

UC Santa Cruz

UC Santa Cruz Previously Published Works

Title

Mothers' and Fathers' Science-Related Talk With Daughters and Sons While Reading Life and Physical Science Books

Permalink

<https://escholarship.org/uc/item/13v9w8sv>

Authors

Shirefley, Tess A
Leaper, Campbell

Publication Date

2022

DOI

10.3389/fpsyg.2021.813572

Peer reviewed



Mothers' and Fathers' Science-Related Talk With Daughters and Sons While Reading Life and Physical Science Books

Tess A. Shirefley and Campbell Leaper*

Department of Psychology, University of California, Santa Cruz, Santa Cruz, CA, United States

OPEN ACCESS

Edited by:

Joyce Endendijk,
Utrecht University, Netherlands

Reviewed by:

Katherine Short-Meyerson,
University of Wisconsin–Oshkosh,
United States

Liesbeth Hallers-Haalboom,
Utrecht University, Netherlands
Kingsley Schroeder,
Springfield College, United States

*Correspondence:

Campbell Leaper
cam@ucsc.edu

Specialty section:

This article was submitted to
Educational Psychology,
a section of the journal
Frontiers in Psychology

Received: 12 November 2021

Accepted: 29 December 2021

Published: 14 February 2022

Citation:

Shirefley TA and Leaper C (2022)
Mothers' and Fathers'
Science-Related Talk With Daughters
and Sons While Reading Life and
Physical Science Books.
Front. Psychol. 12:813572.
doi: 10.3389/fpsyg.2021.813572

Introduction: In prior studies conducted in the United States, parents' gender-differentiated encouragement of science predicted children's later science motivation. Most of this research has focused on older children or teens and only looked at the impact of mothers. However, accumulating evidence suggests that gender-differentiated encouragement of science interest may begin in early childhood. Moreover, fathers may be more likely than mothers to treat sons and daughters differently in science-learning contexts.

Methods: We examined 50 United States families with both a mother and a father (82% White; 98% with at least some college education) and either a daughter or a son (48–83 months; $M = 62$, $SD = 9$). On separate visits, each parent reads two books with their child. One was about life science and the other was about physical science. We coded parents' science-related talk during these interactions.

Results and Conclusion: In contrast to our predictions, parents used higher proportions of science talk with daughters than sons, including higher average rates of overall science talk and specific types of science talk (e.g., science explanations, science-related personal connections, and science-learning talk). Moreover, most of the child gender effects occurred while reading the physical science books. Book topic and parent gender moderated some additional patterns. Book reading is discussed as a potential context for mitigating socialization experiences that traditionally disfavor girls' interest in physical science.

Keywords: gender differences, mother-child communication, father-child communication, reading, science education

INTRODUCTION

Even though women and men demonstrate comparable levels of participation in the life science workforce in the United States, women remain underrepresented in physical science domains (National Science Foundation, 2021). As documented in earlier reports, interest in physical science more likely increased from middle childhood to adolescence among boys than girls; in contrast, interest in life science remained comparable for girls and boys during this period (e.g., Baram-Tsabari and Yarden, 2008). The development of average gender differences in motivation and

achievement is attributed to a combination of individual, interpersonal, and cultural factors (Cheryan et al., 2017; Eccles and Wigfield, 2020). Among them, researchers have highlighted the potential impact of parents' gender-differentiated socialization on children's developing interests and ability beliefs (Eccles and Wigfield, 2020). We built on prior research in three ways. First, previous research on parents' gender-differentiated socialization of their children's science learning and interest has focused on middle childhood and adolescence. Hence, we explored whether the gender-differentiated patterns might be detected in a younger age group of children between 4 and 7 years of age. Second, previous research studies looked primarily at mothers without considering parent gender as a potential moderator. We examined children's book reading separately with their mothers and fathers. Finally, scant research has separately examined physical science and life science when considering parents' gender-differentiated treatment. Hence, we observed parents reading separate science books on life science and physical science with their children.

Parents' Gender-Differentiated Socialization of Children's Science Interest

Longitudinal studies established how parents' gender-differentiated beliefs about their children's science, technology, engineering, and mathematics (STEM)-related interests or abilities predicted later changes in children's motivational beliefs and achievement (e.g., Simpkins et al., 2015). However, if parents' gender-stereotyped expectations matter, then how are they manifested in their interactions with their children at young ages? According to ecological and social cognitive theories of development (Bussey and Bandura, 1999; Bronfenbrenner, 2005), this can occur when parents provide different opportunities for learning to children based on their gender. For example, this was indicated by Tenenbaum and Leaper (2003) in their observations of parents with their 10-year-old daughter or son while engaging in assigned science activities. On average, fathers (but not mothers) used more science-related talk (e.g., explanations, scientific vocabulary) with their sons than daughters during a physical science task. But other studies suggest that this kind of gender-differentiated treatment may occur at much younger ages. In at least three studies, parents of preschool-age children were observed talking more about science with their sons than daughters. These effects were observed at a science museum (Crowley et al., 2001) while playing with a physics toy at home (Tenenbaum et al., 2005) and reading a science-related book (Shirefley et al., 2020). Although the evidence is limited, two studies suggest that gender-related variations might occur with some types of science talk more than others (Tenenbaum et al., 2005; Shirefley et al., 2020).

Shared Book Reading as a Context for Investigating Parents' Talk With Young Children

Shared book reading is a common context in many families where informal learning for young children occurs with their

parents (Scholastic Inc, 2016). More specifically, researchers have highlighted how parents' book reading with preschool-age children was a means for discussing and learning complex science concepts (e.g., Kelemen et al., 2014; Shirefley et al., 2020) and imparting lessons about gender roles (e.g., Friedman et al., 2007; Endendijk et al., 2014). However, no prior work has considered how conversations during shared reading may vary with the type of science book (life vs. physical) or with both mothers and fathers.

Comparing Fathers' and Mothers' Science Talk With Children

When considering parents' gender as a moderator of science talk, two patterns have been previously identified. First, average differences between mothers' and fathers' behavior with their children may occur (refer to Leaper, 2015 for review). Some studies have found that mothers were more verbal than fathers when interacting with children (refer to Leaper et al., 1998 for a meta-analysis). Only a few studies have compared mothers' and fathers' verbal behavior specifically during shared reading with their young children. Their results have been mixed. Two studies observed greater talking or more teaching-related comments among mothers than fathers (Conner et al., 1997; Schwartz, 2004). One study noted more talking among fathers than mothers (Anderson et al., 2004). In addition, another investigation found negligible differences between mothers' and fathers' teaching-related speech during shared reading (Blake et al., 2006). None of these studies, however, observed the shared reading of books focused on science topics.

A second pattern regarding parent gender differences indicated in the research literature is for fathers to be more likely than mothers to treat daughters and sons differently (refer to Leaper, 2015). Regarding science-related talk with young children, one study observed that both mothers and fathers used more science talk with boys than girls at a science museum, but the trend was stronger among fathers (Crowley et al., 2001). We do not know whether similar patterns would be seen while reading science books.

In addition, research with older children suggests that differences between fathers and mothers in gender-differentiated encouragement of science may partly depend on the type of science. Two studies looked at mothers' and fathers' hands-on involvement with elementary-school-age children in both life science and physical science tasks. In the first study, fathers used more science-teaching talk with sons than daughters but only during the physical science task; conversely, mothers did not differ with daughters and sons in either task (Tenenbaum and Leaper, 2003). In the second study, researchers surveyed parents based on the kinds of science problems they solved with their children (Short-Meyerson et al., 2016). Mothers favored more life science tasks, whereas fathers preferred more physical science tasks. From these studies, there is evidence to suggest that average differences in mothers' and fathers' behavior may occur when reading science books to their young children. Accordingly, we took into account the parent gender, the child gender, and the type of science book being read.

Current Study

To build on earlier research investigating parents' science-related talk with children, we observed parents with their 4–7-year-old children while reading physical and life science books in their homes. We chose book reading as it is a common shared activity among many parents and their young children, and it is an activity that is easily arranged in families' homes. We tested for variations in parents' science-related talk by child gender, parent gender, and the type of science book. Our hypotheses were as follows: first, we expected that parents would use a greater proportion of science-related talk with their sons than daughters. Second, we predicted that parents' gender-differentiated science talk would be more likely for fathers than mothers. Finally, we hypothesized that these effects would be stronger when reading the physical science book. When conducting our analyses, we looked at parents' overall science talk. In addition, we examined specific forms of science talk to explore whether some might be related to gender-related variations more than others. Among the few studies that examined parents' science talk, none of them considered whether gender-differentiated treatment was more likely for some forms of science talk than others.

METHODS

Participants

Participants were recruited in northern California through social media posts, local community spaces, and preschools. This study focuses on families in our sample with heterosexual parents in which both the mother and the father were able to participate, which initially comprised 55 families. Of these families, five were removed due to technical difficulties ($n = 2$) or child non-compliance with the tasks ($n = 3$). Our analyses are based on 50 families with a participating daughter or son ($n = 25$ each) between 4 and 7 years of age ($M = 62$ months, $SD = 9.5$). The average age of daughters and sons did not significantly differ. For mothers, 82% self-identified as White and 88% had attained at least a bachelor's degree. For fathers, 82% self-identified as White and 74% had attained at least a bachelor's degree (refer to **Table 1** for more detail). Parent-child dyads were asked to read and discuss the books as it was most natural to them ($n = 48$ exclusively in English, $n = 1$ in English and Spanish, and $n = 1$ in English and German).

MATERIALS AND PROCEDURE

Science Books

We selected four science books from the *Let's Read-and-Find-Out Science* series by HarperCollins written for preschool-aged children. All books were in English. Two different books focused on physical science [*What Is The World Made Of?* (about solids, liquids, gasses) and *Light Is All Around Us* (how light brightens the world)] and two books were on life science [*From Seed to Pumpkin* (process of a pumpkin

growing) and *From Caterpillar To Butterfly* (transformation from caterpillar to butterfly)]. We edited the four books to balance the proportion of science-related content across books. Each book was about 13 pages with approximately 30% of the text containing science words.

After obtaining signed consent, parent-child dyads were video-recorded while reading one life science book and one physical science book (with different versions provided to mothers and fathers). No time limit was imposed. The order of books and the versions of each book type were counterbalanced across parent gender and child gender. We attempted to counterbalance the order of visits with mothers and fathers; however, several fathers would not participate in the study unless mothers participated first. Mothers were visited first in 17 of 25 families with daughters and 16 of 25 families with sons. Home visits were conducted 1–2 weeks apart.

After parents completed the reading of the science books, they completed a brief survey assessing their attitudes and beliefs about science. Among these questions, two items assessed their beliefs about their child's science ability and interest (from Tenenbaum and Leaper, 2003): "My child finds science (0 = *very boring* to 7 = *very interesting*)" and "My child finds science... (0 = *very hard* to 7 = *very easy*)." Also, we asked "How often do you read a storybook to your child?" (0 = *never*, 1 = *a few times per year*, 2 = *about once per month*, 3 = *about once per week*, and 4 = *almost every day*).

Coding

We first transcribed parent-child video recordings using Datavyu. We parsed parent-child talk into utterances representing individual thought units. Parent and child utterances were coded into 16 coding categories, which included five science-related codes (based on Shirefley et al., 2020). Five research assistants coded 20% of the dataset to assess intercoder reliability. After achieving reliability and discussing differences, each coder coded 20% of the remaining samples. The five types of the science-related talk were as follows: *scientific explanations*, *science labels*, *scientific personal connections*, *scientific story inferences*, and *scientific-learning talk* (refer to **Table 2** for definitions and **Table 3** for descriptive statistics). Based on

TABLE 1 | Demographic backgrounds of mothers and fathers.

Variable	Mothers	Fathers
Ethnicity		
White	41	41
Latinx	5	6
Asian/Pacific Islander	1	2
Black	1	0
Multi/Other	2	1
Education level		
High school diploma	1	1
Some college/Associate's	5	12
College bachelors	19	20
Masters/Doctorate/Medical	25	17

the guidelines developed by Landis and Koch (1977), the intercoder agreement for each code was acceptable (refer to **Table 2**).

RESULTS

Statistical Design

Children were observed on separate occasions with their mother and father, and each parent reads two types of science books. Because members of dyads are not independent, we utilized linear mixed models to conduct our analyses (Kenny et al., 2006). Child gender was a between-group factor, whereas parent gender and book type were nested factors. The mixed linear model is only able to examine one criterion variable at a time. Accordingly, we ran six models with parents' overall science talk and the five specific types of science talk. To control for variations across parents in the time spent talking about the book, we calculated each type of science talk as a proportion of total utterances (excluding reading text from the book).

Preliminary Analyses

We conducted preliminary analyses to test for gender-related variations in a few factors that might influence parents' gender-differentiated talk. First, we did not find significant differences in parents' views of daughters' and sons' science ability or interest, although mothers were more likely than fathers to rate their children as finding science easy ($p = 0.032$). Second, we did not find differences in parents' reported reading to daughters vs. sons. Indeed, 94% of mothers and 90% of fathers reported reading to their children "almost every day." Finally, we did not find differences between daughters' and sons' total talk and science-related talk with either science book, although children used proportionally more science talk with the life science book than the physical science book ($p < 0.001$).

Testing Hypotheses

In summarizing the results below, only significant effects from the models are noted (refer to **Table 4** for more information). With any significant pairwise comparisons tests, Cohen's d indices of

TABLE 2 | Science talk codes: descriptions and intercoder reliability.

Measure	Definition	Percent agreement	Kappa coefficient	Evaluation ¹
Scientific explanations	Generic facts vocabulary and explanations about a phenomenon specifically related to the scientific material (e.g., "Roots suck up water like a straw").	88	0.66	Substantial
Science labels	The naming of a specific part of an image within the book (e.g., "Those are called pupa").	95	0.65	Substantial
Scientific personal connections	Relating the scientific material of the book to a child/parent/family's prior experience (e.g., "Remember when we made Play-Doh and at first it was really liquidy but then we added more starch to make it solid?").	95	0.72	Substantial
Scientific story inferences	Anticipating the next step in the story (taking information not visible on the page of the book to then infer understanding (e.g., "There was a lot of rain, I wonder what will happen to the pumpkin seeds").	99	0.37	Fair
Scientific-learning talk	A reference to new scientific knowledge gained or the opportunity for parent or child to check in with each other about their understanding of information (e.g., "Did you know the sun was that hot?!").	96	0.42	Moderate

¹Source: Landis and Koch (1977).

Story inferences occurred infrequently (refer to **Table 3**), which likely accounts for the relatively low intercoder agreement.

TABLE 3 | Mean frequencies and proportions for science-related talk variables of parents.

	Frequencies		Proportions	
	Life science <i>M (SD)</i>	Physical science <i>M (SD)</i>	Life science <i>M (SD)</i>	Physical science <i>M (SD)</i>
Total talk	50.8 (25.5)	53.3 (36.7)	N/A	N/A
Overall science talk	30.8 (17.8)	37.8 (24.4)	0.60 (0.13)	0.59 (0.14)
Scientific explanations or vocabulary	13.0 (10.5)	22.6 (18.1)	0.24 (0.12)	0.34 (0.14)
Science labels	5.7 (4.3)	3.7 (4.4)	0.12 (0.09)	0.06 (0.06)
Scientific personal connections	6.7 (5.5)	6.7 (6.2)	0.14 (0.09)	0.11 (0.08)
Scientific story inferences	0.8 (2.1)	0.3 (0.6)	0.01 (0.03)	0.004 (0.01)
Scientific-learning talk	4.5 (3.8)	4.9 (4.1)	0.09 (0.05)	0.08 (0.05)

N/A, not applicable.

The total talk reflects all utterances excluding reading text from the book. Proportion scores reflect the proportions of each science talk variable in relation to parents' total utterances (excluding reading text from book).

TABLE 4 | Summary of results from linear mixed models.

	Overall $F_{(1,46)}$	Explanations $F_{(1,47)}$	Labels $F_{(1,48)}$	Connections $F_{(1,48)}$	Inferences $F_{(1,47)}$	Learning $F_{(1,47)}$
Child gender (CG)	4.70*	4.14*	0.07	0.27	0.17	8.98**
Parent gender (PG)	1.46	1.64	0.63	0.64	2.42	0.65
Book type (BT)	0.38	63.57***	44.75***	9.62**	11.92***	2.14
CG × BT	5.24*	1.03	0.01	7.33*	0.29	7.15**
PG × BT	0.32	1.15	0.05	2.07	6.93*	1.25
CG × PG	0.13	0.02	0.01	1.61	0.16	8.36**
CG × PG × BT	0.33	0.43	0.03	0.33	0.04	0.18

* $p < 0.05$, ** $p < 0.01$, and *** $p < 0.001$.

effect size are reported. Effect sizes are negligible when $d < 0.2$ (or $\eta^2 < 0.01$), small when $d = 0.2$ (or $\eta^2 = 0.01$), moderate when $d = 0.5$ (or $\eta^2 = 0.06$), and large when $d = 0.8$ (or $\eta^2 = 0.14$) or greater (Cohen, 1988).

The Proportion of Overall Science Talk

The main effect of child gender occurred whereby parents used more overall science talk with daughters ($M = 0.62$, $SD = 0.12$) than sons ($M = 0.57$, $SD = 0.15$), $F_{(1,46)} = 4.70$, $p = 0.035$, $\eta^2_{partial} = 0.09$, $d = 0.37$. This main effect was subsumed by a Science Topic × Child Gender interaction, $F_{(1,46)} = 4.50$, $p = 0.040$, $\eta^2_{partial} = 0.09$. Follow-up pairwise comparisons revealed that parents reading the physical science book used a higher average proportion of overall science talk with daughters ($M = 0.64$, $SD = 0.13$) than sons ($M = 0.55$, $SD = 0.14$), $p = 0.003$, $d = 0.67$. Parents did not significantly differ in their overall science talk with daughters ($M = 0.62$, $SD = 0.11$) and sons ($M = 0.59$, $SD = 0.16$) when reading the life science book.

The Proportion of Science Explanations

A significant main effect of child gender indicated that parents were more likely to use science explanations with daughters ($M = 0.31$, $SD = 0.15$) than sons ($M = 0.26$, $SD = 0.14$), $F_{(1,47)} = 4.60$, $p = 0.037$, $\eta^2_{partial} = 0.09$. Also, a significant main effect of science topic revealed that parents were more likely to use science explanations when reading the physical science book ($M = 0.34$, $SD = 0.15$) than the life science book ($M = 0.22$, $SD = 0.12$), $F_{(1,47)} = 63.57$, $p = 0.003$, $\eta^2_{partial} = 0.18$.

The Proportion of Science Labeling

A main effect of science topic indicated that parents used proportionally more scientific labels on average when reading the life science book ($M = 0.12$, $SD = 0.09$) than the physical science book ($M = 0.06$, $SD = 0.06$), $F_{(1,48)} = 44.75$, $p < 0.001$, $\eta^2_{partial} = 0.10$.

The Proportion of Science Personal Connections

Based on the main effect of science books, parents were more likely to make science-related personal connections when reading the life science book ($M = 0.14$, $SD = 0.09$) than the physical science book ($M = 0.10$, $SD = 0.08$), $F_{(1,48)} = 9.62$, $p = 0.001$,

$\eta^2_{partial} = 0.20$. In addition, there was a significant Science Topic × Child Gender interaction, $F_{(1,48)} = 6.10$, $p = 0.017$, $\eta^2_{partial} = 0.12$. Follow-up pairwise comparison tests revealed child gender differences based on the science topic. When reading the physical science book, parents made more science-related personal connections with daughters ($M = 0.13$, $SD = 0.09$) than sons ($M = 0.08$, $SD = 0.05$), $p = 0.04$, $d = 0.69$. When reading the life science book, parents did not significantly differ in their use of scientific personal connections with daughters ($M = 0.13$, $SD = 0.08$) and sons ($M = 0.15$, $SD = 0.11$).

The Proportion of Science Inferences

The main effect of science topic revealed that parents used significantly more science inferences when reading the life science book ($M = 0.01$, $SD = 0.03$) than the physical science book ($M = 0.00$, $SD = 0.01$), $F_{(1,47)} = 11.92$, $p = 0.003$, $\eta^2_{partial} = 0.17$. A significant Parent Gender × Science Topic interaction [$F_{(1,47)} = 6.9$, $p = 0.011$, $\eta^2_{partial} = 0.13$] indicated a significant parent gender difference depending on science topic. On average, fathers ($M = 0.02$, $SD = 0.04$) were more likely than mothers ($M = 0.01$, $SD = 0.02$) to use science inferences when reading the life science book, $p = 0.012$, $d = 0.47$; but mothers ($M = 0.01$, $SD = 0.01$) and fathers ($M = 0.00$, $SD = 0.06$) did not significantly differ when reading the physical science book.

The Proportion of Science-Learning Talk

A significant main effect of child gender showed that parents generally used more science-learning talk with daughters than sons, $F_{(1,47)} = 10.5$, $p = 0.002$, $\eta^2_{partial} = 0.19$. However, this effect was subsumed into two interaction effects. First, there was a Child Gender × Parent Gender interaction, $F_{(1,47)} = 9.6$, $p = 0.003$, $\eta^2_{partial} = 0.17$. Follow-up pairwise comparison tests revealed that mothers used proportionally more science-learning talk with daughters ($M = 0.11$, $SD = 0.06$) than sons ($M = 0.05$, $SD = 0.04$), $p < 0.001$, $d = 1.08$. There was no significant difference in fathers' science-learning talk with daughters ($M = 0.08$, $SD = 0.05$) and sons ($M = 0.08$, $SD = 0.05$). Also, a significant Child Gender × Science Topic interaction occurred, $F_{(1,47)} = 9.5$, $p = 0.003$, $\eta^2_{partial} = 0.17$. On average, while reading the life science book, parents used a higher proportion of science-learning talk with daughters ($M = 0.11$, $SD = 0.06$) than sons ($M = 0.06$, $SD = 0.05$),

$p < 0.001$, $d = 0.91$. There were no significant differences in science-learning talk used between daughters ($M = 0.08$, $SD = 0.06$) and sons ($M = 0.07$, $SD = 0.05$) when reading the physical science book.

DISCUSSION

Our findings revealed patterns of gender differentiation in the science talk of mothers and fathers when reading physical and life science books to their sons or daughters. In contrast to our hypothesis, parents used a higher proportion of several forms of science talk with daughters compared to sons. Moreover, the magnitudes of these average differences were moderate-to-large in size. The science topic moderated some of these differences and parent gender moderated child gender differences although not always in an expected manner. Also, gender-related differences occurred across various types of science talk. As discussed below, the results suggested that science book reading with young children may be a context in some families in which parents may especially engage girls in science learning.

To the best of our knowledge, only three prior studies examined gender differences in parents' science talk with preschool- and early elementary-aged children. In these investigations, parents were more likely to use science explanations with boys than girls at a science museum (Crowley et al., 2001) while playing with a science activity at home (Tenenbaum et al., 2005) or reading a science-related book (Shirefley et al., 2020). We observed the opposite pattern whereby parents generally used more scientific explanations and overall science talk with their daughters than sons across both books. In addition, mothers (but not fathers) used more science-learning talk with daughters than sons across both books.

The science topic moderated some additional effects. When reading the physical science book, parents used proportionally more overall science talk and made more science-related personal connections with their daughters than sons. Given the gender gap in motivation and achievement in the physical sciences observed during adolescence, i.e., when boys have often participated in the physical sciences than girls (refer to Cheryan et al., 2017), this pattern was surprising.

Our sample comprised mothers and fathers who generally were highly educated and active readers with their children. Perhaps these parents made concerted efforts to counteract cultural stereotypes about gender and science (e.g., physical sciences being stereotypically masculine). In doing so, they may have sought to engage their daughters especially in the science topic that was most counter-stereotypical. Mothers, in particular, may have been focused on this goal, as we found mothers but not fathers used more science-learning talk with daughters than sons. Families in our study also lived near many scientific/technology industries and in communities where issues of gender and STEM are often highlighted in local and national media. In one pertinent study, researchers discovered that girls' enrollment in high school physics courses was higher in communities where women were employed in nearby STEM occupations

(Riegle-Crumb and Moore, 2014). An analogous effect may be occurring with our sample. Of course, this interpretation is speculative and requires testing in future research.

Another potential explanation for parents' greater average science talk with daughters than sons is that parents were responding to subtle gender differences in children's behavior (Bell, 1968). On average, girls tend to do somewhat better in reading (Robinson and Theule Lubinski, 2011) and to be more talkative during early childhood (Leaper and Smith, 2004). Although we did not find average gender differences in children's overall science talk, perhaps girls were more likely receptive to shared book reading and parents found it easier to engage them in science talk. If so, why was parents' science talk more likely among girls (vs. boys) specifically while reading the physical science book? Perhaps engaging the child's interest was more challenging while discussing the more abstract physical science books than the more concrete life science books. Once again, these are speculations that need testing.

In contrast to several prior studies indicating gender-differentiated socialization was more likely among fathers than mothers (refer to Leaper, 2015 for review), we did not observe this in the results. We did observe that fathers were more likely than mothers to make scientific inferences while reading the life science book. Perhaps fathers were generally more comfortable to make these more abstract and cognitively demanding forms of talk (e.g., Tenenbaum and Leaper, 1998). Fathers could also be less familiar than mothers with their children's cognitive abilities, which might lead to using more complex talk. Given that the science inference code was infrequent, these interpretations should be viewed cautiously.

One notable limitation of our study is that our sample was comprised of parents from highly educated backgrounds who also regularly read to their children. Prior study has noted that parents' shared book reading is positively correlated with their education (e.g., Yarosz and Barnett, 2001). Therefore, shared book reading is not a common activity in all families. Another limitation was that the parents in our study were predominantly from White European-heritage backgrounds. Other research suggests that gender-differentiated talk in reading and other learning tasks may vary across different ethnic or cultural groups (e.g., Shirefley et al., 2020).

CONCLUSION

Our findings pose new research questions regarding parents' gender-differentiated encouragement of children's science interest, confidence, and achievement. In contrast to prior studies, we discovered that parents used the more scientific talk with their daughters than sons. This was especially likely with the physical science book. Although more research is needed to replicate and better understand the results, one possibility is that shared book reading could be a learning context conducive for promoting science interest in many girls. To test this premise, short-term longitudinal studies could examine whether this type of book reading in early childhood is related to an increase

in girls' interest in physical science. Moreover, similar benefits may accrue to boys and thereby help all children's developing interest in science.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the University of California, Santa Cruz Institutional Review Board. Written informed consent to participate in this study was provided by the adult participants and the legal guardian of the minor participants.

REFERENCES

- Anderson, J., Anderson, A., Lynch, J., and Shapiro, J. (2004). Examining the effects of gender and genre on interactions in shared book reading. *Read. Res. Instruct.* 43, 1–20. doi: 10.1080/19388070409558414
- Baram-Tsabari, A., and Yarden, A. (2008). Girls' biology, boys' physics: evidence from free-choice science learning settings. *Res. Sci. Technol. Educ.* 26, 75–92. doi: 10.1080/02635140701847538
- Bell, R. Q. (1968). A reinterpretation of the direction of effects in studies of socialization. *Psychol. Rev.* 75, 81–95. doi: 10.1037/h0025583
- Blake, J., Macdonald, S., Bayrami, L., Agosta, V., and Milian, A. (2006). Book reading styles in dual-parent and single-mother families. *Br. J. Educ. Psychol.* 76, 501–515. doi: 10.1348/000709905X49719
- Bronfenbrenner, U. (2005). *Making Human Beings Human: Bioecological Perspectives on Human Development*. Thousand Oaks, CA: Sage.
- Bussey, K., and Bandura, A. (1999). Social cognitive theory of gender development and differentiation. *Psychol. Rev.* 106, 676–713. doi: 10.1037/0033-295X.106.4.676
- Cheryan, S., Ziegler, S. A., Montoya, A. K., and Jiang, L. (2017). Why are some STEM fields more gender balanced than others? *Psychol. Bull.* 143, 1–35. doi: 10.1037/bul0000052
- Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences*, 2nd Edn, Mahwah: Lawrence Erlbaum.
- Conner, D. B., Knight, D. K., and Cross, D. R. (1997). Mothers' and fathers' scaffolding of their 2-year-olds during problem-solving and literacy interactions. *Br. J. Dev. Psychol.* 15, 323–338. doi: 10.1111/j.2044-835X.1997.tb00524.x
- Crowley, K., Callanan, M. A., Tenenbaum, H. R., and Allen, E. (2001). Parents explain more often to boys than to girls during shared scientific thinking. *Psychol. Sci.* 12, 258–261. doi: 10.1111/1467-9280.00347
- Eccles, J. S., and Wigfield, A. (2020). From expectancy-value theory to situated expectancy-value theory: a developmental, social cognitive, and sociocultural perspective on motivation. *Contemp. Educ. Psychol.* 61:13. doi: 10.1016/j.cedpsych.2020.101859
- Endendijk, J. J., Groeneveld, M. G., van der Pol Lotte, D., van Berkel, S. R., Hallers-Haalboom, E., Mesman, J., et al. (2014). Boys don't play with dolls: mothers' and fathers' gender talk during picture book reading. *Parent. Sci. Pract.* 14, 141–161. doi: 10.1080/15295192.2014.972753
- Friedman, C. K., Leaper, C., and Bigler, R. S. (2007). Do mothers' gender-related attitudes or comments predict young children's gender beliefs? *Parent. Sci. Pract.* 7, 357–366. doi: 10.1080/15295190701665656
- Kelemen, D., Emmons, N. A., Seston Schillaci, R., and Ganea, P. A. (2014). Young children can be taught basic natural selection using a picture-storybook intervention. *Psychol. Sci.* 25, 893–902. doi: 10.1177/0956797613516009
- Kenny, D. A., Kashy, D. A., and Cook, W. L. (2006). *Dyadic Data Analysis*. New York, NY: Guilford Press.
- Landis, J. R., and Koch, G. G. (1977). The measurement of observer agreement for categorical data. *Biometrics* 33, 159–174.
- Leaper, C. (2015). "Gender and social-cognitive development," in *Handbook of Child Psychology and Developmental Science: Cognitive Processes*, 7th Edn, Vol. 2, eds R. M. Lerner, L. S. Liben, and U. Muller (New York, NY: Wiley), 806–853.
- Leaper, C., Anderson, K. J., and Sanders, P. (1998). Moderators of gender effects on parents' talk to their children: a meta-analysis. *Dev. Psychol.* 34, 3–27. doi: 10.1037/0012-1649.34.1.3
- Leaper, C., and Smith, T. E. (2004). A meta-analytic review of gender variations in children's language use: talkativeness, affiliative speech, and assertive speech. *Dev. Psychol.* 40, 993–1027. doi: 10.1037/0012-1649.40.6.993
- National Science Foundation (2021). *Women, Minorities, and Persons With Disabilities in Science and Engineering*. Washington, DC: National Science Foundation.
- Riegle-Crumb, C., and Moore, C. (2014). The gender gap in high school physics: considering the context of local communities. *Soc. Sci. Q.* 95, 253–268. doi: 10.1111/ssqu.12022
- Robinson, J. P., and Theule Lubienski, S. (2011). The development of gender achievement gaps in mathematics and reading during elementary and middle school: examining direct cognitive assessments and teacher ratings. *Am. Educ. Res. J.* 48, 268–302. doi: 10.3102/0002831210372249
- Scholastic Inc (2016). *Kids and Family Reading Report 2016*. Available online at: <http://www.scholastic.com/readingreport/key-findings.htm> (accessed October 20, 2021).
- Schwartz, J. I. (2004). An observational study of mother/child and father/child interactions in story reading. *J. Res. Childhood Educ.* 19, 10–105. doi: 10.1080/02568540409595058
- Shirefley, T. A., Castañeda, C. L., Rodriguez-Gutiérrez, J., Callanan, M. A., and Jipson, J. (2020). Science conversations during family book reading with girls and boys in two cultural communities. *J. Cogn. Dev.* 20, 551–572. doi: 10.1080/15248372.2020.1797750
- Short-Meyerson, K., Sandrin, S., and Edwards, C. (2016). Gender influences on parent-child science problem-solving behaviors. *J. Res. Childhood Educ.* 30, 334–348. doi: 10.1080/02568543.2016.1178194

AUTHOR CONTRIBUTIONS

TS was largely responsible for data collection, coding, and the data analyses. Both authors worked on writing the report and developed the research questions and methodology.

FUNDING

This research was supported by grants to CL from the Spencer Foundation (grant 201900111) and the UCSC Academic Senate (grant 36146).

ACKNOWLEDGMENTS

The authors are grateful to the parents and the children for their time and participation and also appreciative of Tessa Blood, Kendra Cornell-Rath, Dena Gohari, and Rebecca Upton for their help during data collection, transcription, and coding.

- Simpkins, S. D., Fredricks, J., and Eccles, J. S. (2015). The role of parents in the ontogeny of achievement-related motivation and behavioral choices. *Monogr. Soc. Res. Child Dev.* 80, 1–151. doi: 10.1111/mono.12158
- Tenenbaum, H. R., and Leaper, C. (1998). Gender effects on Mexican-descent parents' questions and scaffolding during toy play: a sequential analysis. *First Lang.* 18, 129–147. doi: 10.1177/014272379801805301
- Tenenbaum, H. R., and Leaper, C. (2003). Parent-child conversations about science: the socialization of gender inequities? *Dev. Psychol.* 39, 34–47. doi: 10.1037/0012-1649.39.1.34
- Tenenbaum, H. R., Snow, C. E., Roach, K. A., and Kurland, B. (2005). Talking and reading science: longitudinal data on sex differences in mother-child conversations in low-income families. *J. Appl. Dev. Psychol.* 26, 1–19. doi: 10.1016/j.appdev.2004.10.004
- Yarosz, D. J., and Barnett, W. S. (2001). Who reads to young children?: Identifying predictors of family reading activities. *Read. Psychol.* 22, 67–81. doi: 10.1080/02702710151130235

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's Note: All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

Copyright © 2022 Shirefley and Leaper. This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY). The use, distribution or reproduction in other forums is permitted, provided the original author(s) and the copyright owner(s) are credited and that the original publication in this journal is cited, in accordance with accepted academic practice. No use, distribution or reproduction is permitted which does not comply with these terms.