T. A., Langdon, D., McKittrick, G., Khan, B., & Doms, M. E. (2011). Women in STEM: A gender gap to innovation. *Social Science Research Network*. https://doi.org/10.2139/ssrn.1964782

Beilock, S. L., Gunderson, E. A., Ramirez, G., & Levine, S. C. (2010). Female teachers' math anxiety affects girls' math achievement. *Proceedings of the National Academy of Sciences*, *107*(5), 1860–1863. https://doi.org/10.1073/pnas.0910967107

Bian, L., Leslie, S., J., & Cimpian, A. (2017). Gender stereotypes about intellectual ability emerge early and influence children's interests. *Science,* 355, no. 6323: 389–91. https://doi.org/10.1126/science.aah6524

Buunk, A. P., Peiró, J. M., & Griffioen, C. (2007). A positive role model may stimulate career-oriented behavior. *Journal of Applied Social Psychology*, *37*(7), 1489–1500. https://doi.org/10.1111/j.1559-1816.2007.00223.x

Catalyst (2020). *Women in science, technology, engineering, and mathematics (STEM): Quick take.* https://www.catalyst.org/research/women-in-science-technology-engineering-and-mathematics-stem/

Chambers, D. W. (1983). Stereotypic images of the scientist: The draw-a-scientist test. *Science Education*, *67*(2), 255–265. https://doi.org/10.1002/sce.3730670213

Cheryan, S., Plaut, V., C., Handron, C., & Hudson, L. (2013). The stereotypical computer scientist: gendered media representations as a barrier to inclusion for women. *Sex Roles*, 69, no. 1: 58–71. https://doi.org/10.1007/s11199-013-0296-x

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

Cimpian, A., Hammond, M. D., Mazza, G., & Corry, G. (2017). Young children's self-concepts include representations of abstract traits and the global self. *Child Development*, *88*(6), 1786–1798. https://doi.org/10.1111/cdev.12925

Collins, K. H., Joseph, N. M., & Ford, D. Y. (2020). Missing in action: Gifted Black girls in science, technology, engineering, and mathematics. *Gifted Child Today*, *43*(1), 55–63. https://doi.org/10.1177/1076217519880593

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

Dar-Nimrod, I., & Heine, S. J. (2006). Exposure to scientific theories affects women's math performance. *Science*, *314*(5798), 435–435. https://doi.org/10.1126/science.1131100

Dasgupta, N. (2011). Ingroup experts and peers as social vaccines who inoculate the self-concept: The stereotype inoculation model. *Psychological Inquiry,* 22, no. 4, 231–46. https://doi.org/10.1080/1047840X.2011.607313

Funk, C., & Parker, K. (2018). Diversity in the STEM workforce varies widely across jobs. *Pew Research Center*. https://www.pewsocialtrends.org/2018/01/09/diversity-in-the-stem-workforce-varies-widely-across-jobs/

Goldstein, T. R., & Lerner, M. D. (2018). Dramatic pretend play games uniquely improve emotional control in young children. *Developmental Science*, *21*(4). https://doi.org/10.1111/desc.12603

Halim, L., Abd Rahman, N., Zamri, R., & Mohtar, L. (2018). The roles of parents in cultivating children's interest towards science learning and careers. *Kasetsart Journal of Social Sciences*, *39*(2), 190–196. https://doi.org/10.1016/j.kjss.2017.05.001

Harris, P. L. (2021). Early constraints on the imagination: The realism of young children. *Child Development*, *92*(2), 466–483. https://doi.org/10.1111/cdev.13487

Hazari, Z., Sadler, P. M., & Sonnert, G. (2013). The science identity of college students: Exploring the intersection of gender, race, and ethnicity. *Journal of College Science Teaching*, *42*(5), 82–91. http://www.jstor.org/stable/43631586

Herrmann, S. D., Adelman, R. M., Bodford, J. E., Graudejus, O., Okun, M. A., & Kwan, V. S. Y. (2016). The effects of a female role model on academic performance and persistence of women in STEM Courses. *Basic and Applied Social Psychology*, *38*(5), 258–268. https://doi.org/10.1080/01973533.2016.1209757

Hoffmann, J., & Russ, S. (2012). Pretend play, creativity, and emotion regulation in children. *Psychology of Aesthetics, Creativity, and the Arts*, *6*(2), 175–184. https://doi.org/10.1037/a0026299

Hyde, J. S., Lindberg, S. M., Linn, M. C., Ellis, A. B., & Williams, C. C. (2008). Gender similarities characterize math performance. *Science*, *321*(5888), 494–495. https://doi.org/10.1126/science.1160364

Karniol, R., Galili, L., Shtilerman, D., Naim, R., Stern, K., Manjoch, H., & Silverman, R. (2011). Why superman can wait: Cognitive self-transformation in the delay of gratification paradigm. *Journal of Clinical Child & Adolescent Psychology*, *40*(2), 307–317. https://doi.org/10.1080/15374416.2011.546040

Leslie, S. J., Cimpian, A., Meyer, M., & Freeland, E. (2015). Expectations of brilliance underlie gender distributions across academic disciplines. *Science,* 347, no. 6219, 262–65. https://doi.org/10.1126/science.1261375

Lips, H. M. (2004). The gender gap in possible selves: Divergence of academic self-views among high school and university students. *Sex Roles* 50, no. 5/6, 357–71. https://doi.org/10.1023/B:SERS.0000018891.88889.c9

Markus, H., & Nurius, P. (1986). Possible selves. *American Psychologist, 41(*9), 954-969. https://doi.org/10.1037/0003-066X.41.9.954

Marx, D. M., & Roman, J. S. (2002). Female role models: Protecting women's math test performance. *Personality and Social Psychology Bulletin*, *28*(9), 1183–1193. https://doi.org/10.1177/01461672022812004

Master, A., Cheryan, S., & Meltzoff, A. N. (2017). Social group membership increases STEM engagement among preschoolers. *Developmental Psychology*, *53*(2), 201–209. http://dx.doi.org/10.1037/dev0000195

Miller, D. I., Nolla, K. M., Eagly, A. H., & Uttal, D. H. (2018). The development of children's gender-science stereotypes: A meta-analysis of 5 decades of U.S. draw-a-scientist studies. *Child Development*, 89, no. 6 (2018): 1943–55. https://doi.org/10.1111/cdev.13039

National Center for Education Statistics. (2020). Undergraduate enrollment. https://nces.ed.gov/programs/coe/indicator_cha.asp

Nhundu, T. J. (2007). Mitigating gender-typed occupational preferences of Zimbabwean primary school children: The use of biographical sketches and portrayals of female role models. *Sex Roles*, *56*(9–10), 639–649. https://doi.org/10.1007/s11199-007-9204-6

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. *Frontiers in Psychology*, *9*. https://doi.org/10.3389/fpsyg.2018.02264

Oyserman, D., Bybee, D., & Terry, K. (2006). Possible selves and academic outcomes: How and when possible selves impel action. *Journal of Personality and Social Psychology*, *91*(1), 188–204. https://doi.org/10.1037/0022-3514.91.1.188

Rhodes, M., Leslie, S. J., Yee, K. M., & Saunders, K. (2019). Subtle linguistic cues increase girls' engagement in science. *Psychological Science,* 30, no. 3: 455–66. https://doi.org/10.1177/0956797618823670

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

Rowley, S. J., & Camacho, T. C. (2015). Increasing diversity in cognitive developmental research: Issues and solutions. *Journal of Cognition and Development*, *16*(5), 683–692. https://doi.org/10.1080/15248372.2014.976224

Steinke, J. (2017). Adolescent girls' STEM identity formation and media images of STEM professionals: Considering the influence of contextual cues. *Frontiers in Psychology*, 8. https://doi.org/10.3389/fpsyg.2017.00716

Stout, J. G., Dasgupta, N., Hunsinger, M., & McManus, M. A. (2011). STEMing the tide: Using ingroup experts to inoculate women's self-concept in science, technology, engineering, and mathematics (STEM). *Journal of Personality and Social Psychology, 100*(2), 255–270. https://doi-org.proxy.library.cornell.edu/10.1037/a0021385

Taylor, M., Sachet, A. B., Maring, B. L., & Mannering, A. M. (2013). The assessment of elaborated role-play in young children: Invisible friends, personified objects, and pretend identities. *Social Development*, *22*(1), 75–93. https://doi.org/10.1111/sode.12011

Trujillo, G., & Tanner, K., D. (2014). Considering the role of affect in learning: Monitoring students' self-efficacy, sense of belonging, and science identity. *CBE—Life Sciences Education*, 13, no. 1, 6–15. https://doi.org/10.1187/cbe.13-12-0241

U.S. Census Bureau (2019). *Income and Poverty in the United States: 2019*. https://www.census.gov/library/publications/2020/demo/p60-270.html

Van Camp, A. R., Gilbert, P. N., & O'Brien, L. T. (2019). Testing the effects of a role model intervention on women's STEM outcomes. *Social Psychology of Education*, *22*(3), 649–671. https://doi.org/10.1007/s11218-019-09498-2

Weisberg, D. S. (2015). Pretend play. *WIREs Cognitive Science*, *6*(3), 249–261. https://doi.org/10.1002/wcs.1341

White, R. E., Prager, E. O., Schaefer, C., Kross, E., Duckworth, A. L., & Carlson, S. M. (2017). The "Batman effect": Improving perseverance in young children. *Child Development*, *88*(5), 1563–1571. https://doi.org/10.1111/cdev.12695