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EMPIRICAL ARTICLE

CHILD DEVELOPMENT

How does caregiver–child conversation during a scientific storybook reading impact children's mindset beliefs and persistence?

Amanda S. Haber[1,2] | **Sona C. Kumar**[1,3] | **Kathryn A. Leech**[4] | **Kathleen H. Corriveau**[1]

[1]Boston University, Boston, Massachusetts, USA
[2]Fairfield University, Fairfield, Connecticut, USA
[3]Purdue University, West Lafayette, Indiana, USA
[4]The University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, USA

Correspondence
Amanda S. Haber, Fairfield University, 1073 North Benson Road, Fairfield, CT, USA.
Email: ahaber@fairfield.edu

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Abstract
This study explores how caregiver–child scientific conversation during storybook reading focusing on the challenges or achievements of famous female scientists impacts preschoolers' mindset, beliefs about success, and persistence. Caregiver–child dyads ($N=202$, 100 female, 35% non-White, aged 4–5, $f=.15$) were assigned to one of three storybook conditions, highlighting the female scientist's *achievements*, *effort*, or, in a *baseline* condition, neither. Children were asked about their mindset, presented with a persistence task, and asked about their understanding of effort and success. Findings demonstrate that storybooks highlighting *effort* are associated with growth mindset, attribution of success to hard work, and increased persistence. Caregiver language echoed language from the assigned storybook, showing the importance of reading storybooks emphasizing hard work.

From an early age, children's scientific conversations and shared storybook reading experiences with others convey more than just content: they also impact children's social inferences and send messages about the importance of hard work and effort in science, technology, engineering, and mathematics (STEM) (Haber et al., 2022; Leech et al., 2019, 2020; Miller-Goldwater et al., 2023; Rhodes et al., 2019, 2020). In turn, such interactions impact children's beliefs about themselves as learners, their ability to persist when they experience failure, and potentially their later identification and interest in pursuing a career in STEM. Drawing on a science identity lens, hearing about scientists who struggled on their path to achieving success may normalize failure as a part of this process and increase feelings of relatedness, especially for students who struggle to view themselves as STEM in-group members (Banchefsky et al., 2019; Dou et al., 2019; Gee, 2000; Hazari et al., 2010; Lin-Siegler et al., 2016). As a result, children conceptualize failure and hard work as a part of the process of achieving success (Haber et al., 2022; Lin-Siegler et al., 2016). The primary aim of this study was to explore how caregiver–child scientific discourse and storybooks focusing on the achievements or struggles of famous White or Black female scientists (Marie Curie, Katherine Johnson) impact preschoolers' mindset beliefs, understanding of effort in relation to success, and persistence when faced with a challenging task. Our focus on preschool age children is aligned with recent national efforts recognizing the significance of the preschool years as a time to encourage the development of life-long positive beliefs about STEM that could lead to higher engagement in the STEM workforce (Building Blocks of STEM Act, 2019).

Subtle differences in adult language impact children's persistence, engagement, and beliefs about intelligence in STEM

A growing body of research demonstrates that differences in language from adults have the potential to reinforce gender and race stereotypes such as “innate brilliance” that are often attributed to White men (e.g., Bian et al., 2017; Cvencek et al., 2011; Dickhäuser

Abbreviations: CHILDES, child language data exchange system; STEM, science, technology, engineering, and mathematics.

& Meyer, 2006; Jones et al., 2000; Rhodes et al., 2020). In turn, such brilliance stereotypes affect beliefs about ability (e.g., viewing girls as having poorer scientific skills) and sense of belongingness in science (e.g., viewing women as part of the outgroup), which impact the development of a STEM identity during early childhood, science achievement during formal schooling (Leibham et al., 2013) and decisions to pursue a career in science (e.g., Banchefsky et al., 2019; Cheryan et al., 2015; Master, 2021; Tiedemann, 2000).

Some research has found variability in adult talk about scientific and mathematical concepts by child gender (Crowley et al., 2001; Tenenbaum & Leaper, 2003). For example, by 18 months, caregivers talk more to boys about math concepts than girls (Leech et al., 2022). Further, caregivers are more likely to provide scientific explanations to boys rather than girls in early (Crowley et al., 2001; Tenenbaum et al., 2005) and middle childhood (Tenenbaum & Leaper, 2003). During school, caregivers may also have lower expectations for their daughters' math and science skills, as compared to their sons (e.g., children aged 8–9; Stout et al., 2011; Tiedemann, 2000), based on the belief that science is more difficult and less interesting (children aged 10–13; Tenenbaum & Leaper, 2003). Accordingly, language input from caregivers may be one way in which children receive different messages about who should participate in STEM.

Second, recent research demonstrates that subtle language cues in scientific conversations with children may influence their beliefs about themselves as learners, their interest in science activities in formal schooling, or their later motivation to pursue careers in STEM (Niu, 2017; Rhodes et al., 2019, 2020). For example, 4-year-old girls, but not boys, are likely to persist longer at a scientific task if they are told they are "doing science" instead of "being scientists" (Rhodes et al., 2019, 2020). Girls' persistence on such scientific tasks is often attributed to sensitivity of linguistic cues ("doing" vs. "being") that involve more inclusive representations, which in turn, increases their engagement and sense of belonging in STEM. Further, 6-year-old girls are more likely to choose a game for people who "work really hard" (emphasizing effort) rather than a game for people who are "really smart" (highlighting brilliance) and avoid activities that are for "really smart" children (Bian et al., 2017).

Thematic differences in a scientific storybook about famous scientists impact achievement and persistence in STEM

In addition to language cues, thematic differences in a story about a famous scientist's struggles (as compared to emphasizing achievement without any mention of failure) were associated with enhanced performance in high school science classes (Lin-Siegler et al., 2016). Further, high school students who read storybooks that focused on failure and challenges reported higher levels of connectedness to the scientists and demonstrated higher levels of motivation in science classes, compared to students who read about the scientist's achievements without any mention of setbacks. More recently, Haber et al. (2022) adapted this paradigm to explore the impact of storybooks including language about failure and success on preschool children's persistence on a challenging task and their beliefs about motivation. Preschoolers (aged 4–5) were either assigned to read a book about a scientist who struggled or faced no setbacks prior to achieving success. To explore the impact of the book on persistence, children were presented with an impossible task, where they were told to find the differences between two identical pictures. The results indicated that children who had read the book including struggles persisted longer on the impossible task than children who read the book containing only success. There was no impact of bookreading on children's mastery motivation beliefs.

The findings from Haber et al. (2022) highlight how thematic differences in a storybook about scientific struggles enhance children's persistence during a challenging task. Nevertheless, several open questions remain. First, the stories used draw on the personal narratives of either White males (Albert Einstein, Michael Faraday) or female scientists. Focusing on these individuals, especially White male scientists, may send messages to students about "who can be a scientist," reinforcing gender and racial brilliance stereotypes. In the current study, we focus on the personal narratives of one White and one Black female scientist: Marie Curie and Katherine Johnson. We chose these scientists in an effort to utilize an intersectional framework, recognizing that Black women might be perceived differently than White women in STEM contexts (e.g., Crenshaw, 1990; Jaxon et al., 2019; Lei & Rhodes, 2021). Additionally, highlighting the success of individuals in STEM who reflect groups that are often unrepresented in STEM fields diversifies the image of who can be a successful scientist for young children. In turn, this may impact children's later identification with STEM.

Second, an open question from this work is why the thematic language cues in the storybook did not impact children's beliefs about persisting when faced with a difficult task (mastery motivation beliefs). We reasoned that changes in persistence beliefs might require systematic exposure to language emphasizing hard work and effort via storybooks coupled with caregiver–child discourse to impact children's beliefs about intelligence and effort in STEM. Accordingly, we extend Haber et al. (2022) to examine how caregiver–child conversation during the bookreading session may impact children's mindset beliefs, understanding of effort in relation to success in STEM, and their persistence when faced with a challenging task.

We focus on children's mindset beliefs, or beliefs about whether intelligence is malleable and can develop over time (growth mindset) or an unchangeable trait (fixed mindset; Dweck, 2006; Dweck & Leggett, 1988). Such intelligence beliefs are associated with students' academic motivation, achievement or GPAs, and engagement during formal schooling (Blackwell et al., 2007; Mangels et al., 2006): Students who endorse more of a growth mindset demonstrate higher academic performance in courses (Claro et al., 2016). Such work posits that individuals' mindsets impact their *achievement goals* (endorsing a growth mindset is associated with choosing tasks that focus on learning goals vs. performance goals, which emphasize intelligence) and *responses when faced with challenges in achievement contexts* (endorsing a growth mindset is associated with persistence through failure rather than withdrawing from the activity or class; e.g., Blackwell et al., 2007; Claro et al., 2016; Dweck, 1999; Muradoglu et al., 2022). Within the science domain, middle- and high-school students' growth mindset is associated with superior science and math performance and overall interest in pursuing a career in STEM (Blackwell et al., 2007; Wonch Hill et al., 2017). Importantly, to the best of our knowledge, little research has explored these relations during the preschool years.

The current study

Although young children's interest and motivation in STEM are impacted by language from adults (Bian et al., 2017; Rhodes et al., 2019, 2020), little is known about how caregiver–child conversations during a scientific storybook intervention may impact preschoolers' mindset beliefs in the science domain, prior to the onset of formal schooling. In the current study, we argue that two forms of input are needed to impact children's mindset beliefs and understanding of effort in relation to success in the science domain: *storybooks* (text that emphasizes hard work rather than intelligence) and *caregiver–child talk*. Children often acquire knowledge through conversations (Harris et al., 2018; Kurkul & Corriveau, 2018). This is especially true for topics that cannot be learned through firsthand experience alone (e.g., electricity, Harris & Corriveau, 2014; Leech et al., 2020). It is plausible that failure, like other unobservable processes, might require testimony from others to understand its role in achieving success. This hypothesis draws on a social interactionist framework and stems from prior work (e.g., Callanan et al., 2020; Leech et al., 2020) demonstrating that social interaction is a critical process by which caregivers shape children's early science learning. Indeed, recent work (Miller-Goldwater et al., 2023) suggests that caregivers' extratextual talk during a narrative science storybook interaction with 4-to-5-year-olds predicted children's science learning. Further, findings from Leech et al. (2020) suggest that simply reading books that contain more mechanistic explanations might not be enough for children (aged 4–5) to fully comprehend the mechanism underlying scientific concepts like electricity. Rather, it is the exposure to the language from the storybook coupled with the scientific caregiver–child discourse that can teach children about more complex processes.

Thus, our primary goal was to explore how caregiver–child discourse during scientific storybook reading focusing on the achievements or struggles of female scientists impacts mindset beliefs, understanding of effort in relation to success in the science domain, and persistence when faced with a challenging task. We designed two sets (Marie Curie, Katherine Johnson) of three storybooks. Caregiver–child dyads were assigned to one of three conditions (adapted from Haber et al., 2022): *achievement* (focuses on the scientist's success without any mention of failure), *effort* (focuses on the scientist's challenges on the path to achieving success), and *baseline* (does not highlight hard work or achievement). We examined how the storybook condition and caregiver–child discourse impacted children's persistence, mindset beliefs, and their understanding of effort in relation to success in STEM.

Research questions and hypotheses

We had two main research questions. First, how does caregiver–child talk about effort, brilliance, feelings of relatedness and emotion differ by storybook condition? We hypothesized that in the *effort condition*, caregiver–child dyads will spend more time talking about effort and hard work, whereas dyads in the *achievement condition* will spend more time talking about brilliance. We also coded for caregiver–child talk that focused on feelings of relatedness, or personal connections between the child and the story (e.g., *This is like when you tried really hard to learn how to do the monkey bars even though you kept falling down at first*.). When children learn from storybooks (e.g., reading *Pinocchio*), they often adopt the main character's traits, which in turn, can impact their behavior (Dore et al., 2017; Lee et al., 2014). We targeted feelings of relatedness and emotion talk because we viewed such language as a potential mechanism for increasing engagement in science and greater persistence during challenging tasks. This hypothesis is also in line with prior work (Haber et al., 2022; Lin-Siegler et al., 2016), which has argued that hearing about scientists who struggle increases children's feelings of relatedness to the scientists in the story. Additionally, we were particularly interested in dyadic talk related to emotion (e.g., *Marie Curie was really sad when her experiment failed*) to explore how scientific storybooks may create opportunities to engage in social–emotional learning within the science domain. Indeed, the scientific method is grounded in the idea that scientists engage in a process of experimentation in which they test theories and conduct experiments that often do not support their original idea. A critical component of this success is that scientists continue to try in the face of challenges, which may elicit feelings of sadness, frustration, and anger. Therefore, we would anticipate dyads engaging in more emotion talk in the *effort* condition because focusing on the mistakes and failed experiments along the process toward ultimately achieving success creates more opportunities to engage in conversation targeting such feelings.

Second, how does the storybook manipulation impact children's (a) mindset beliefs, (b) persistence on a challenging task, and (c) understanding of effort in relation to success in the science domain? To examine differences in mindset beliefs (question 2a), we investigated if children are more likely to endorse more of a fixed or a growth mindset after reading a storybook about a scientist's struggles (or achievements). We predicted that children in the *achievement* condition would be more likely to endorse a fixed mindset because the story focuses on innate brilliance. In contrast, we predicted that children in the *effort* condition would be more likely to endorse a growth mindset because they will focus on intelligence as something malleable.

For part (2b), we expected to replicate the original Haber et al. (2022) findings that children in the *effort* condition persist longer on the challenging task than children in the *achievement* condition. For part (2c), we explored if children are more likely to attribute a scientist's award to brilliance (being smart) or effort (working hard) following the reading interaction. We predicted that children assigned to the *effort* condition will be more likely to attribute success to effort (hard work), whereas children assigned to the *achievement* condition will be more likely to attribute success to brilliance (being smart).

Please note that this study is not a purely confirmatory or exploratory study. Our hypotheses are not preregistered, however, they are grounded in prior literature.

METHOD

Participants

Two hundred and thirty-three caregiver–child dyads participated on Zoom from across the United States. We aimed to recruit approximately 180 participants, 30 caregiver–child dyads per condition for two scientists: Marie Curie and Katherine Johnson. A priori analyses conducted using G*power (Faul et al., 2007) indicated that we needed at least 146 children (power = .95) to detect a small effect size (f = .15). Informed consent was obtained according to the Institutional Review Board. Of the 233 caregiver–child dyads, we excluded 31 dyads (n = 6 dyads for the child not speaking English; n = 12 dyads for the child being distracted during the study (e.g., child was playing with toys, watching television); n = 7 for the caregiver interfering with the persistence task (e.g., caregiver tried to help look for differences between the pictures); n = 3 for technology issues (e.g., Zoom did not work); and n = 3 dyads for the child being outside of the age range). The final sample included 202 dyads (children aged 4–5; M_{age} = 59.61 months, SD = 6.89 months; 100 girls).

As illustrated in Table 1, over 35% of children were non-White (note 4.5% (n = 9) of caregivers did not report their child's race). Table 2 includes the demographic information for caregivers (189 = female; 11 = male) including the highest education level achieved as well as income level. Ninety-two percent of caregivers received at least a 4-year college degree and 64.9% reported an annual income level of greater than $100,000. Additionally, 40% (n = 81) of caregivers self-identified as working in a STEM field.

Procedure

Dyads were recruited to participate on Zoom through a laboratory database, public advertisements on social media, and local schools in Northeastern cities in the United States.

Based on Haber et al. (2022), we randomly assigned caregiver–child dyads to read a book about a female scientist (Marie Curie, n = 99; see Supporting Information 1a or Katherine Johnson, n = 103; see Supporting Information; storybook protagonist 1b in one of three storybook reading conditions) (see Table 3): *Achievement* (achieves success without failure; n = 67), *effort* (faces failures along the path to achieving success; n = 69), and *baseline* (no emphasis on effort or achievement; n = 66). Child age and gender were balanced across the three conditions. See Supporting Information (2) for a table displaying children's race and ethnicity according to story protagonist (i.e., Marie Curie or Katherine Johnson). All dyads received a $15 gift card for their

TABLE 1 Children's race and ethnicity (as reported by caregivers).

Race and ethnicity	Number (percent of total sample)
Asian	23 (11.4)
American Indian	1 (0.5)
Brazilian American	1 (0.5)
Black	3 (1.5)
Greek	1 (0.5)
Hispanic	4 (2)
Middle Eastern and North African	1 (0.5)
Mixed race	34 (16.8)
Southern Asian or Indian	2 (.99)
White	122 (60.3)
Not reported	10 (5)

TABLE 2 Caregiver demographic information (highest education level achieved, income).

	Demographic characteristics	Number (percent of sample)
Education level	High school or general education diploma	3 (1.49)
	Some college	7 (3.5)
	Associate's	6 (2.97)
	Bachelor's	51 (25.2)
	Master's	97 (48.0)
	Professional degree or doctorate	30 (14.9)
	Not reported	8 (3.96)
Income	Under $25,000	5 (2.6)
	$25,000–$50,000	9 (4.7)
	$50,000–$74,999	8 (4.2)
	$75,000–$99,000	13 (6.8)
	$100,000–$149,000	36 (18.8)
	$150,000–$199,000	33 (17.3)
	$200,000–$249,000	27 (14.1)
	$250,000–$299,000	17 (8.9)
	Over $300,000	11 (5.8)
	Not reported	43 (22.5)

TABLE 3 Count of caregiver–child dyads by storybook condition (achievement, effort, baseline) and storybook protagonist (Marie Curie, Katherine Johnson).

Condition	Storybook protagonist	Count
Achievement (n=67)	Marie Curie	33
	Katherine Johnson	34
Effort (n=69)	Marie Curie	34
	Katherine Johnson	35
Baseline (n=66)	Marie Curie	32
	Katherine Johnson	34
Total sample		202

participation. Data were collected between October 2021 and April 2022.

The study included five phases presented in a fixed order: *caregiver–child storybook, child mindset beliefs, child persistence task*, *child effort explanation*, and *caregiver reports*. All sessions were video-recorded and lasted approximately 10 min.

Storybook reading

For the *storybook reading session*, caregiver–child dyads read their condition-specific storybook. The experimenter sent the dyad an electronic version of the book via Zoom and asked them to read the story just like they would normally read a book together at home. No time limit was given. Two sets of three researcher-developed books contained one of two female scientist protagonists: Marie Curie or Katherine Johnson. We utilized two of the storybooks (*achievement and effort* conditions) about Marie Curie from Haber et al. (2022). A third book was developed for the *baseline* condition. Additionally, three new storybooks were created for Katherine Johnson. All books were eight pages long and were matched on story length (number of words: 130; see Supporting Information 3 for full text). In addition, the first, second, and final pages of the story were identical. The critical difference between the three storybook conditions is the emphasis on challenges (*effort* story), achievement without any setbacks (*achievement* story), or a story that does not highlight achievement or failure (*baseline* story).

For example, in the *achievement* condition, caregiver–child dyads read, *People believe that she was a genius. In 2010, Time Magazine named Curie one of the most powerful women of the century*. In the *effort* condition, caregiver–child dyads read, *She worked really hard and focused on solving challenging problems and learning from her mistakes*. In the *baseline* condition, caregiver–child dyads read facts about Marie Curie's life that did not emphasize achievement or failure, for example, *Curie's mom and dad were both teachers. Curie's mom ran a boarding school for girls in Poland. Curie's dad taught math and physics in school*.

Storybook reading measures

First, we calculated the amount of time (number of seconds) dyads spent engaging with the storybook. Second, we analyzed the caregiver–child dyadic talk during the storybook reading session. Consistent with prior work (Leech et al., 2020), sessions were transcribed at the utterance level by two trained research assistants according to the conventions of the child language data exchange system (CHILDES; MacWhinney, 2000). Next, transcripts were verified for accuracy by another trained research assistant. Finally, as depicted in Table 4, transcripts were coded for utterances that referenced language focusing on brilliance (talk about being really smart), effort (talk about working hard, making mistakes), feelings of relatedness (talk that includes connections between the scientist and a child's personal experiences), and emotion (talk that focuses on the feelings of the scientist). Note that utterances that were verbatim text from the storybook were not coded. All utterances that fell into each of these categories were summed to create a total individual measure for brilliance, effort, feelings of relatedness, and emotion talk. Drawing on a social interactionist framework and prior work (Leech et al., 2020), total language measures included both caregiver and child language. Approximately 75% of the utterances were produced by caregivers. Because parent and child language are highly correlated and because children's

TABLE 4 Coding scheme for caregiver–child talk during the storybook reading session.

Language code	Definition	Examples
Brilliance talk	Language that focuses on innate intelligence (e.g., being smart) and knowledge or expertise about science, technology, engineering, and mathematics	• "She is a genius" • "She is really smart" • "She knows a lot about science"
Effort talk	Language that focuses on the process of success (emphasizing making mistakes, facing challenges along the path to learning something new)	• "Some people make mistakes" • "It is important to keep trying" • "After it didn't work, she kept trying and learned from her mistakes"
Feelings of relatedness talk	Language that focuses on connections between the child (past experiences) and the scientist in the story	• "This is like when you tried really hard to learn how to do the monkey bars even though you kept failing at first" • "This scientist makes mistakes just like when you are learning something new"
Emotion talk	Language that focuses on the feelings or emotions of the scientist in the story	• "She looks really sad" • "How do you think she is feeling?"

language was relatively infrequent (less than 25% of total utterances), we combined both speaking partners' input together. Nevertheless, to ensure results were not driven by one speaking partner, we reran analyses with only caregiver language, yielding similar results (see Supporting Information 6 for caregiver-only language analyses). In line with prior work (e.g., Kurkul & Corriveau, 2018; Leech et al., 2020), the first author and a trained research assistant randomly coded 17.33% of the transcripts (κ = .92). Disagreements were resolved through discussions.

Child mindset beliefs

Following the storybook reading session, the experimenter asked the child a question, adapted from Bempechat et al. (1991) aimed at understanding their beliefs about intelligence.

Specifically, the experimenter asked, "Some kids say you can get smarter and smarter all the time (*growth mindset*). Other kids say that how smart you are stays pretty much the same (*fixed mindset*). Which kids do you agree with?" The question was repeated twice to ensure that children understood the question. In addition, the experimenter also asked the child to justify their response. The experimenter said, "Why do you think you can get smarter and smarter all the time (how smart you are stays pretty much the same)?" Responses were given a 0 for *Fixed Mindset* and a 1 for *Growth Mindset*. We developed a coding scheme for children's justification responses based on patterns and themes in the data (see Supporting Information 4 for full coding scheme). The main codes included references to *knowledge* (e.g., "because you get smarter"), *effort or growth* (e.g., "because I learn from my mistakes"), adult source of information (e.g., "because I listen to my mommy"), school (e.g., "I learn things in school"), and curiosity, (e.g., "because you keep asking questions"). We also included codes for responses that included "I don't know," or irrelevant information.

Child persistence

Children were presented with an impossible task (e.g., Pitcairn & Wishaart, 1994) of two identical pictures of Snap Circuits © (see Haber et al., 2022). The experimenter said, "I am going to show you two pictures of Snap Circuits ©. Your job is to find the differences between the two pictures. When you are done looking for differences, let me know." No time limit was given.

We calculated the number of seconds children spent looking for differences.

Effort explanation task

To examine children's beliefs about whether they attribute effort or brilliance to success the experimenter asked, "A scientist won an award for a new science invention. Do you think the scientist is smart or hardworking?" Children were also invited to justify their beliefs. Responses were scored a 0 for *Smart* and a 1 for *Hard-Working*.

RESULTS

Preliminary analyses and overview

First, we examined differences in family demographic characteristics between the three conditions. There were no significant differences in caregiver education (p = .62) or STEM occupational status (p = .44) by storybook condition. Further, no significant differences emerged in reading narrative ($\chi^2(n = 202, df = 3) = 7.29$, p = .12; n = 158 caregivers reported reading narrative books *daily*,

$n = 40$ *once or twice a week*, $n = 3$ *once or twice a month* and $n = 0$ *hardly ever*) or informational books ($\chi^2(n = 202, df = 3) = 7.01$, $p = .32$; $n = 38$ caregivers reported reading informational books *daily*, $n = 97$ *once or twice a week*, $n = 52$ *once or twice a month* and $n = 14$ *hardly ever*) by storybook condition.

Caregiver–child talk

Recall that our first research question focused on differences in caregiver–child talk by storybook condition. We approached this by first examining the overall time caregiver–child dyads spent engaging with the storybook. On average, dyads spent 131.82 s (SD = 59.94 s). Caregiver–child dyads in the *achievement* condition ($M = 145.43$, SD = 68.84 s) spent significantly more time engaging with the storybook than dyads in the *effort* condition ($M = 122.39$, SD = 46.57 s, $\beta = -23.04$, SE = 9.49, $p = .02$). There was no significant difference in time engaging with the storybook between dyads in the *achievement* and *baseline* conditions ($M = 127.85$, SD = 47.8 s, $\beta = -17.58$, SE = 9.6, $p = .07$) or *baseline* and *effort* conditions ($\beta = -5.46$, SE = 9.52, $p = .57$).

Next, we explored differences in dyads' overall talk during the storybook. Collapsing across the three storybook conditions (*achievement*, *effort*, and *baseline*), dyads produced an average of 25.12 (SD = 24.55, range = 0–127) total extratextual utterances (language that was not verbatim text). Dyads in the *achievement* condition ($M = 30.67$, SD = 29.15, range = 1–127) produced more utterances than dyads in the *baseline* condition ($M = 20.45$, SD = 20.02, range = 0–91, $\beta = 10.22$, SE = 4.22, $p = .02$). There were no significant differences between the *achievement* and *effort* conditions ($M = 24.2$, SD = 22.83, range = 0–110; $\beta = -6.47$, SE = 4.17, $p = .12$) or *baseline* and *effort* conditions ($\beta = -3.75$, SE = 4.19, $p = .37$).

We then examined potential differences in the total talk for each of the four categories (brilliance, effort, feelings of relatedness, emotion). Of the total utterances ($n = 5075$) produced by dyads, 2.05% ($n = 104$; $M = 0.51$, SD = 1.62, range = 0–11) were coded as brilliance talk, 3.3% ($n = 167$, $M = 0.83$, SD = 3.3, range = 0–36) were coded as effort talk, 9.83% ($n = 499$, $M = 2.47$, SD = 4.77, range = 0–27) were coded as feelings of relatedness talk and 2.78% ($n = 141$, $M = 0.70$, SD = 1.93, range = 0–13) were coded as emotion talk. The majority of caregivers and children also discussed other elements of the story such as identifying items in pictures or counting the number of objects on a page, which were outside the scope of the current study.

As illustrated in Figure 1, whereas 92% of total utterances related to brilliance talk were produced by dyads in the *achievement* condition, 96.4% of total utterances related to effort talk were produced by dyads in the *effort* condition. Interestingly, emotion talk was only found in

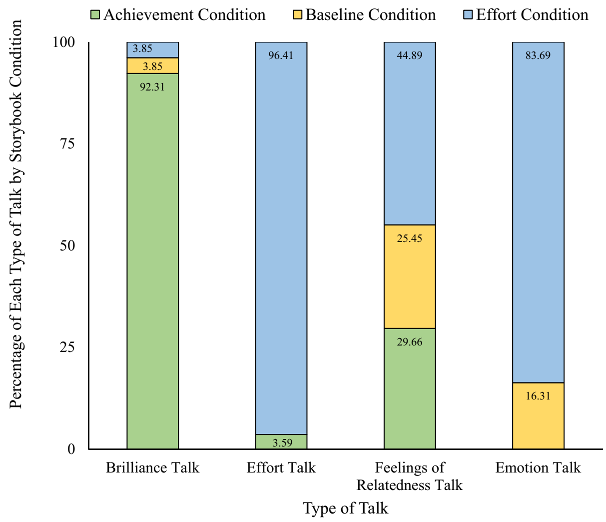

FIGURE 1 Total talk for each of the four language categories by storybook condition.

the *effort* (83.7% of total emotion talk) and *baseline* (16.3% of total emotion talk) conditions. Finally, approximately 45% of overall feelings of relatedness talk was produced in the *effort* condition, compared to 29.7% in the *achievement* condition and 25.5% in the *baseline* condition. All formal language-level analyses were calculated based on the proportion of each type of talk by storybook condition; the results hold when analyzing raw utterances.

To determine differences in talk by condition, we ran four generalized linear models assuming a linear response with two fixed effects: Storybook condition (*achievement*, *effort*, and *baseline*) and storybook protagonist (*Marie Curie*, *Katherine Johnson*) and proportion of talk (*effort*, *brilliance*, *feelings of relatedness*, and *emotion*) as the response variable.

Brilliance talk

The average proportion of brilliance talk was .01 (1%, SD = 0.07), with an average of .04 (4%, SD = 0.07) in the *achievement* condition, .002 (0.2%, SD = 0.01) in the *effort* condition, and .001 (0.1%, SD = 0.01) in the *baseline* condition. A significant difference by storybook condition emerged: dyads in the *achievement* condition produced more brilliance talk than dyads in the *effort* ($\beta = -0.04$, SE = 0.01, $p < .001$) or *baseline* conditions ($\beta = -0.04$, SE = 0.01, $p < .001$; see Table 5). There was no significant difference between the *effort* and *baseline* conditions ($\beta = 0.00$, SE = 0.00, $p = .97$). Further, there was no significant difference by storybook protagonist ($\beta = -0.001$, SE = 0.01, $p = .74$).

Effort talk

The average proportion of effort talk was .02 (2%, SD = 0.06), with an average of .002 (0.02%, SD = 0.01) in the *achievement* condition and .05 (5%, SD = 0.09) in the *effort* condition, and no utterances related to effort talk in the *baseline* condition. A significant difference in the proportion of effort talk by storybook condition emerged: dyads in the *effort* condition produced more effort talk than dyads in the *achievement* ($\beta=0.05$, SE = 0.01, $p<.001$) and *baseline* conditions ($\beta=0.05$, SE = 0.01, $p<.001$; see Table 6). Note there was no significant difference in the proportion of effort talk between the *achievement* and *baseline* conditions ($\beta=0.00$, SE = 0.01, $p=.81$). Further, dyads who read storybooks about Marie Curie ($M=0.03$, SD = 0.08) produced more effort talk than dyads who read storybooks about Katherine Johnson ($M=.005$, SD = 0.03, $\beta=-0.03$, SE = 0.01, $p<.001$).

Feelings of relatedness talk

The average proportion of feelings of relatedness talk was .07 (7%, SD = 0.13), with an average of .05 (5%, SD = 0.10) in the *achievement* condition, .10 (10%, SD = 0.14) in the *effort* condition, and .07 (7%, SD = 0.13) in the *baseline* condition. A significant difference in the proportion of feelings of relatedness talk by storybook condition developed: dyads in the *effort* condition produced more feelings of relatedness talk than dyads in the *achievement* condition ($\beta=0.05$, SE = 0.02, $p=.03$; see Table 7). There was no significant difference in the proportion of feelings of relatedness talk between the *effort* and *baseline* conditions ($\beta=0.03$, SE = 0.02, $p=.21$) or *baseline* and *achievement* conditions ($\beta=0.02$, SE = 0.02, $p=.36$). Further, there was no significant difference in feelings of relatedness talk by dyads who read books about Marie Curie ($M=0.07$, SD = 0.11) or Katherine Johnson ($M=0.08$, SD = 0.14, $\beta=0.01$, SE = 0.02, $p=.51$).

Emotion talk

The average proportion of emotion talk was .02 (2%, SD = 0.07), with no utterances related to emotion talk in the *achievement* condition, .06 (6%, SD = 0.09) in the *effort* condition, and .02 (2%, SD = 0.07) in the *baseline* condition. A significant difference in the proportion of rmotion talk by storybook condition emerged: dyads in the *effort* condition produced more emotion talk than dyads in the *achievement* ($\beta=0.06$, SE = 0.01, $p<.001$; see Table 8) and *baseline* conditions ($\beta=0.04$, SE = 0.01, $p<.001$). There was no significant difference in emotion talk between the *achievement* and *baseline* conditions ($\beta=0.02$, SE = 0.01, $p=.16$). Also, there was no significant difference in emotion talk by dyads who read books about Marie Curie ($M=0.02$, SD = 0.06) or Katherine Johnson ($M=0.03$, SD = 0.07, $\beta=0.003$, SE = 0.01, $p=.73$).

Taken together, there are three critical language-level findings. First, dyads in the *achievement* condition produced more brilliance talk than dyads in the *effort* and *baseline* conditions. Second, families in the *effort* condition produced more effort and emotion talk than dyads in the *achievement* and *baseline* conditions. Third, families in

TABLE 5 Differences in proportion of brilliance talk by storybook condition.

Variable	Proportion of brilliance talk model: Coefficient	SE	t	p
Intercept (achievement)	.04	.01	6.36	<.001***
Intercept (baseline)	.00	.00	0.01	1
Condition: effort versus achievement	−.04	.01	−5.14	<.001***
Condition: baseline versus achievement	−.04	.01	−5.19	<.001***
Condition: effort versus baseline	.00	.00	0.09	.97
Storybook protagonist (Curie vs. Johnson)	−.001	.01	0.33	.74

$^{\dagger}p<.10$; $^{*}p<.05$; $^{**}p<.01$; $^{***}p<.001$.

TABLE 6 Differences in proportion of effort talk by storybook condition.

Variable	Proportion of effort talk model: Coefficient	SE	t	p
Intercept (achievement)	.02	.01	2.22	.03*
Intercept (baseline)	.02	.01	1.95	.05*
Condition: effort versus achievement	.05	.01	5.54	<.001***
Condition: baseline versus achievement	.00	.01	−0.24	.81
Condition: effort versus baseline	.05	.01	5.81	<.001***
Storybook protagonist (Curie vs. Johnson)	−.03	.01	−3.83	<.001***

$^{\dagger}p<.10$; $^{*}p<.05$; $^{**}p<.01$; $^{***}p<.001$.

the *effort* condition produced more feelings of relatedness talk than dyads in the *achievement* condition.

Child-level measures

Recall that our second research question focused on the impact of the storybook on child-level outcomes. We first explored children's mindset beliefs. Collapsing across conditions, 66.83% (n=135) of children endorsed a growth mindset and 33.17% (n=67) endorsed a fixed mindset. Preliminary analyses indicated no significant differences by storybook protagonist: (Curie (70%) vs. Johnson (63%, $\chi^2(1)=0.08$, $p=.77$)) or child gender (Female (50.37%) vs. Male (49.62%, $\chi^2(1)=0.02$, $p=.88$)).

To determine if children are more likely to hold more of a growth mindset after reading a storybook about a scientist's struggles, we ran a generalized liner model assuming a binary logistic response with storybook condition (*achievement*, *effort*, and *baseline*) as the fixed effect and children's mindset response as the dependent variable. Because children's mindset scores did not significantly differ by story protagonist or child gender, those predictors were not included. Children in the *effort* condition were 3.38 times more likely to endorse a growth mindset than children in the *achievement* condition (80% vs. 53%, $\beta=1.22$, SE=0.39, $p=.001$, see Figure 2). Children in the *effort* condition were 1.96 times more likely to endorse a growth mindset, compared to children in the *baseline* condition (66%, $\beta=0.68$, SE=0.40, $p=.08$).

Further, we also coded children's justification for their mindset responses (see Supporting Information 4 & 5). Overall, 27.22% of justifications referenced *effort* or *growth*, 11.34% referenced *knowledge*, 5.45% referenced School, 2.48% referenced an *adult source of information*, 1.5% referenced *curiosity*, 10.40% of justifications were classified as *other* (did not fall into the above categories), 20.79% said *I Don't Know*, 2.97% were *irrelevant*, and 17.82% did not respond. Children who endorse a growth mindset were more likely to justify their responses by *effort or growth*, as compared to children who endorse a fixed mindset (38.52% vs. 4.48%, $\chi^2(8)=47.76$, $p<.001$; see Supporting Information 5).

Next, we explored the impact of storybook on children's persistence on an impossible task. Children persisted for an average of 48.61 s (SD=31.81 s). We ran a generalized linear model assuming a linear response with one fixed effect of storybook condition and persistence (time in seconds) as the response variable. Because persistence did not significantly differ by story protagonist or child gender, those predictors were not included. As illustrated in Figure 3, children in the *effort* condition (M=63.88 s, SD=37.02) persisted for longer than children in the *achievement* (M=37.66 s, SD=24.58, $\beta=26.23$, SE=5.13, $p<.001$), or the *baseline* conditions (M=43.77 s, SD=26.19, $\beta=20.11$, SE=5.14, $p<.001$). There was no significant difference in persistence between children in the *achievement* and *baseline* conditions ($\beta=6.12$, SE=5.18, $p=.24$).

Finally, we investigated the impact of storybook on children's attribution of success to brilliance (being smart) or effort (working hard). Overall, 54.9% (n=111) of children attributed the scientist's success to effort. We conducted a generalized linear model assuming a binary logistic response with one fixed effect of storybook condition (*achievement*, *effort*, and *baseline*) and children's effort explanation task response as the

TABLE 7 Differences in proportion of feelings of relatedness talk by storybook condition.

	Proportion of feelings of relatedness talk model			
Variable	**Coefficient**	**SE**	***t***	***p***
Intercept (achievement)	.04	.02	2.51	.01*
Intercept (baseline)	.06	.02	3.62	<.001***
Condition: effort versus achievement	.05	.02	2.12	.03*
Condition: baseline versus achievement	.02	.02	0.92	.36
Condition: effort versus baseline	.03	.02	1.26	.21
Storybook protagonist (Curie vs. Johnson)	.01	.02	0.66	.51

†$p<.10$; *$p<.05$; **$p<.01$; ***$p<.001$.

TABLE 8 Differences in proportion of emotion talk by storybook condition.

	Proportion of emotion talk model			
Variable	**Coefficient**	**SE**	***t***	***p***
Intercept (achievement)	−.00	.01	−0.18	.86
Intercept (baseline)	.01	.01	1.56	.12
Condition: effort versus achievement	.06	.01	5.17	<.001***
Condition: baseline versus achievement	.02	.01	1.43	.16
Condition: Effort versus baseline	.04	.01	3.73	<.001***
Storybook protagonist (Curie vs. Johnson)	.00	.01	0.35	.73

†$p<.10$; *$p<.05$; **$p<.01$; ***$p<.001$.

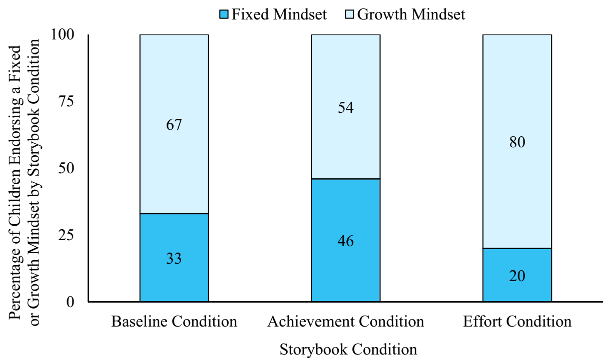

FIGURE 2 Percentage of children endorsing a growth and fixed mindset by storybook condition.

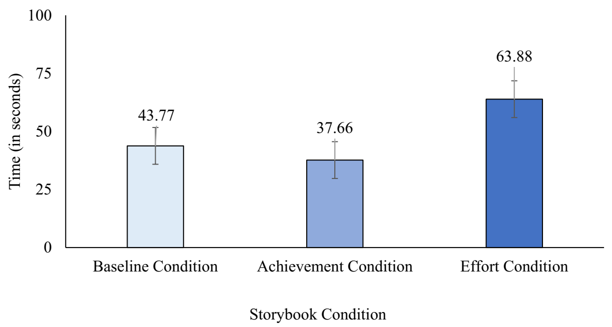

FIGURE 3 Children's average persistence on the impossible task by condition.

dependent variable. Note that because children's effort explanation task responses did not significantly differ by story protagonist or child gender, those predictors were not included. As illustrated in Figure 4, children in the *effort* condition were 3.41 times more likely to attribute the scientist's success to hard work than children in the *achievement* condition (71.01% vs. 41.79%, $\beta=1.23$, SE=0.36, $p<.001$). Further, children in the *effort* condition were 2.31 times more likely to attribute the scientist's success to hard work than children in the *baseline* condition (71.01% vs. 51.52%, $\beta=0.84$, SE=0.36, $p=.02$). There was no significant difference in children's attribution of the scientist's award to hard work versus brilliance in the *achievement* and *baseline* conditions (51.5% vs. 41.79%, $\beta=0.39$, SE=0.35, $p=.26$).

DISCUSSION

We examined whether reading and talking with caregivers about achievements versus struggles of famous White or Black female scientists impacts preschoolers' mindset beliefs, their understanding of effort in relation to success in the science domain, and their persistence when faced with a challenging task. The results indicate that caregivers augment the specific language from their assigned storybook when engaging with their children, highlighting the importance of reading storybooks that

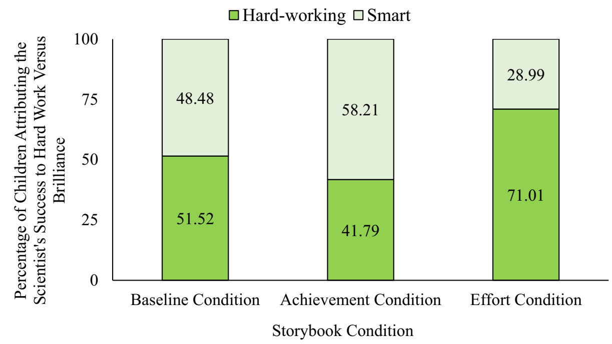

FIGURE 4 Percentage of children attributing the scientist's award to hard work versus brilliance by condition.

target language related to hard work and making connections between the child and the scientist in the story. Moreover, exposing dyads to storybooks that highlight the challenges scientists face on the path to achieving success encourages children to endorse a growth mindset, attribute success in STEM to hard work, and persist on a challenging task.

Reading a storybook about effort leads to more talk about effort and relatedness

During the storybook reading, caregivers augmented the specific language from their assigned storybook when they interacted with their child, yielding significant differences in discourse by storybook condition. In line with our hypotheses, families in the *achievement* condition used a greater proportion of utterances related to brilliance talk and families in the *effort* condition used a greater proportion of utterances related to effort and emotion talk than dyads in the other storybook conditions.

Importantly, families were not given any prompts before reading the storybook. Thus, all language was spontaneously generated. In the *achievement* condition, caregivers were more likely to emphasize the scientist's innate brilliance, often explaining to children what it means to be a genius, such as “she is a genius, so that means she's very, very smart” (P5) or “a genius is someone who is really smart” (P10). In contrast, caregivers in the *effort* condition emphasized language such as “trying really hard,” and “learning from your mistakes.” For example, a caregiver said, “it is really good that she keeps trying even when it doesn't work” (P17) and “struggling means when you try really, really hard on something that is not easy to do” (P31). Further, caregivers in the *effort* condition also emphasized the emotional states of the scientist. For example, caregivers asked, “how does she feel?” (P152), or “why doesn't she look happy in that picture?” (P21). No families in the *baseline* condition produced language related to effort talk and no families in the *achievement* condition produced utterances related to emotion talk, suggesting that dyads build on storybook text when engaging in extratextual discussion.

We found that families who read storybooks about Marie Curie and Katherine Johnson produced a similar amount of talk related to brilliance, emotion, and feelings of relatedness. However, results also indicated that dyads who read storybooks about Marie Curie produced more effort talk compared to dyads to read storybooks about Katherine Johnson. One plausible explanation is that families perceived Black women as more brilliant than White women. Indeed, prior work has found that compared to Black men, Black women are perceived by 5- and 6-year-old children as more brilliant, whereas White women are perceived as less brilliant than White men (Jaxon et al., 2019). This argument draws on an intersectional framework, and sheds light on the importance of diversifying the image of who can be a successful scientist for young children.

We also explored the impact of condition on conversation about personal connections between the child and the scientist. Consistent with our hypothesis, families in the *effort* condition produced a greater proportion of feelings of relatedness utterances compared to those in the *achievement* condition (10% vs. 5%). Importantly, the proportion of feelings of relatedness talk did not significantly differ between the *achievement* and *baseline* conditions (5% vs. 7%) or *effort* and *baseline* conditions (10% vs. 7%), suggesting that even in the control group, caregivers and children were making connections between the child and the scientist in the story. Such findings suggest that the language in the *effort* condition storybook may create more opportunities to engage families in conversation aimed at helping the child see similarities between themselves and a scientist. Importantly, because this study focused on Marie Curie and Katherine Johnson, it provided an opportunity for families to engage in a storybook reading interaction and conversation centered on the personal narratives of individuals who are often underrepresented in STEM. Arguably, exposing children to such stories during early childhood diversifies the image of who can be a successful scientist. Repeated exposure to these messages during early childhood may have implications for children's future sense of belonging and identity development in STEM (Cheryan et al., 2015; Dou et al., 2019; Hong & Lin-Siegler, 2012). Future work should build on the practices that families are already engaging in by targeting language emphasizing feelings of relatedness in scientific storybook interactions.

Note that caregiver–child language related to brilliance, effort, emotion, and feelings of relatedness was quite rare (approximately 10% of total utterances). These findings are consistent with prior research indicating that explanatory language is rare in everyday conversations (e.g., Rowe, 2012; Tabors et al., 2001). Importantly, although this talk is quite rare, prior research indicates that it is consistently predictive of children's learning. Accordingly, interventions that target talk about science do not need to enact large changes in the language included in conversation to achieve meaningful impacts on child outcomes. Additionally, as we highlight below, it is plausible that this talk was quite rare because of the nature of the *short* storybook intervention. Future work should explore caregiver–child conversation during a repeated exposure storybook intervention.

Nevertheless, the language-level findings indicate that including effort language ("struggling, learning from your mistakes, keep trying") in a storybook coupled with caregiver–child conversation can help to elucidate the process by which failure and hard work relate to success in the science domain. As mentioned in the Introduction, when children are inquiring about more abstract processes or concepts that are challenging to learn through firsthand experience alone, they often acquire such information through conversations (e.g., Harris et al., 2018; Harris & Corriveau, 2014; Kurkul & Corriveau, 2018). Arguably, failure, like other unobservable concepts and entities such as electricity, germs, or the shape of the Earth, may be a process that requires the testimony of others, such as primarily caregivers. Accordingly, such brief, scientific storybook interventions (particularly the language in such books) play an important role in impacting caregiver–child discourse, and children's subsequent knowledge acquisition, during early childhood.

Reading a storybook about effort impacts children's mindset beliefs, attribution of success in STEM, and persistence during a challenging task

In addition to exploring the impact of storybook on caregiver–child language, we also explored how this intervention impacted child-level outcomes. Regardless of storybook condition, children were more likely to endorse a growth mindset. Indeed, children in the *baseline* condition were more likely to give such an endorsement. In line with our hypotheses, children in the *effort* condition were significantly more likely to endorse a growth mindset, as compared to children in the *achievement* condition. Importantly, there was no significant difference in children's mindset beliefs between the *achievement* and *baseline* conditions, indicating that the language in the *achievement* condition does not encourage a fixed mindset. Rather, the language in the *effort condition*, enhances growth mindset beliefs. Indeed, children who endorsed a growth mindset were more likely to justify their responses using *effort or growth* reasoning. These findings suggest that such mindset beliefs may be malleable during the early childhood years, highlighting a critical period for intervention. Future research should explore how such language highlighting effort over innate intelligence may also foster children's learning and achievement during formal schooling as well as their later sense of belonging in STEM, as they view working hard and learning from mistakes as critical to their own success in the science domain (e.g., Master, 2021; Muradoglu et al., 2022).

We also found that storybook condition was associated with children's persistence on the impossible task. Children in the *effort* condition persisted longer on the challenging task than children in the *baseline* or *achievement* conditions. The data are consistent with our initial prediction and the Haber et al. (2022) findings, providing further evidence that reading a storybook about scientists who struggled increased children's persistence during a challenging activity. Importantly, there were no significant differences in children's persistence in the *achievement* and *baseline* conditions, suggest that reading about the achievements does not decrease persistence (as compared to the baseline group). Arguably, exposing individuals to the challenges and setbacks that even very famous scientists face through storybooks and caregiver–child conversations "normalizes" failure as part of the path to achieving success. As a result, when children are faced with a challenging task, they are willing to persist, even when they do not immediately achieve a solution (Haber et al., 2022; Lin-Siegler et al., 2016).

Finally, we explored the impacts of storybook condition on children's attribution of success. Children in the *effort* condition were more likely to attribute the scientist's success to hard work than were children in the *achievement* or *baseline* conditions, again with no significant difference between the *achievement* and *baseline* conditions. Therefore, reading the book focusing only on the achievements of famous scientists does not encourage children to attribute success to innate brilliance. However, emphasizing the struggles and challenges female scientists experienced along the path to becoming successful does encourage children to view hard work (something that is attainable) versus innate intelligence (something based on ability) as an essential ingredient for success.

Taken together, the findings provide further evidence that in the domain of science, young children's mindset beliefs, understanding of effort in relation to success, and their persistence engaging in a challenging task are impacted by storybook text and engagement in conversations with caregivers. This work also adds to existing literature indicating that children's mindsets are influenced by adult language and societal messages in their environment (Cimpian et al., 2007; Gladstone & Cimpian, 2021; Gunderson et al., 2013). To date, a growing body of research reveals that having more of a growth mindset is associated with superior science and math performance in middle and high school students and overall interest in pursuing a career in a STEM field (Blackwell et al., 2007; Wonch Hill et al., 2017). We extend this research to include younger children. The results from this study provide evidence that children's mindset beliefs during the preschool years impact their persistence during a challenging task: if children view intelligence as something that can grow over time, they spend more time engaging in a challenging task. These findings may have implications for students' later motivation when faced with academic challenges during formal schooling.

Recently, Gladstone and Cimpian (2021) posited that STEM role models have a positive impact on student motivation when they send the message to students that the abilities needed to succeed in science can grow over time (vs. the fixed abilities of certain students). Arguably, the famous Black and White female scientists in our study (who represent groups often underrepresented in STEM fields) serve as STEM role models for young children. Drawing on Gladstone and Cimpian (2021), reading storybooks about the challenges, setbacks, and struggles that famous female scientists experienced along the pathway to success may positively impact students' motivation because it (1) encourages a growth mindset and (2) highlights hard work as the mechanism for success. Indeed, children who read such stories were more likely to endorse a growth mindset, persisted longer on the impossible task, and attributed the scientist's success to hard work rather than innate intelligence. Thus, such storybook interventions may encourage children to embrace academic challenges (e.g., failed science experiment) as an opportunity to learn from their mistakes during K-12 schooling (e.g., Dweck, 2006; Suh et al., 2008). In addition, they may enhance children's early STEM identity development: if children view success as due to controllable factors such as effort, they may infer that all students can be successful in the science domain, which in turn, fosters their own sense of belonging and later identity development in STEM (Banchefsky et al., 2019; Cheryan et al., 2015; Chestnut et al., 2018; Dou et al., 2019; Master, 2021; Master et al., 2016; Master, Cheryan, & Meltzoff, 2017; Master, Cheryan, Moscatelli, et al., 2017; Stout et al., 2011).

Limitations and future directions

There are several limitations of the current study. First, the relatively immediate results from the storybook intervention may fade over time. Future work should retest children at least 1 or 2 weeks after the initial experiment to explore the impact of the storybook intervention on beliefs about intelligence, persistence, and understanding of the relation between hard work and STEM over time. Second, due to the nature of our study design, we did not measure children's mindset beliefs prior to reading the storybook. Thus, although our study cannot examine individual changes in mindset beliefs, we do have a baseline condition that provides some initial information about children's mindset beliefs. Third, in contrast with past work (Haber et al., 2022), our design choice focused on caregivers, rather than experimenters, serving as children's conversational partners to understand how the language in the storybook coupled with additional caregiver–child discourse impacted children's mindset and effort beliefs as well as their persistence. Because a caregiver-led (vs. experimenter-led) intervention could not be implemented in a standardized way (Leech et al., 2020), there was variation in the amount of language families engaged in related to brilliance, effort, emotion, and feelings of relatedness. However, it is important to note that a strength of this design is that it demonstrates what would more likely naturally occur when a caregiver is reading to a child. Further, as noted above, the language we coded for in this study was quite rare and thus, caregivers engaged in other linguistic features when engaging in the storybook reading session with their child, which may have also fostered children's persistence, mindset, and effort beliefs.

Importantly, another limitation of this work is that our sample size was not large enough to examine how participants' race, ethnicity, gender, and the intersection of these identities might impact their connection to the scientist in the story. Future work should utilize an intersectional framework to consider how identity contributes to engagement and sense of belonging in STEM (Crenshaw, 1990).

Generalizability statement

The sample of caregiver–child dyads in this study were primarily White, middle-to upper-middle-class, and highly educated (see Tables 1 and 2). These findings are therefore not generalizable beyond the sample studied. Thus, it will be critical to explore potential differences in caregiver–child talk based on race, ethnicity, and socioeconomic status in order to gain a fuller picture of how dyadic reading impacts children's persistence, mindset, and effort beliefs.

CONCLUSION

In summary, the findings demonstrate that caregiver–child discourse during a shared storybook reading intervention focusing on the achievements or struggles of female Black or White scientists (from groups often underrepresented in STEM fields) impact preschoolers' mindset beliefs, understanding of effort in relation to success in the science domain, and their persistence when faced with a challenging task. This work highlights how early interventions during the preschool years can impact young children's understanding of effort and brilliance in the domain of science, which in turn, has the potential to impact their beliefs about who can be a scientist and their own identification and sense of belongingness in STEM (Banchefsky et al., 2019; Dou et al., 2019; Master, 2021; Stout et al., 2011). Finally, the findings have implications for how to address early STEM learning needs prior to the onset of formal schooling.

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CONFLICT OF INTEREST STATEMENT

No conflict of interest to declare.

DATA AVAILABILITY STATEMENT

The data necessary to reproduce the analyses presented here are not publicly accessible. Data are available from the first author upon reasonable request. *Analytic code*: The analytic code necessary to reproduce the analyses presented in this paper is not publicly accessible. Code is available from the first author. *Materials*: The materials necessary to attempt to replicate the findings presented here are publicly accessible through OSF. Materials are also available from the first author. *Preregistration*: The analyses presented here were not registered.

ORCID

Amanda S. Haber https://orcid.org/0000-0001-9578-3826

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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