Brief stories of successful female role models in science help counter gender stereotypes regarding intellectual ability among young girls: A pilot study

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Disclosure of interests: The authors declare that they have no conflict of interest to report.

Funding: There was no funding for the present study.

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Abstract

Negative stereotypes about female intellectual abilities occur in children as young as 6-years-old and can shape a child's educational path and career choice, particularly in relation to Science, Technology, Engineering and Math (STEM). The current study (*N* = 40) explored pre-existing gender stereotypes in a purposeful sample of 6 to 8-year-old white British girls at a dance and performing arts center and tested the impact of a brief story-based intervention that exposed young girls to intellectually brilliant female role models in STEM. Findings indicated that exposure to stories about women in science can help counter negative stereotypes concerning female intellectual ability. Another stereotype, "females are nicer than males", was prevalent in most participants and was not affected by the current intervention. A key implication of this study is that young girls who learn about members of their own gender group who accomplished success in STEM fields may be more inclined to think of STEM careers as a possibility for females in future.

Keywords: Gender stereotypes, STEM, science, education, girls.

Women remain substantially underrepresented in Science, Technology, Engineering, and Math (STEM) fields (Dasgupta & Stout, 2014; Schwab et al., 2016; Stoet & Geary, 2018). In the UK, 26% of the total graduating in 2018 with a core STEM degree (e.g., math, engineering, computer science) were women (WISE, 2019). Without encouraging more women to enter and remain in STEM fields many countries risk a shortage of STEM qualified individuals thereby failing to remain competitive in these fields (Sánchez de Madariaga et al., 2012). However, gender stereotypes, acquired from an early age, continue to present barriers to women's progression within scientific fields (Bian, Cimpian, & Leslie, 2018; Miller, Nolla, Eagly, & Uttal, 2018).

In a recent review, Ellemers (2018) found there is overwhelming evidence that gender stereotyping impacts on the physical and intellectual development of children. A stereotype is defined as, and can reflect, a generalized expectation about members of a social group even when individual members of that group may vary from one another (Ellemers, 2018). Social role theory (Eagly & Wood, 1999; Wood & Eagly, 2012) suggests that a gendered division of labor concentrates females in more communal roles and males in agentic roles, which has implications for typical gender-specific behavior. For example, it can compromise the success of males and/or females in social roles perceived as being in opposition with gender typical roles (e.g., males in caring roles and females in agentic roles; Sczesny, Nater, & Eagly, 2018). Typically, Western gender stereotypes positively relate women with being warm, maternal and nurturing, yet negatively stereotype them as intellectually less competent than their male counterparts (Glick & Fiske, 2000; Tipton, 2018).

However, meta-analyses (e.g., Voyer & Voyer, 2014) have consistently found that girls outperform boys on most measures of scholastic achievement at school. Moreover, there is little evidence for an intrinsic aptitude difference between males and females in science and math (Spelke, 2005; Stoet & Geary, 2018; but see also Miller & Halpern, 2014). Large-scale meta-analyses of cognitive sex differences, such as math ability, have mainly found small or very small effect sizes (e.g., Hyde, 2014; Zell, Krizan & Teeter, 2015), with cross-cultural examinations demonstrating substantial variability in effect size magnitude internationally (see Miller & Halpern, 2014). This lends support to the assertion that gender gaps in STEM fields are likely largely due to sociocultural factors (e.g., Steinke, 2017; Hill, Corbett, & St. Rose, 2010) rather than innate biological differences in ability between the sexes (Hyde, 2014). The more gender-equal a country is the less a gender gap in math favoring boys is detected (Guiso, Monte, Sapienza, & Zingales, 2008). However, the stereotype persists that males have more talent for scientific endeavors (Bian et al., 2018; Chestnut, Lei, Leslie, & Cimpian, 2018; Cimpian & Leslie, 2017; Steinke, 2017).

The impact of gender stereotyping

Societal stereotypes about gender can shape the educational and career paths of young people (Muntoni & Retelsdorf, 2019). For example, math-gender stereotypes favoring men are acquired early in life (Cvencek, Meltzoff, & Greenwald, 2011) and can impair math performance among women (e.g., Spencer, Steele, & Quinn, 1999) and girls, even when these stereotypes occur at an implicit level (Galdi, Cadinu, & Tomasetto, 2014). In educational settings, Leslie, Cimpian, Meyer, and Freeland (2015) infer that gender stereotyping about innate intellectual ability or 'brilliance' results in male students being seen as more talented than female students across all areas of math (e.g., Passolunghi, Ferreira, & Tomasetto, 2014) and science. This contributes to women's continued underrepresentation in STEM fields as such stereotyping may steer females away from scientific or leadership roles (Storage, Horne, Cimpian, & Leslie, 2016).

These negative stereotypes regarding academic brilliance are acquired in children as young as six years old (Bian, Leslie, & Cimpian, 2017). Master and Meltzoff (2016) suggest that stereotypes favoring boys' ability and suitability for STEM subjects play an important role in girls' lower motivation and interest in STEM careers. For example, boys are perceived as smarter than girls and this can reduce girls' interest in intellectually challenging tasks (Bian et al., 2017). Additionally, when females demonstrate competency or agency, they may experience backlash for violating the status quo and are often perceived as less 'nice' (Prentice & Carranza, 2002; see The Industry Gender Gap, 2016). In sum, intellectually brilliant, agentic individuals are typically perceived as best suited to STEM (Carli, Alawa, Lee, Zhao, & Kim, 2016; Master & Meltzoff, 2016) and this more closely aligns with stereotypes of males rather than females. Thus, it is important to counter these intellectual stereotypes so that females are deemed just as able to succeed in STEM as males.

Can stories counter gender stereotypes?

Gender stereotypes appear fairly prevalent in society (Eagly & Steffen, 1984; Haines, Deaux, & Lofaro, 2016) and can propagate via the media and cues in academic environments, for example (Cheryan, Master & Meltzoff, 2015; Steinke, 2017). However, these stereotypes may be malleable and dynamic, particularly female stereotypes (Diekman & Eagly, 2000). The reduction of negative gender-STEM stereotypes and their effect has been explored in a number of ways including diversifying stereotypes about STEM itself (e.g., Cheryan et al., 2015), exposure to counter-stereotypical cues (e.g., Galdi et al., 2014) and relevant role models (e.g., Stout, Dasgupta, Hunsinger, & McManus, 2011). A recent meta-analysis of Draw-A-Scientist studies (Miller et al., 2018) indicated that children still perceive scientists as predominantly male, yet this stereotype has weakened over the last 50 years. This could be due to children being exposed to more female scientists (Steinke, 2017; Stout et al., 2011). Social role theory suggests that as exposure to successful women in STEM increases, a gradual shift in beliefs about female roles should occur (Wood & Eagly, 2012).

There is evidence from a field study that exposure to STEM women as role models can increase middle school girls (age 11-13) sense of fit in science (O'Brien et al, 2017). Indeed, exposing female students, aged 12 to 16, to real-life female role models that currently hold a successful professional occupation in STEM fields helped increase the girls' enjoyment of and belief in importance of mathematics, along with enhanced expectations of their own success in mathematics (González-Pérez, Mateos de Cabo, & Sáinz, 2020). Moreover, González-Pérez et al. reported a reduction in effects of negative gender stereotypes. Given that these negative gender stereotypes may emerge in girls as young as six years old (Bian et al, 2017), there is a need to advance more readily adaptable developmentally appropriate approaches that target primary education age children than more logistically challenging interventions such as actual in-vivo experiences with STEM role models.

Storytelling may be one such promising approach to influence gender stereotypes regarding intellectual ability among girls. Children learn effectively through story and storytelling, which enhances comprehension or story reading and improves language complexity (Isbell, Sobol, Lindauer, & Lowrance, 2004). The practice of teaching through story is a fundamental method that humans have used to teach and pass information through generations throughout human history (Lawrence & Paige, 2016) and is an essential strategy in teaching infants, especially in the classroom (Jalongo, 2004). Further, positive relationships between children's stories and the activities acted out in play (Holmes, et al., 2019) suggest stories leave an impressionable mark on a child and can influence how they behave socially.

Story-based interventions have previously shown some success reducing gender stereotypes among children. Ashby and Wittmaier (1978) found that after exposure to stories describing women in careers deemed nontraditional at the time (e.g., television director), girls were more likely to select nontraditional jobs and adjectives than girls who were exposed to more traditional career stories (e.g., telephone operator). This suggests the importance of the types of role models portrayed in the books that girls read. However, Ashby and Wittmaier (1978) suggested that the presence of a female experimenter reading the stories may have strengthened their effect. Bartholomaeus (2016) suggests that the effect of stories that try to counter gender stereotypes may not be straightforward as children's understanding of the story's message may vary. Further engagement with these stories through class discussions and activities, for example, may be required to clarify their effect.

However, Karniol and Gal-Disegni (2009) found that children briefly exposed to more gender-fair basal readers deemed more activities as appropriate for both males and females, particularly activities stereotypically associated with females. Stereotypically male or gender-neutral activities were not significantly impacted by basal reader type, suggesting it may be more challenging to shift stereotypes about what is appropriate for males. Thus, counter-stereotypical stories may be an effective intervention to influence the stereotypes held by children. The current research adds to the literature by examining whether gender stereotypes specifically related to intellectual ability can be countered by brief stories, particularly in the context of STEM. Additionally, the inclusion of a male experimenter will help determine whether the presence of a female experimenter is necessary for counter-stereotypical stories about women to have an impact (see Ashby & Wittmaier, 1978).

The current study

Negative stereotypes about female intellectual ability emerge early in development and can influence educational and career paths. Through a series of correlational studies, Bian and colleagues (2017) developed a novel way to measure children's stereotypes associated with intellectual brilliance (e.g., genius, high-level intellectual ability). Studies 1 and 2 exposed children (aged of 5 - 7 years) to pictures and stories about adults and children, and asked them to make judgements about who they believed was smarter or nicer, based on appearance or story characterization. Bian et al. reported that girls age 6 and 7 were significantly less likely to associate intellectual brilliance with their own gender. Interestingly, this outcome was not observed in 5-year-old girls and boys, who were found to associate brilliance with their own gender, signifying children may go through an important shift in their beliefs between the ages of 5 to 7 years. Bian and colleagues (2017), further showed, in studies 3 and 4, that these pre-existing gendered beliefs about brilliance can shape the child's interests, potentially steering young girls away from activities for "children who are really, really smart". Thus, it is imperative to counter these intellectual stereotypes to reduce barriers for women and girls entering fields associated with high intellectual ability such as STEM.

The present study modified the tasks from Bian et al.'s (2017) studies 1 and 2 to assess changes in children's beliefs influenced by a developmentally appropriate story-based intervention which represents a novel contribution in this domain. We had two aims: (i) to assess girls' pre-existing gender stereotypes around female intellectual ability and 'niceness'; and (ii) to gauge the effectiveness of a story-based intervention designed to challenge these intellectual gender stereotypes. An exploration of 'niceness' stereotypes was included as competent females are often deemed less likeable or 'nice' (Szymanowicz & Furnham, 2011; see The Industry Gender Gap, 2016). Therefore, we wished to examine whether increasing beliefs about female intellectual ability produced a backlash effect whereby females were seen as less 'nice'.

The current intervention consisted of stories about female scientists who have changed the world and are known for their intellectual brilliance (Wissinger, 2016). Ultimately, this intervention aimed to determine whether we can shape or reduce negative intellectual stereotypes and promote more positive beliefs about female intellectual ability among girls. This is important because, as Bian et al. (2018) express "the seemingly subtle differences in how people think about the intellectual abilities of women and men translate into macrolevel inequalities in their professional trajectories” (p. 1140), with women systematically underrepresented in scientific fields that are associated with higher intellectual capacity or brilliance (Leslie et al., 2015). We hypothesized that a UK sample of 6-8-year old girls would perceive males as more intellectually able (‘smarter’) and their own female gender as ‘nicer’. We aimed to counter these negative stereotypes by exposing the girls to stories about female scientists known for their intellectual brilliance. We further hypothesized that girls exposed to this intervention would be more likely to choose their own gender as ‘smart’. It was less clear whether this would affect stereotypes about female ‘niceness’ but it is important to determine whether a backlash effect is produced, in other words, females perceived as smart but not nice.

Method

Participants

The participants in the present study were recruited from a dance and theatre arts company based in X, United Kingdom. Permission for testing from the principal was obtained. All participants (N = 40; n = 20 Intervention group; n = 20 Control group) were females aged 6- 8 years old (M = 7 years). The sample size was dependent on the limited availability of parents who were required to be present on site to consent their child’s participation in the study, and therefore, we did not compute an a priori power analysis. A quasi-randomization procedure was employed with this white British sample, as every other participant was allocated into the control group on study sign-up. Males were not included in this study as the intervention aimed to influence female children’s views about their own gender’s intellectual ability. Ethical approval was obtained from the Institutional Research Ethics committee. Written informed consent was obtained from each child’s parent or caregiver prior to the experiment and assent forms were competed by all participants. The only information retained by the experimenter was the age of participants. No other demographic, socioeconomic or schooling status information was collected. The children were tested individually in a private room in a community center. Parents/caregivers were present in the testing room but remained out of eye contact with the child and were told to avoid interacting with the participant during the experiment.

Materials

The current study materials were adapted from Bian et al.'s (2017) study. The supplementary materials, stimuli and datasheets were obtained from Bian and colleagues to effectively adapt the relevant tests for the aims of the current study. In particular, Tasks (i) and (ii) from Bian and colleagues' (2017) study 1 were adapted in the current study: Task (i) was unmodified, while for Task (ii) pictures of children were excluded so the participants only rated pictures of adults. The pictures used across all tasks were of white males and females who were normed for attractiveness via Amazon's Mechanical Turk (Bian et al., 2017). The datasheets were adapted to measure responses across two tasks and were in written format.

The intervention consisted of the participant being exposed to (i.e., being read to) a set of two short stories about female scientists who have changed the world. The stories were taken from "Science Wide Open: Women in Biology" and were designed to teach children about inspirational women who have changed the world with scientific discoveries (Wissinger, 2016). They included information such as, "Linda Buck won a Nobel Prize because she helped discover that nose cells have tiny message receivers called receptors. When different smells hit the receptors, the cells send messages to your brain. That is why, even if you closed your eyes, you could smell the difference between a flower and a dog" and

"Just look at Jane Cooke Wright! She was a doctor who saved many lives. She grew cells in dishes and then studied what different medicines did to the cells. The cells helped her figure out the best treatments to give her patients". At the end of the story, the participant completed a recall task whereby they were shown pictures of scientists from the book and asked questions about them and their discoveries (e.g. "this woman is really smart; can you remember what she discovered?"). If they failed to remember, then the experimenter showed them the relevant book page. This highlighted the gender of the scientist for the participant and reinforced the strong intellectual ability of these female scientists.

Procedure

At the beginning of the experiment, each participant was given a set of 12 screening questions that assessed whether they understood the key terms, 'smart' (6 questions) and 'nice' (6 questions). In each question, the experimenter described the behavior of a child without specifying gender (e.g., "the child in this picture can always answer the hardest questions" and "the child in this picture always shares their toys with other children"). The participant was then shown a picture of the child (a mixture of boys and girls were shown across the screening task) and asked "is this child smart, not smart, or are you not sure?" or "is the child nice, not nice, or are you not sure?". These questions were accompanied with pictures of emoticon faces to aid the child's response (e.g., "point to a smiling thumbs up emoji for Nice/Smart, a sad thumbs down emoji for Not Smart/Not Nice, and a confused scratching head emoji for Not Sure). Verbal (e.g., saying "smart") and non-verbal (e.g. the child pointed to the relevant emoticon) were deemed acceptable answers from the children. For each trait, (*smart* and *nice*), the participant had to answer 4 out of 6 questions correctly to be included in the experiment. Children were verbally corrected if they gave the incorrect answer. All participants met the inclusion criterion; therefore, all were included in the analysis.

The participants were allocated to one of two groups, Intervention or Control, with the use of a random number generator program. The Intervention group, prior to testing, were exposed to stories of ‘Women in Biology’ (Wissinger, 2016) and the related recall task, followed by the tasks that measured stereotypes. The Control group were not exposed to the women in science stories and only completed the stereotype tasks.

To assess gender stereotypes, each participant performed two tasks. Task 1 consisted of two stories (see Table 1) describing an unfamiliar person whose gender was unspecified. One story discussed ‘a really, really nice person’, and the other, ‘a really, really smart person’. Following each story, the participant was shown four pictures (2 male and 2 female models), in random order. These pictures were of new male and female models and did not include pictures of the female scientists from the story intervention. The participant was then asked which person (i.e., model) they thought might be the person described in the story about a ‘really, really nice’ or ‘really, really smart’ person. If the participant chose the picture of the female model (i.e., own-gender selection) they were allocated a score of 1; if they chose a picture of the male model (i.e., opposing-gender selection), they were allocated a score of 0.

INSERT TABLE 1 ABOUT HERE

Task 2 consisted of six trials. The first two trials were practice trials (no scores assigned) and involved evaluating pictures of two individuals of the same gender (i.e., two females or two males). These were carried out for two reasons: (1) to ensure the child understood the task, and (2) to disrupt pre-existing expectations or demand characteristics. The children were unaware these were practice trials. In the remaining four critical trials the participant was shown a picture of two individuals – 1 male and 1 female. The participant was told that one of the two people was ‘really, really smart’ (2 trials) or ‘really, really nice’

(2 trials). They were then asked which person they believed had the particular trait. The participant's responses were recorded per trial. They were scored a 1 if they chose the female individual as 'really, really smart' or 'really, really nice'; otherwise they were scored 0. Thus, there was a maximum score of 2 for 'smart' and 2 for 'nice'.

Task 1 and Task 2 scores were combined from each of the trials (i.e., one trial for Task 1 and two trials for Task 2 for each of the traits - 'smart' and 'nice') to create a single score for the 'smart' trait and a single score for the 'nice' trait. These scores were then coded for the purpose of analysis – if a participant selected a different gender (i.e., male) on 2/3 or 3/3 trials this was coded as a male response bias (i.e., selected the male more often as smart or nice). If they chose female on 2/3 or 3/3 trials this was coded as a female response bias (i.e., selected the female more often as smart or nice).

After all tasks were completed, the participant was thanked for their cooperation and received a detailed debriefing designed to give them an understanding of what gender stereotypes are and the effect they can have on a person's life (e.g., "a negative stereotype can make people believe that girls are not as smart as boys, or boys are not as nice as girls but this is not true. These stereotypes can make girls believe that being a doctor or a scientist is for boys"). The Control group were exposed to the intervention stories following completion of the experiment.

Data Analytic Plan

Two binary logistic regressions were used to assess whether a story-based intervention influenced gender stereotypes related to the intellectual ability and niceness of women.

Results

Intellectual Ability or 'Smart' stereotypes

A binary logistic regression was performed to ascertain whether learning about female scientists known for their intellectual brilliance significantly affected girls' stereotypes regarding females' intellectual ability. The regression model containing participant group as a predictor (b = 2.34, SE = .742) was significant, X^2 = 10.60, df = 1, p = .001. The model explained 31.1% (Nagelkerke R^2) of the variance in responses and correctly classified 75% of cases. The final model indicated that girls exposed to stories about intellectually brilliant female scientists were significantly more likely to choose their own gender as being 'really, really smart' or intellectually capable than the Control group, Wald = 9.06, df = 1, p = .003. In the Control group, only 20% of participants chose more females as smart, whereas in the Intervention group 70% of participants chose more females as smart. The Cox and Snell R-square was .233 indicating a moderate fit of the model to the data.

'Nice' stereotypes

A second binary logistic regression was conducted to assess whether the present intervention significantly affected girls' stereotypes regarding which gender is perceived as 'really, really nice'. The final model indicated a non-significant finding (b = 2.097, SE = 1.136) for nice stereotyping, Wald = 3.407, df = 1, p = .065. Across both groups, the majority of participants selected females more often as being 'really, really nice' (Intervention group: 95%; Control group: 70%). Therefore, girls who learn about women known for their intellectual brilliance were significantly more likely to choose their own gender as intellectually capable over their male counterparts; however, this did not appear to significantly effect stereotyping in relation to which gender is perceived as nice.

Discussion

The current study aimed to examine the utility of a brief story-based intervention to influence gendered stereotypes regarding intellectual ability or brilliance. Additionally, it assessed whether gendered stereotypes regarding ‘niceness’ were also influenced. The findings suggest that teaching young girls about women in STEM fields who are intellectually brilliant, can influence gender-intellect stereotypes in favor of females. More specifically, after exposure to stories about female scientists, girls were more likely to choose other females as ‘really, really smart’ over males. This is in contrast to the typical male-brilliance stereotype observed among both boys and girls at ages 6 and 7 (Bian et al., 2017). By exposing the participating girls to counter-stereotypical characters (female scientists), a positive relation between females and intellectual ability appeared to be reinforced. This furthers the literature (e.g., Ashby & Wittmaier, 1978; Karniol & Gal-Disegni, 2009; Steinke, 2017) by demonstrating that storytelling might be an effective strategy to influence gendered intellectual stereotypes among children, particularly young girls. This effect was found even with the presence of a male experimenter. Additionally, increased selections of females as smart did not appear to create a backlash effect whereby females were then deemed less likely to be nice. Across both groups, the majority of participants still selected females as ‘really, really nice’ over males. The current intervention was not designed to infleunce the ‘nice’ stereotype but this lack of effect is important to note as previous research has suggested that an individual who violates gender norms (e.g. an extrememly competent woman) may face backlash (Rudman, Moss-Racusin, Glick, & Phelan, 2012) and be perceived as less likeable (e.g., The Industry Gender Gap, 2016).

An examination of the Control group provided some insight into the gendered intellectual ability stereotypes of a UK sample of girls. As mentioned, this study adapted measures from the study by Bian and colleagues (2017) assessing male-brilliance stereotypes. Bian et al. (2017) utilized an American sample of children, therefore, it was important to determine whether similar stereotypes are held in the UK. This comparison is of interest as both the UK and the US are perceived as culturally similar, Western countries. Similar to

Bian et al.'s findings, girls aged 6-8 years old demonstrated stereotypes regarding academic brilliance in favor of males with 80% of the Control participants selecting males as 'really, really smart' over females. Cross-cultural studies assessing more culturally diverse children should be undertaken, however, to further our knowledge in this domain as sociocultural factors contribute to gender stereotypes (see Wood & Eagly, 2012).

Bandura, Barbaranelli, Vittorio Caprara, and Pastorelli (2001) suggest that exposing children to inspirational role models may boost self-efficacy. Traditional stereotypes may, therefore, contribute to boys' higher levels of self-efficacy and interest in math (O'Brien, Martinez-Pons, & Kopala, 1999), engineering (Marra, Rodgers, Shen, & Barbara, 2009) and general scientific fields (see Stoet & Geary, 2018), whilst girls are encouraged towards more social or communal roles (Eagly & Steffen, 1984; Miller et al., 2018). The current results indicate that showing female scientists in an inspirational light prompted girls to more often select their own sex when asked "who is really, really smart?" Greater belief in female intellectual ability may encourage more girls into STEM domains and increase STEM-related self-efficacy. An increase in female representation across STEM fields may help diversify stereotypes regarding who is most suitable for these careers (see Leslie et al., 2015) as stereotypes often portray people in STEM as geeky, lonely, boring and predominatly male (Hillman, Bloodsworth, Tilburg, Zeeman, & List, 2014). Providing girls with realistic examples of women in STEM celebrated for intellectual brilliance may help make STEM careers feel more attainable by increasing positive beliefs in females' intellectual ability. This may, in turn, enhance females' sense of belonging in these fields (e.g., Cheryan et al., 2015; Chestnut et al., 2018; Cimpian & Leslie, 2017; Master, Cheryan, & Meltzoff, 2016; Master, Cheryan, & Meltzoff, 2017).

Limitations & Future Directions

The present study suggests that teaching girls about intellectually brilliant women can influence stereotypical behavior (i.e., choice of who is smart between a male and a female), but this study is not without its limitations. First, the experiment was conducted in line with the assumption that female children hold negative stereotypes about female intellectual ability, as per the findings of Bian et al. (2017). Although a Control group was present which supported this, no baseline measurement was obtained for the Intervention group. It would be of interest to measure baseline stereotyping about intellectual ability and niceness to assess stereotype change more directly post-intervention. However, due to time constraints regarding access to the current sample, the present experiment relied on previous literature and a Control group as a proxy for a baseline measure.

Second, it is crucial to point out that our participants were recruited from an environment that places females in important roles such as principal, vice-principal and teachers. This exposure to women in dominant positions may facilitate greater receptiveness to messages about females' intellectual ability. Conversely, a dance and theatre arts company (from which participants were recruited) is arguably a stereotypical environment associating females with the Arts as opposed to STEM careers. The association between females and Arts subjects and males and STEM subjects is fairly robust within the literature (Nosek et al., 2009). The current intervention used stories about females in STEM to influence gendered stereotypes about intellectual ability. The significant impact, even within an environment that emphasizes the Arts, may speak to its effectiveness as a brief intervention. It is, however, important for future studies attempting to influence these negative stereotypes to recruit from a wider variety of sample groups, such as students from mixed-sex and single-sex schools.

As this was a pilot study the small sample size must be acknowledged as a limitation. Due to the time constraints and limited accessibility to participants, the sample did not meet the recommended size to represent the parameters in the intended population (Bujang, Sa'at,

& Bakar, 2018). Therefore, while our results appear to support the use of counter-stereotypical storytelling, replication of these results with a larger sample is critical to ensure these pilot study results generalize. It is important to note that as the tasks were adapted from Bian et al. (2017), and therefore shortened (i.e., not a direct replication), the present study used scores as opposed to proportion of responses utilized in the original Bian and colleagues study. This warrants future research to expand on these preliminary findings by analyzing data using averaged proportion of trials on which children associated intelligence with their own gender as an indicator of gender stereotypes. Also, as the study was conducted with female children only, we cannot draw conclusions about the effect this same intervention may have had on male children. For example, would male children have been more likely to select females as smart or would they have selected males at higher rates? This represents an interesting avenue for further research to gain a more nuanced picture of the utility of the current intervention. Furthermore, future researchers could examine whether any positive intervention effects hold over time by conducting a follow-up assessment (e.g., a one-month or six-month interval).

Moreover, further studies should examine whether exposure to these stories of brilliant female scientists increase girls' STEM interest and self-efficacy (e.g., Bandura et al., 2001; O'Brien et al., 1999; see also Ehrlinger & Dunning, 2003) as well as their beliefs around female intellectual ability. Researchers could utilize pre- and post-measures of these beliefs. It would be pertinent to examine whether there is a link between possible self-efficacy increase and negative gender stereotype reduction as Stout et al. (2011) reported that while female self-efficacy may be enhanced after exposure to same-gender scientist role models, negative gender stereotypes regarding females and STEM may still persist. Additionally, there is a suggestion that if a female role model's success seems too unattainable then they could actually have a negative effect, at least among older girls (Betz

& Sekaquaptewa, 2012). Therefore, influencing beliefs around female intellectual ability remains crucial to potentially aid the impact that successful female role models in STEM can have. Indeed, the present storytelling procedure could be combined with various interventions such as social group membership (Master et al., 2017), exposure to same-gender role models in person (Stout et al., 2011), or popular female scientist characters in the media (Steinke, 2017) to explore whether there are any additive or multiplicative effects such as increased engagement and self-efficacy with STEM subjects among young girls.

Future research could consider a broader range of response options rather than the forced-choice response option employed in this study. There is some indication that forced-choice response methodology might not be optimum for assessing gender stereotypes, particularly in younger children (e.g., Signorella, Bigler, & Liben, 1993). Finally, more robust evidence for the present study's findings would be provided by a larger sample size that could inferentially examine possible interaction effects between the smart and nice variable interventions. Indeed, recruitment of a larger sample would allow for a mixed effects logistic regression analysis to further examine stability and generalizability of the findings presented in the present work.

Practical Implications

As we have shown in this pilot study, young girls appear to benefit from learning about intellectually brilliant STEM women as positive relations between females and intellectual ability appeared enhanced after a brief story-based intervention. Therefore, the question must be raised – are scientific women fairly represented in current school curricula and media more broadly? Previous research suggests such representation is low (e.g., Brotman & Moore, 2008; Steinke, 2017). Current curricula may not intend to create an archetypal view of scientists, yet still it appears children are experiencing these stereotypes at key early stages. The use of storybooks to counter stereotypes shows promise and points to the importance of diverse exemplars and characters within children's stories. In the first instance, schools should consider the gender of key STEM figures that are taught at the level of primary or elementary school where gender stereotypes are already forming about intellectual ability.

Providing girls with realistic examples of women celebrated for intellectual brilliance may boost confidence in the classroom and perhaps extend to help make STEM careers feel exciting and attainable for girls. Educators must understand how they are portraying the subjects they are teaching. For example, does a child automatically perceive a brilliant scientist as male? Could a story about a brilliant female scientist (e.g., Marie Curie) create a different picture in this child's mind of who can be really smart and a scientist? It is plausible to suggest that our society repeatedly reinforces gender stereotypes that influence academic and career choices (Bian et al., 2017, 2018; Steinke, 2017), thus further insight regarding how one might counter these stereotypes may broaden the prospects of future generations.

Conclusion

Women remain starkly underrepresented in STEM fields. While personal choice must be considered (Ceci & Williams, 2011), it is important to ensure that career decisions are not being made on the basis of gender stereotypes about who is best suited or most able for these fields (see Master & Meltzoff, 2016; Leslie et al., 2015). As previous research supports the early development of gendered intellectual stereotypes (e.g., Bian et al., 2017), it is important to try and intervene against these stereotypes at an early age. The current findings from this study suggest that young girls' negative stereotypes regarding female intellectual ability can be influenced by a brief story-based intervention. This may increase their interest in domains such as STEM which are stereotyped as requiring academic brilliance. The present intervention shows promise as a fairly simple means by which parents and educators may help counter negative gender stereotypes with the aim to increase gender equality, particularly within STEM fields. Such interventions require further systematic examination with larger, more culturally and gender diverse samples to determine the generalizability and replicability of the current results. Additionally, it will be of interest to determine whether similar story-based interventions are as effective at countering other gender stereotypes among children, such as the appropriateness of stereotypically female domains (e.g., caring professions) for males, as these stereotypes may be more difficult to shift.

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Table 1

Stories Used to Measure Stereotypes in Task 1

	Trait: Smart	**Trait: Nice**
Stories about an adult:	There are lots of people at the place where I work. But there is one person who is really special. This person is really, really smart. This person figures out how to do things quickly and comes up with answers much faster and better than anyone else. This person is really, really smart.	There are lots of people at the place where I work. But there is one person who is really special. This person is really, really nice. This person likes to help others with their problems and is friendly to everyone at the office. This person is really, really nice.