Journal of Experimental Child Psychology 207 (2021) 105124

Contents lists available at ScienceDirect

Journal of Experimental Child Psychology

journal homepage: www.elsevier.com/locate/jecp

Facilitating young children's numeracy talk in play: The role of parent prompts

Sarah H. Eason [a,*,1], Ariadne E. Nelson [b], Eric Dearing [b], Susan C. Levine [a]

[a] Department of Psychology, University of Chicago, Chicago, IL 60637, USA
[b] Department of Counseling, Developmental, and Educational Psychology, Boston College, Chestnut Hill, MA 02467, USA

ARTICLE INFO

Article history:
Received 19 March 2020
Revised 5 February 2021
Available online 14 March 2021

Keywords:
Early numeracy
Mathematical language
Parent–child interactions
Playful learning
Preschoolers
Family math engagement

ABSTRACT

Previous research has demonstrated the contribution of parents' number language to children's own engagement with numbers and later mathematical achievement. Although there is evidence that both the quantity and complexity of parent number talk contribute to children's math learning, it is unclear whether different forms of parents' number talk—statements versus prompts—offer unique contributions to how children engage in math. We examined parent number talk among 50 dyads of parents and 2- to 4-year-olds during pretend play, coding parents' provisions of informative number statements and prompts inviting children to engage in number talk. The total amount (tokens) and diversity (types) of children's number words were analyzed separately. Parents' number utterances, particularly prompts about number, were infrequent. Both parents' number statements and their prompts were uniquely related to children's number word tokens. Only prompts were associated with children's number word types. Follow-up analyses indicated that prompts were associated with lengthier parent–child conversations about number than parent statements and that children used larger number words when responding to parent prompts than when they themselves initiated number talk. These findings highlight the importance of parents' prompts for enhancing the quality of parent–child math exchanges by providing opportunities for children to advance their current use of numerical language. Consequently, parents' use of number-related prompts may play an important role in children's early math engagement.

* Corresponding author.
E-mail address: season@purdue.edu (S.H. Eason).
[1] Current address: Department of Human Development and Family Studies, Purdue University, West Lafayette, IN 47906, USA.

https://doi.org/10.1016/j.jecp.2021.105124
0022-0965/

Introduction

Language facilitates much of young children's learning in a wide range of domains, including mathematics. Children's mathematical language has been found to be predictive of math achievement (Levine, Suriyakham, Rowe, Huttenlocher, & Gunderson, 2010; Purpura & Reid, 2016), and there is evidence that interventions exposing children to mathematical language can improve their number skills (Gibson, Gunderson, & Levine, 2020; Purpura, Napoli, Wehrspann, & Gold, 2017) and increase children's attention to number (Braham, Libertus, & McCrink, 2018). Equipping young children with strong mathematical language, consequently, may be a promising approach to ensuring that children are prepared to learn math at the time they enter school.

The home environment offers opportunities for children to engage in mathematical talk during play and everyday routines with family members, and studies have linked parent talk about number to children's own number talk and later math knowledge (e.g., Levine et al., 2010; Susperreguy & Davis-Kean, 2016). Notably, beyond *how much* exposure to number talk children receive, studies have revealed qualitative variations where exposure to more advanced mathematical concepts in particular predicts later math knowledge (e.g., Casey et al., 2018; Gunderson & Levine, 2011). We propose that actively engaging children in number talk is a key mechanism through which parents' number talk supports children's math knowledge, based on the theoretical perspective that language facilitates cognitive development (Gauvain, Beebe, & Zhao, 2011; Vygotsky, 1986). However, it is unclear what qualitative aspects of parents' number talk most effectively engage children in conversations about math. One underexamined possibility is that parents' attempts to engage their children in math conversations through questions and prompts play an important role in children's number learning. Existing studies suggest that parents' use of number-related statements is one mechanism through which children learn about numbers (e.g., Levine et al., 2010). Yet, in addition to number statements, we hypothesize that parent prompting is key to encouraging children's own use of number words as well as their engagement in dynamic conversations about number and mathematical thinking (e.g., Vandermaas-Peeler, Mischka, & Sands, 2019; Vandermaas-Peeler, Westerberg, Fleishman, Sands, & Mischka, 2018).

The current study measured variations in parents' number talk to examine the unique contributions of parents' number statements and number prompts as predictors of young children's own engagement in number talk during play. Although previous studies have examined some qualitative aspects of the number talk to which children are exposed (Casey et al., 2018; Gunderson & Levine, 2011; Ramani, Rowe, Eason, & Leech, 2015), they generally have not distinguished between parent statements and prompts. Furthermore, such studies have often focused on how parents' number talk was related to children's math knowledge rather than how children were engaging in math themselves. We proposed that both parents' number statements and their number prompts would contribute to children's own number engagement because together they provide opportunities for parents to (a) expose children to numerical language and (b) invite children to engage in mathematical thinking and participate in conversations about number themselves. We first review literature discussing how parent number talk supports children's mathematical engagement. Then we address why prompts, which are considerably rarer than number statements in naturalistic parent–child interactions, may be of particular importance in facilitating children's high-quality number exploration and thinking.

Parent number talk and children's math knowledge and engagement

According to sociocultural theory, language is a cultural tool that supports cognition through social exchanges where more experienced partners such as parents provide guided opportunities for young learners to hear and use such language (Gauvain, 2001; Gauvain et al., 2011). In the domain of mathematical cognition, children's mathematical language indeed has been shown to be predictive of their numerical skills (Levine et al., 2010; Purpura et al., 2017; Purpura & Reid, 2016) and parents' number talk with young children is linked to children's concurrent and later math skills. Levine et al. (2010),

for example, found that parents' use of number words during five 90-min naturalistic home observations when children were 14–30 months old predicted children's understanding of the cardinal meanings of the number words at 46 months of age after controlling for family socioeconomic status (SES) and overall parent and child talk. Parents' number talk with older children during the preschool years has also been linked to children's number knowledge. Examining number talk with preschoolers, Susperreguy and Davis-Kean (2016) found that mothers' talk about numbers with their 3- to 5-year-old children during mealtime predicted children's performance on a standardized test of mathematical ability (i.e., the Test of Early Mathematics Ability) 1 year later.

Critically, the relation between number talk and children's math learning appears to vary depending on *how* parents use number words. Gunderson and Levine (2011), for example, found that only parents' talk about number in relation to visible sets of objects predicted children's cardinal knowledge. Furthermore, parents' talk about larger sets of current objects (i.e., 4–10) predicted children's cardinal knowledge, whereas their talk about smaller sets (1–3) did not. Other studies of parents and preschoolers engaging in games and pretend play during short observations (i.e., 10–15 min) have also shown associations between more complex number talk and children's math knowledge. Casey et al. (2018) found that mothers' labeling set sizes, but not numeral identification or one-to-one counting, during pretend play was linked to preschoolers' later number knowledge. Looking at complexity of number talk, Ramani et al. (2015) found that parents' talk about more advanced number concepts (i.e., cardinality, ordinal relations, arithmetic) during play and book reading was related to children's performance on measures of advanced number knowledge (i.e., counting principles, enumeration and cardinality, number line estimation, and magnitude comparison). In contrast, parents' use of foundational number concepts (i.e., counting and numeral identification) was not related either to children's performance on measures of foundational concepts (i.e., numeral identification and verbal counting) or to their advanced number knowledge.

An important distinction between the studies described with toddlers and those described with preschoolers is the inclusion of number-related prompts in measures of parent number talk. Levine and colleagues noted that prompts such as "How many are there?" and "Can you count these?" were too infrequent to incorporate into analyses when examining parent number talk with 14- to 30-month-olds, which likely can be attributed to the children's young age (Gunderson & Levine, 2011; Levine et al., 2010). In contrast, studies with preschool-aged children have included parents' prompts about number but have tended to collapse number talk across parents' statements and prompts (Casey et al., 2018; Ramani et al., 2015; Susperreguy & Davis-Kean, 2016). Although useful for capturing the total amount of parent talk, collapsing these forms of talk may obscure a distinction that is important for understanding mechanisms of children's math engagement and learning.

Whereas studies have primarily examined the role of parent input in predicting children's math achievement, several studies have also found that parent number talk is correlated with child number talk (e.g., Levine et al., 2010; Ramani et al., 2015). However, our understanding of how different forms of parent talk facilitate children's engagement in number talk is limited. Several studies have categorized parents' math talk during cooking and board game activities, distinguishing between parents' questions and explanations and hints in response to children's errors (Vandermaas-Peeler, Boomgarden, Finn, & Pittard, 2012; Vandermaas-Peeler, Ferretti, & Loving, 2012; Vandermaas-Peeler & Pittard, 2014). However, in these studies parents' number talk and child engagement were measured as outcomes to compare differences across experimental groups. Consequently, it remains unclear how parents' statements versus prompts may uniquely contribute to engaging children in number talk. Next, we discuss why prompts might play a unique role beyond that of parents' provisions of statements about number in engaging children's mathematical talk and thinking.

Scaffolding children's number talk and learning through prompts

Studies linking parent number talk to child number knowledge are consistent with theories positing that language learning depends on social interactions with conversational partners. However, according to sociocultural theory, children benefit the most when they themselves are active participants in these interactions (Gauvain & Rogoff, 1989; Wertsch, 2008). For instance, one study found that preschoolers' conversational turns with adults predicted their verbal skills and brain activity

during language processing above and beyond the contribution of the total amount of verbal adult input (Romeo et al., 2018). In the domain of math, children's own number talk was found to marginally predict later math skills after controlling for the amount of parent number talk (Levine et al., 2010). Furthermore, children's symbolic number knowledge, including their abilities to use number words, has been linked to later math skills (e.g., Geary & vanMarle, 2016; Purpura & Napoli, 2015). Given these findings, optimal child number engagement may stem from parent practices that lead to dyadic conversations about number and provide opportunities for children to practice using number words themselves.

In particular, adults can scaffold children's active participation and support language learning through asking questions and posing prompts. There is evidence in the field of language and literacy development linking parents' questions to children's engagement and learning. Parents' questions have been found to be predictive of children's own contributions during shared book reading both concurrently and over time (Kuchirko, Tamis-LeMonda, Luo, & Liang, 2016). In addition, parents' questions during book reading have been positively linked to children's later language skills (Fletcher, Cross, Tanney, Schneider, & Finch, 2008; Whitehurst et al., 1988). Commonly referred to as dialogic reading, this interactive approach to book reading, where adults ask questions of children, supports children's expressive language more than noninteractive book reading (Mol, Bus, de Jong, & Smeets, 2008).

Similarly, parents' active engagement of children in math activities may support children's math language engagement in a way that parents' number word input alone does not. Studies examining the role of inquiry in children's math and science learning have illustrated how parents' questions and prompts can enhance the depth and complexity of children's engagement (e.g., Vandermaas-Peeler, Massey, & Kendall, 2016; Vandermaas-Peeler et al., 2018). For instance, families who were prompted to use inquiry had more frequent and more extensive exchanges around math and science compared with families in a control group (Vandermaas-Peeler et al., 2019). In addition, prompts might function as a scaffold in the zone of proximal development by setting up opportunities for children to engage with numbers in ways that they cannot yet do on their own (Rogoff, 1998; Vygotsky, 1986).

In the current study, we built on this work to further examine the role of parents' prompts in increasing children's engagement in mathematics. This work will help to illuminate the particular mechanisms through which parent number talk contributes to children's math engagement, thereby informing recommendations to parents and caregivers for how to effectively support early math engagement.

The current study

The primary question in the current study was as follows: To what extent does parents' use of number statements and number prompts predict children's own use of number words? We used both the quantity (i.e., total frequency of number words) and diversity (i.e., frequency of different number words used) of number words as measures of children's engagement in number talk. This allowed us to examine separately how parents' number statements and prompts were related to the amount and complexity of child number talk because a child who uses the word "one" 10 times might not be engaging in the same depth of number talk as a child who uses the words "one" through "five" 2 times each. Our hypothesis was that both parents' number statements and their prompts would contribute uniquely to variance in children's use of number words. Being exposed to number words through statements is essential to equip children with necessary vocabulary for engaging in number conversations and may draw children's attention to numeric concepts. Consequently, we hypothesized that parents' statements would contribute to the frequency and diversity of children's number word use. However, we also argue that prompts serve as a critical scaffold for encouraging children to increase their number engagement. We hypothesized that parent prompts would account for additional variance in the frequency and diversity of child number word use.

We observed parents and children during pretend play with a kitchen set. This activity is a common play theme and also reflects an everyday context that would be familiar to many families. We chose this activity because it offers opportunities to talk about number, but parents and children could also

play with the toys using little or no number talk; number talk is not required when playing with these toys. For instance, some families might focus on dividing items equally among two people, whereas other families might identify their favorite foods or emphasize elements of dramatic play. Therefore, it was expected that there would be wide variation in number talk in this play context.

Method

This study was approved by a university's Institutional Review Board prior to data collection.

Participants

Participants were 50 dyads of 2- to 4-year-old children (M = 42.80 months, SD = 10.58; 24 girls and 26 boys) and their parents (39 mothers and 11 fathers) who visited a research booth at a large public venue in the midwestern United States. The families' participation was part of a larger investigation (N = 111) using survey and observational methods to examine parent and child math engagement (additional findings from this project are reported in Chan, Praus-Singh, and Mazzocco (2020) and Clements, LeMahieu, Nelson, Eason, and Dearing (2021)). From this larger study, a total of 60 parent–child dyads participated in the videotaped observational portion of the study with the kitchen set. The remaining families opted to not be videotaped or to participate only in the survey portion of the study or participated on days where other materials (such as e-books) were used for the observation. The interactions of 6 dyads could not be analyzed due to technical difficulties that resulted in partial or no available audio recordings. An additional 4 dyads were excluded from the study due to other interferences with the established data collection protocol (e.g., parent took a phone call in the middle of the interaction).

All but 1 of the participating families reported that their primary language was English, with 8 of these families reporting that they spoke another language at home in addition to English. One family reported that Tagalog was the primary language spoken at home but indicated that English was also spoken at home. Parents reported child race/ethnicity as follows: 74% White; 10% multiracial; 8% Spanish, Latino, or Hispanic; 4% Asian or Asian American; and 4% Black or African American. Similarly, parents reported their own race/ethnicity as follows: 84% White, 6% Asian or Asian American, 4% Latino, 2% Black or African American, 2% Native American or Alaskan Native, and 2% multiracial. The majority (74%) of parents reported their educational attainment as a bachelor's degree or higher. Specifically, in terms of highest level of education, 4% completed high school/GED, 12% completed at least 1 year of college, 10% completed an associate's or 2-year degree, 38% completed a bachelor's or 4-year degree, 8% completed some graduate training, and 28% completed a graduate or professional degree.

Procedure

Recruitment and data collection for the current analyses occurred as part of a university-based initiative to promote public participation in research. This initiative established temporary research facilities at a state fair that provided research teams with space to recruit participants and conduct research studies. Data collection for the current study occurred over 6 days at a research booth set up under a large sided tent with office-style wall dividers used to create semiprivate areas for the dyads to interact. Although the dividers did not soundproof the play area, they served to reduce distractions and muffle noise from other families.

Families passing by the research area were recruited by being invited to participate in a "game buffet." Parents were told that the researchers were interested in how parents and children interact with different activities without any specific mention or prompting for them to engage in math. In exchange for their participation, children received a small piggy bank.

After obtaining consent from parents, dyads were videotaped while engaging in three activities (play with a kitchen playset, play with Duplos, and reading a math storybook) that have been shown to provide opportunities for math engagement. Parent–child dyads engaged with each activity for

approximately 6 min. The three activities were provided to parent–child dyads, with each activity stored in clear plastic containers. Parents and children were allowed to select the order in which they engaged with the materials, and 35 of the dyads (70%) selected to play with the kitchen playset first. After 5 min had elapsed from the start of play with each activity, a researcher prompted the dyad to transition to the next activity within 2 min. Following the interaction with the activities, parents completed a survey including items regarding beliefs, attitudes, and engagement regarding math and reading with preschoolers and well as demographic information. Given the focal questions for the current study and the power of a relatively small sample, only the demographic information from the survey was used for the current study.

We chose to focus on the kitchen playset as a play context that did not explicitly prompt families to talk about numbers. In contrast, we excluded the storybook interactions from this particular study because they contained explicit numerical content and prompts that would reduce the variability we would observe in parent–child number talk. Furthermore, for a separate research question not addressed in this current study, some dyads played with Duplos sets including several blocks with printed numerals and with decals representing quantities (e.g., two mice), whereas others played with Duplos without printed numerals or quantities affixed; consequently, we did not include the interactions with Duplos in these analyses.[2]

Materials

The kitchen set included a knife, a cutting board, and wooden foods that were cut into varying numbers (two to five) of pieces and held together with Velcro. The set also included four cups and four plates.

Measures

For parent and child number talk, audio recordings of the parent–child interactions were transcribed verbatim at the level of the utterance by a professional transcription service. A team of trained research assistants then used the video recordings to verify the parent and child talk in the transcripts and ensured that the transcripts adhered to the Codes for the Human Analysis of Transcripts (CHAT) conventions of the Child Language Data Exchange System (CHILDES; MacWhinney, 2000). Following CHAT conventions, we transcribed speech into units of utterances, defined as speech bounded by syntactic structure, intonation, or a pause of more than 2 s by the speaker. In addition, 28 verified transcripts (56%) were also double-checked by a second research assistant in order to ensure consistency across research assistants' adaptations to the CHAT standards.

Parent and child talk was analyzed from the transcripts based on two conceptualizations of numerical language: number word use and number-related utterances. Analyzing number talk at the word level enabled us to assess the frequency (*number tokens*) and diversity (*number types*) of number word use and allowed for a common measure of children's number talk across both their responses to parents and their own initiated talk. Analyzing number talk at the utterance level, in contrast, allowed us to distinguish between parents' delivery of number words in statements and their prompts inviting children to use number words. Furthermore, analyzing number talk utterances distinguished between instances when children were responding to parents and those when they were initiating number talk and yielded descriptive information about the contexts in which dyads talked about number (e.g., counting or comparing quantities). These coding approaches are described in more detail below.

[2] Ten dyads engaged with either the math storybook or Duplos with numerosities before playing with the kitchen set. Parents who engaged in an activity with numerical content prior to the kitchen set used more statements about number during the kitchen set activity but did not use more number prompts. Children's number talk did not differ during the kitchen set based on prior engagement in an activity with numerical content. Furthermore, controlling for exposure to numerical content did not change the relation between parent number talk and child number talk in our regression analyses. Consequently, we report findings for the entire sample regardless of the activity order.

Word-level number talk codes

The first approach examined number talk at the word level. The frequency (*tokens,* or total number words) and diversity (*types,* or total different number words said at least once) for the number words "one" through "twenty" were computed separately for parents and children from the transcripts of the videotaped interactions using the CLAN FREQ command. Each instance of parent and child use of the word "one" was coded manually for whether the usage was numerical (e.g., "Give me one piece") or non-numerical (e.g., "Give me a red one") using previously established coding criteria (see Levine et al., 2010). A second research assistant coded 20% of the utterances including the word "one"; coders were in agreement for 97% of the utterances. All non-numerical uses of "one" were excluded from the parent and child measures of number tokens and number types, both of which were used in analyses in order to assess quantity and diversity of number talk.

Utterance-level number talk codes

The second approach examined number talk at the utterance level. This level of coding was conducted to gain a more detailed understanding of how parents and children engaged in number talk during the activity. A two-step process was used to code all utterances in the transcript to identify and categorize utterances with number talk. First, all parent and child utterances, as previously defined by CHAT conventions, were coded as to whether or not they contained number talk. An utterance was identified as containing number talk if the speaker either used a number word or prompted the use of one or more numerical skills such as asking a child to count or identify a quantity, similar to coding systems used in previous studies (e.g., Ramani et al., 2015). In some cases, an instance of number talk, such as a single counting sequence, extended across multiple utterances. When this occurred, only the final utterance within this instance was coded as constituting number talk. For instance, "One. Two. Three." would be coded as one occurrence of counting even if it extended over multiple utterances because of pauses.

Utterances coded as number talk received two codes: *content of number talk* and *utterance type.* Content of number talk categorized number talk based on what number concepts were discussed (e.g., counting, cardinality, numeral identification) (see Table 1 for complete list and examples). Utterance type categorized utterances based on how they engaged and were related to the other speaker. Parent utterances were coded as statements (i.e., parent demonstrates or makes statement that provides information about number) or prompts (i.e., parent asks a question about number or tells child to perform numeracy skill such as counting). We initially subcategorized parent utterances as whether parents were initiating number talk or responding to child number talk; however, parent responses to child number talk were infrequent, so these were included in the overall counts of statements or prompts.

Child utterances were coded as either responses to parents or initiated number talk. Children's responses to parents were coded as responses to either prompts or statements; however, unless otherwise specified, responses to prompts and statements are reported together because responses to statements were infrequent (see Table 2). Similarly, we distinguished between children's initiating statements and questions but collapsed them together as child-initiated number talk because child-initiated questions were rare.

Two trained coders conducted the utterance-level coding. Approximately 25% of the transcripts were double-coded in order to assess inter-rater reliability. Where codes differed, the coders reached a consensus to determine the final code. Reliability was strong, with a Cohen's kappa coefficient of .90 for the parent codes and .87 for the child codes.

Analytic method

For the current analyses, we included the total number of parent statements and prompts as the two measures of parent number talk. To examine how parents' number talk was related to both the quantity and diversity of children's number use, child number talk was primarily analyzed at the word level as number tokens and number types. Additional descriptive and follow-up analyses used utterance-level codes pertaining to whether child number utterances were a response to parent number talk or were child initiated.

Table 1
Coding scheme for parent and child number utterances.

Number content code	Definition	Example
Counting	Counting or prompting to count	"Let's count the pieces." "I have one, two, three."
Cardinality	Labeling set size or asking about quantity	"How many do you have?" "You have two plates."
Equal distribution	Talking about equally dividing objects or matching one to one	"One for you and one for me." "We each get two."
Fraction	Referring to a portion of an item using a fraction word	"Can I have half of the apple?" "That's a quarter of the pepper."
Magnitude	Comparing or prompting to compare two quantities or talking about relative quantities	"I have more than two pieces." "Are these the same amount?"
Ordinality	Describing or prompting regarding the sequence of numbers	"What comes after four?" "Two then three . . ."

Table 2
Summary of parent and child number talk and overall talk.

	Parent			Child		
Variable	*M*	*SD*	Range	*M*	*SD*	Range
Number word use						
Types	1.38	1.18	0–4	1.38	1.60	0–6
Tokens	2.80	3.28	0–17	2.98	4.39	0–17
Number utterances						
Parent statements	2.64	3.37	0–15			
Parent prompts	1.18	1.98	0–8			
Child- initiated total				1.96	3.82	0–17
Initiated statements				1.92	3.83	0–17
Initiated questions				0.04	0.20	0–1
Child total responses to parent				0.64	1.51	0–7
Responses to prompts				0.58	1.50	0–7
Responses to statements				0.06	0.31	0–2
Overall talk (including non-numerical utterances)	119.00	47.84	44–230	39.78	23.50	0–86

To test our initial hypothesis regarding how parents' statements and prompts contribute to the frequency and diversity of child number word use, we used linear regression modeling to assess both forms of parent number utterances as predictors of child number word use across the interaction. In each model, we controlled for parents' education and child age. Parents' overall talk was correlated with parents' number statements ($r = .42$, $p = .001$) and number prompts ($r = .25$, $p = .038$), suggesting that parents who are more talkative may also talk more about numbers. Similarly, children's overall talk was correlated with their use of number tokens and types (both $r = .35$, $p = .006$). Consequently, we also controlled for overall parent and child talk (total utterances) in the regression models.

Results

We first report descriptive statistics for different types of parent and child number talk. We then present bivariate correlations and regression analyses examining the relations between different forms of parent number utterances (statements and prompts) and child number word use. Finally, we present findings from follow-up analyses regarding episodes of parent–child number talk as well as differences in children's number word use in initiated statements and in response to parent input in order to gain further insight into how different forms of parent number talk were related to child number talk.

Frequency and content of number talk

On average, number word use by parents and children was relatively infrequent, but there was considerable variability in both (see Table 2 for means and standard deviations). The majority of parents (74%) used at least one number word during play, but frequencies ranged from 0 to 17 total number tokens and from 0 to 4 number types. In turn, the majority of children (64%) also used at least one number word during play, with similar frequencies ranging from 0 to 17 number tokens and from 0 to 6 number types.

At the utterance level, the majority of parents (70%) provided at least one statement about number, but only 42% of parents provided at least one prompt about number. More than a third of parents provided only statements (36%), and just over another third provided both statements and prompts (34%), whereas 8% of parents used only prompts and more than a fifth of parents did not use any number talk (22%). Overall, parents used more number statements (M = 2.64, SD = 3.37) than number prompts (M = 1.18, SD = 1.98).

Less than a third of children (30%) had one or more number-related response utterances, and on average children had 0.64 (SD = 1.51) number responses during the interaction. Only 2 children (4%) responded to parent statements, whereas 26% of children responded to parent prompts, and 91% of child responses followed parent prompts rather than parent statements. Parent prompts also had a higher rate of child number responses than parent statements (49% vs. 2%). Slightly more than half of children (52%) initiated a number utterance at least once during the interaction, with children providing an average of 1.96 (SD = 3.82) initiated number utterances during the interactions.

We next examined the frequencies of different content areas of parent and child number talk to identify the most common contexts for number talk. To examine relative frequencies, in the text we report the percentage of number talk utterances coded as each individual content area and utterance type (e.g., parent prompts about cardinality/total parent number utterances). Because speakers who did not engage in number talk would have a denominator of 0, only speakers who used at least

Table 3
Summary of parent and child instances of number utterances by content area.

	Parent			Child		
	M	*SD*	Range	*M*	*SD*	Range
Counting						
Statements	0.12	0.39	0–2			
Prompts	0.18	0.48	0–2			
Initiated				0.06	0.32	0–2
Responses				0.32	0.87	0–4
Cardinality						
Statements	1.62	2.06	0–10			
Prompts	0.78	1.33	0–5			
Initiated				1.30	2.61	0–12
Responses				0.34	0.75	0–3
Equal distribution						
Statements	0.30	0.95	0–6			
Prompts	0.12	0.44	0–2			
Initiated				0.44	1.15	0–5
Responses				0.06	0.24	0–1
Fractions						
Statements	0.12	0.33	0–1			
Prompts	0.04	0.20	0–1			
Initiated				0.08	0.34	0–2
Responses				0	0	0
Magnitude						
Statements	0.44	0.88	0–4			
Prompts	0.02	0.14	0–1			
Initiated				0.08	0.28	0–1
Responses				0.02	0.14	0–1

Note. Values are the mean total of instances observed for each form of number utterance.

one number utterance are included. (Table 3 presents raw means and standard deviations for instances of each content area and utterance type across all parents and children, including those who did not engage in any number talk.)

The most common types of number utterance for parents involved cardinality. Among parents who engaged in any number talk, statements about cardinality accounted for an average of 49.9% of parent number utterances and prompts about cardinality accounted for an average of 16.6% of parent number talk. The next most frequent types of parent utterances were magnitude statements (average of 8.9% of parent number utterances) and prompts about equal distribution (average of 4.9% of parent number utterances). Notably, counting was relatively infrequent in parents' statements and prompts (averages of 2.1% and 3.4% of parent number utterances, respectively). For children, number utterances most often were initiated utterances about cardinality (average of 48.5% of children's number utterances). The next most frequent types of child number utterances were responses to parents' prompts about counting (average of 16.0% of child number utterances) and about cardinality (average of 12.6% of child number utterances). Children also initiated talk about equal distribution (average of 10.9% of child number utterances), but initiated counting was relatively infrequent (average of 3.3% of child-initiated number utterances).

Relations between parent and child number talk

To examine whether parents' number statements and number prompts were differentially related to children's number engagement during play, we analyzed relations between parent and child number talk, focusing on the frequency (tokens) and diversity (types) of children's number word use. Bivariate correlations among parent and child number talk variables are presented in Table 4. Both parents' number statements and their prompts were significantly correlated with children's number word tokens (statements: $r = .44$, $p = .001$; prompts: $r = .53$, $p < .001$) and types (statements: $r = .29$, $p = .043$; prompts: $r = .59$, $p < .001$).

To follow up on the bivariate correlations, we used regression analyses to determine whether parents' use of number statements and number prompts differentially predicted children's number talk. We analyzed separate regression models for the frequency (tokens) and diversity (types) of child number word talk. In each model, we controlled for parents' education and child age (Model 1), followed by parents' overall talk (Model 2) and children's overall talk (Model 3), both measured as total utterances. Parents' statements and prompts were entered in separate steps: first statements (Model 4) followed by prompts (Model 5). Whereas statements and prompts were strongly correlated, the variance inflation factor was 1.469 and tolerance was .681, indicating that collinearity was not a significant concern.

Predicting child number word frequency

Results from the regression analyses predicting the frequency of children's total number words (tokens) are shown in Table 5. The overall model explained 46.6% of the variance in children's number tokens, $F(6, 43) = 6.25$, $p < .001$. After accounting for child age and parent education as well as parent and child overall talk together, parents' number statements and number prompts together explained 31.6% of the variance in child number tokens. Both forms of parent number talk contributed comparable, significant amounts of unique variance in children's number tokens (each 7.4%, $p = .018$). In the final model, both parents' prompts and their statements as well as children's overall talk were significantly related to children's number tokens.

Predicting child number word diversity

Results from the regression analyses predicting the diversity of children's total number words (types) are shown in Table 6. The overall model predicted 45.8% of the variance in children' number types, $F(6, 43) = 6.067$, $p < .001$. After controlling for child age and parent education as well as parent and child overall talk, parents' number statements and number prompts together explained 27.1% of the variance in child number types; however, only number prompts contributed a significant amount of unique variance (prompts: 22.0%, $p < .001$; statements: 0.0%, $p = .623$). Only parent prompts were significantly related to children's number types in the final model, whereas parent number statements

Table 4
Correlations among parent and child variables.

	1	2	3	4	5	6	7	8	9	10	11
Parent											
1. Education	–										
2. Overall talk	−.15	–									
Number word use											
3. Types	−.05	.29*	–								
4. Tokens	−.08	.43**	.78***	–							
Number utterances											
5. Statements	.04	.42**	.64***	.86***	–						
6. Prompts	−.10	.25	.59***	.68***	.57***	–					
Child											
7. Age	−.02	−.08	.14	.04	.07	.12	–				
8. Overall talk	−.11	.28*	.07	.00	.00	.09	.40**	–			
Number word use											
9. Types	−.09	.22	.50***	.31*	.29*	.59***	.30*	.36*	–		
10. Tokens	−.14	.09	.50***	.44**	.44**	.53***	.26	.35*	.76***	–	
Number utterances											
11. Initiated	.07	−.08	.21	.05	.11	−.15	.01	.35*	.15	.58***	–
12. Responses	−.19	.15	.49***	.57***	.55***	.86***	.21	.11	.65***	.65***	−.10

Note. Overall talk was measured as total utterances.
*$p < .05$. **$p < .01$. ***$p < .001$.

Table 5
Regression analyses predicting child number word tokens.

	Model 1		Model 2		Model 3		Model 4		Model 5	
Predictor variable	*β*	*p*	*β*	*p*	*β*	*p*	*B*	*p*	*β*	*p*
Child age	.260	.069	.268	.063	.150	.335	.038	.779	.020	.878
Parent education	−.132	.351	.117	.414	−.102	.467	−.156	.201	−.115	.322
Parent overall talk			.096	.503	.011	.941	−.277	.061	−.270	.055
Child overall talk					.275	.093	.397	.007	.376	.007
Parent number statements							.561	.000	.367	.018
Parent number prompts									.337	.018
Total R^2	.086	.121	.095	.201	.150	.112	.391	.000	.466	.000
F change	2.207	.121	0.457	.503	2.938	.093	17.418	.000	5.995	.018
Degrees of freedom for *F* change	2, 47		1, 46		1, 45		1, 44		1, 43	

and parent education, child age, and parent and child overall talk were not significantly related to child number types.

Robustness check

Given the frequency of zeros in the parent number talk data, we conducted follow-up models to examine the robustness of our results when using alternative approaches for handling the zeros. First, we ran the regression models excluding dyads where parents did not use number talk. Second, we estimated negative binomial models rather than ordinary least squares regression models. In both cases, our results proved to be robust, with parents' prompts being a stronger predictor of children's number word diversity than statements and both statements and prompts contributing to the frequency of children's number word use.

Follow-up analyses

Regression analyses indicated that parent number prompts were a more robust predictor of child number word use during play compared with parent statements about number. These findings were consistent with our prediction that parents' prompts would uniquely elicit more frequent and diverse

Table 6
Regression analyses predicting child number word types.

	Model 1		Model 2		Model 3		Model 4		Model 5	
Predictor variable	β	p	β	p	β	p	B	p	β	p
Child age	.302	.034	.323	.022	.235	.127	.183	.231	.151	.246
Parent education	−.086	.539	−.049	.722	−.038	.782	−.063	.643	.007	.951
Parent overall talk			.242	.085	.178	.225	.045	.781	.057	.679
Child overall talk					.206	.197	.262	.102	.225	.101
Parent number statements							.258	.093	−.075	.623
Parent number prompts									.580	.000
Total R^2	.099	.086	.156	.048	.187	.049	.238	.030	.458	.000
F change	2.591	.086	3.091	.085	1.718	.197	2.953	.093	17.486	.000
Degrees of freedom for F change	2, 47		1, 46		1, 45		1, 44		1, 43	

child number word use. However, these analyses examined parent and child number talk across the entire interaction rather than examining directly how children respond to parent prompts and how this may be distinct from their responses to parents' statements and their own self-initiated number talk. Consequently, we conducted several exploratory follow-up analyses to examine children's number word use following parents' prompts and statements as well as children's self-initiated number word use. These follow-up analyses addressed two possible explanations for why parent prompts were linked to more frequent and diverse child number word use. First, prompts may lead to longer exchanges about number compared with parents' statements, creating more opportunities for children to use number words. Second, prompts may invite children to use more diverse and higher number words than they would use in their own initiated number talk.

Length of numeracy exchanges following parent prompts and statements

We first examined the length of parent–child number talk as exchanges, identifying episodes of number talk initiated by parent statements versus prompts and then analyzing parent and child number utterances that followed the initiating utterance.

The beginning of a number talk episode was defined as a parent or child utterance that initiated/introduced numerical content into the ongoing interaction; this initiating utterance was coded as a parent statement, a parent prompt, or child initiated. There were only two episodes initiated by child questions, so these were included in the broader category of child initiated. The end of the episode was determined by the dyad's talk shifting away from numerical content. For each number episode, we calculated the total number of subsequent parent and child utterances coded as number talk within the episode. In other words, the initiating number utterance was not counted toward the total utterances in an episode in order to avoid inflating the total utterances. For instance, the following episode was coded as having two child number utterances and three parent number utterances following the parent's initiating number utterance:

Parent: How many did you cut? (Initial number prompt)
Child: Two. (Child number utterance #1)
Parent: No, try again.
Parent: How many did you cut? (Parent number utterance #1)
Child: One, two, three, four. (Child number utterance #2)
Parent: Yeah.
Parent: So how many do we get? (Parent number utterance #2)
Child: [*silently distributes pieces*]
Parent: We each get two pieces. (Parent number utterance #3).

We identified 137 episodes across 41 dyads consisting of at least one number utterance. Descriptives are reported in Table 7. Episodes initiated by a parent prompt contained more child response utterances (M = 0.86, SD = 0.73) than episodes initiated by a parent number statement (M = 0.08, SD = 0.43), and this was a significant difference, t = 5.69, p < .001, d = 1.30. In addition,

child-initiated episodes had significantly more follow-up child utterances (M = 0.59, SD = 1.00) than episodes initiated by a parent statement, t = − 3.34, p = .001, d = 0.66. There was a nonsignificant difference where child-initiated episodes had fewer child follow-up utterances than parent prompt-initiated episodes, t = 1.40, p = .164, d = 0.30.

Parents also engaged in more follow-up number utterances in episodes initiated by a parent prompt (M = 0.89, SD = 1.55) than in episodes initiated by a parent statement (M = 0.23, SD = 0.64), t = 2.39, p = .022, d = 0.56. Parents also engaged in more follow-up number utterances in episodes initiated by a parent prompt than in those initiated by a child utterance (M = 0.29, SD = 0.79), t = 2.11, p = .041, d = .051. Finally, the quantity of parent follow-up number utterances in episodes initiated by a parent number statement versus a child-initiated number utterance did not differ, t = 0.418, p = .677, d = 0.08.

Overall, when parents initiated an episode of number talk with a prompt, it resulted in longer exchanges where both the child and the parent were engaged in a joint conversation about number than when an episode was initiated by a parent number statement. Episodes initiated by parent prompts also had longer exchanges compared with those following child-initiated utterances, especially in terms of parents' sustained engagement in the episode. For instance, in the following example, a parent's prompt led to a child counting pieces and an opportunity for a parent to provide feedback on the child's counting:

Child: [*cutting cucumber*]
Parent: How many pieces are there?
Child: One, two, three. [*points to pieces while counting but skips one*]
Parent: Let's count each one. Let's start here. [*taps pieces*] One ...
Child: One, two, three, four. [*points and taps pieces along with parent*]
Parent: Nice job. [*"high-fives" child*]

In contrast, in the following exchange, a parent briefly responded to a child's initiated number utterance but then followed the child's lead in shifting the focus away from numeracy:

Child: [*distributes three slices of bread on three of the four plates*] We need one more.
Parent: Need more bread? Okay.
Child: [*starts to use toy knife to slice another piece and struggles*]
Parent: Do you want to try another way? [*proceeds to help child use knife to cut bread and does not return to talking about number of pieces*]

Child-initiated episodes also were longer than those initiated by a parent statement, although this appeared to be driven by an increase in additional child number utterances; parents engaged in a similar quantity of follow-up utterances within child-initiated and parent statement-initiated episodes. Although infrequent, it should be noted that there were instances where parents did engage in more extensive follow-up number talk following a child initiation. For instance, in the following example, the parent pushed the numeracy exchange further:

Child: [*distributes pieces of bread across four plates*] One right here, one right here, one right here, and one right here.
Parent: And you have one extra piece.
Child: Huh.
Parent: Huh.
Child: Why?
Parent: Why? Because there were five pieces of bread and four plates. Right?
Child: Or maybe this ... [*puts fifth piece of bread on a plate that already has one piece*]
Parent: Yeah? So they get two pieces?
Child: Yep. [*moves on to cutting the apple*]

Table 7
Summary of parent and child number talk episodes and child number types.

	Episodes initiated by:					
	Parent prompt (n = 35)		Parent statement (n = 53)		Child utterance (n = 49)	
Utterances per episode	*M* (*SD*)	Range	*M* (*SD*)	Range	*M* (*SD*)	Range
Child	0.86 (0.73)	0–3	0.08 (0.43)	0–3	0.59 (1.00)	0–4
Parent	0.89 (1.55)	0–8	0.23 (0.64)	0–3	0.29 (0.79)	0–3
	Child utterance type					
	Response to parent prompt (n = 25)		Child initiated (n = 70)			
Child number talk	*M* (*SD*)	Range	*M* (*SD*)	Range		
Number types	2.44 (1.39)	1–5	1.17 (0.70)	1–5		
Highest number	3.48 (1.30)	1–6	1.27 (0.80)	1–5		

Diversity and complexity of child number talk in self-initiated utterances versus in responses to parents

Finally, to determine whether parents' prompts elicited more advanced child number talk, we compared the diversity (number word types) and complexity (highest number word) of children's number talk in utterances that were self-initiated or in response to parent prompts. Because across the entire sample there were only two instances where a child responded to a parent's statement, we were unable to compare children's use of numbers in responses to statements versus responses to prompts or to child-initiated talk. For each utterance coded as either a child response to a parent prompt or a child-initiated utterance, we counted the number word types and coded the highest number word occurring in the utterance.

We identified 95 utterances among the 32 children who used number words. Descriptives are reported in Table 7. Children used significantly more number word types per utterance in response to parent prompts (M = 2.44, SD = 1.39) than when initiating number talk themselves (M = 1.17, SD = 0.70), t = 4.38, p < .001, d = 1.15. They also used significantly higher number words in response to parents' prompts (M = 3.48, SD = 1.30) than in their own initiated number talk (M = 1.27, SD = 0.80), t = 8.00, p < .001, d = 2.05.

Altogether, our exploratory analyses offer some insight into what accounts for the different contributions of parent statements and prompts to child number talk observed in the regression analyses. The exchanges immediately following prompts were indeed longer, which provided more opportunities for scaffolding children's number talk. Furthermore, children used larger number words in response to parent prompts, which likely accounts for the cumulative association between parent prompts and children's number word types.

Discussion

Previous studies have linked children's number talk and number knowledge to parents' overall number talk and to qualitative differences in the content of their number talk (e.g., Casey et al., 2018; Gunderson & Levine, 2011; Ramani et al., 2015; Susperreguy & Davis-Kean, 2016). The current study adds to this body of literature by showing that *how* parents talk about numbers matters; that is, whereas both parent prompts and parent statements contributed to the total amount of children's number talk, parent prompts were more strongly related to the quality of children's number talk than parent statements. Previous studies have either excluded number prompts (e.g., Gunderson & Levine, 2011; Levine et al., 2010) or collapsed them into a broad number talk measure along with number statements (e.g., Casey et al., 2018; Ramani et al., 2015; Susperreguy & Davis-Kean, 2016). To our knowledge, this study is the first to compare how parents' use of numerical statements and prompts is related to children's engagement with number through their own number talk. By making this distinction, two critical findings emerged. First, prompts were uniquely related to the frequency and diversity of child number words after accounting for parents' number statements. Second, follow-up analyses indicated that prompts were associated with qualitatively richer number talk in child

responses and parent–child number conversations compared with exchanges following parent number statements or children's self-initiated number utterances.

Parents' number statements and prompts are related to frequency of child number use

Both parents' statements and prompts about number were related to the frequency of children's own use of number words after accounting for overall parent and child talk, child age, and parent education. The association between parents' use of number statements and children's number words is consistent with previous literature linking the quantity of parents' number word input with children's own number talk (e.g., Levine et al., 2010). These opportunities for talking about number are important because language can serve as a tool to support thinking (Gauvain, 2001; Gentner & Goldin-Meadow, 2003; Levine & Baillargeon, 2016), and within the domain of mathematics exposing children to increased mathematical language has been linked to improved number knowledge (Gibson et al., 2020; Purpura et al., 2017).

Parents' number prompts were related to the frequency of child number words even after accounting for parents' number statements. The observed association between parents' number prompts and frequency of child number words is also consistent with the existing literature that parents' use of questions enhances children's math engagement (e.g., Vandermaas-Peeler et al., 2016, 2018). Outside of the domain of mathematics, Melzi, Schick, and Kennedy (2011) found that during storybook reading, mothers who asked more questions had children who talked more, and this was driven by a greater number of children's elicited responses. Similarly, our follow-up analyses indicated that the relation between parent prompts and child number words may have stemmed from the prompts eliciting number responses from children; we found that children were more likely to talk about number following parent prompts than following parent statements. Furthermore, parents were also more likely to contribute additional number utterances within number talk episodes initiated by a prompt compared with episodes initiated by a statement that provided additional opportunities for child number talk.

Overall, the nature of parent–child exchanges following parent prompts resulted in longer number-related conversations compared with those following parent statements. Parents' number statements, such as "We both have two pieces" and "There is one thing left to cut," rarely resulted in children responding with additional talk about numbers. Parents' statements likely serve different functions than prompts, with these examples appearing to depict parents simply conveying relevant information rather than aiming to teach. However, the fact that children rarely responded to these statements reiterates the value of prompts; parents' prompts were associated with children more actively engaging in numerical talk and receiving opportunities for feedback.

Notably, episodes of number talk that were initiated by children also contained fewer parent utterances than episodes that were initiated by a parent prompt (excluding the prompt itself). Although it could be inferred that parents might not always recognize or take advantage of opportunities to respond to children's number engagement, less frequent parent number talk in response to children may also reflect parents allowing children to steer the direction of the activity. This is an important practice that aligns with previous research showing the importance of autonomy support for promoting children's early cognitive development (e.g., Bernier, Carlson, & Whipple, 2010; Grolnick, Gurland, DeCourcey, & Jacob, 2002). However, we did observe some instances where parents followed up on child-initiated number talk. Parents may be sensitive to children's activity goals, knowing when pushing conversations about numeracy will build on what children are engaged in and when it may derail them. This sensitivity is critical for effectively building on child-initiated number talk to push the conversation further. Bibok, Carpendale, and Müller (2009), for instance, noted that when parents are attuned to elaborating on what children are engaged in rather than attempting to redirect them, it is more likely to support children's learning. The fact that the effectiveness of parents' guidance is contingent on being attentive to children's goals may have important implications for supporting family math beyond simply encouraging parents to use prompts. There also should be an emphasis on recognizing child-initiated number talk as an opportunity for deeper math exploration and when a child may be most receptive to engaging in such exchanges.

Parents' prompts are associated with higher-quality child number talk

Whereas both parents' statements and their prompts were related to the frequency of child number words, only parents' prompts contributed to the diversity of children's number words. Children used more number word types when their parents used more prompts. Follow-up analyses indicated that children's responses to parents' prompts contained more diverse number words as well as higher number words in comparison with children's self-initiated number talk. These findings are consistent with previous work showing that inquiry-based guidance enhanced the quality of children's math and science exploration (Vandermaas-Peeler et al., 2019). In line with the concept of the zone of proximal development (Rogoff, 1998; Vygotsky, 1986), these findings suggest that a key contribution of parents' number prompts is that they push children to discuss a wider range of numbers than children would on their own. Using prompts to advance children's number talk to include larger quantities may be especially important for developing strong numeracy skills because there is evidence that exposure to higher numbers promotes children's understanding of cardinality (Elliott, Braham, & Libertus, 2017; Gunderson & Levine, 2011).

Parent number prompts are infrequent

As in previous studies (e.g., Levine et al., 2010; Ramani et al., 2015), we found wide variation in the quantity and quality of parent–child number talk, with a quarter of families engaging in no number talk during the observation. Although the activity offered opportunities to engage in number talk, not all families did so, which may be reflective of the extent of parents' routine engagement in number talk with their children. Moreover, even when parents engaged in number talk, number statements were much more frequent than number prompts, with more than half of parents not using any number prompts during the play session. This is particularly important to consider given that parent number prompts led to more diverse child number talk and richer parent–child exchanges about number. Thus, young children whose parents use few number prompts may receive less encouragement to engage in number talk compared with peers whose parents more frequently prompt number talk. Indeed, outside of the domain of mathematics, parent questions and the conversational turns that stem from them are associated with positive language outcomes for young children beyond the contributions of overall language input (e.g., Kuchirko et al., 2016; Romeo et al., 2018; Whitehurst et al., 1988). Similarly, within the domain of math, a lack of parent number prompts, even when parents use number statements, may limit children's opportunities to think and talk about numbers and to hear more extensive parent number talk that develops from prompt-initiated conversations.

An important next step is to examine what factors contribute to some parents using number prompts, whereas the majority of parents do not. This would advance efforts to understand the factors that account for the wide variation in the quantity and quality of number talk and would identify the best approaches to increasing the quantity and quality of parent–child number engagement. To our knowledge, there is no existing work looking at factors contributing to the frequency of parents' number prompts in particular. However, parent characteristics such as SES, their own math abilities, and their enjoyment of math have been linked to the quality of parents' observed number talk and self-reported math engagement at home (Elliott et al., 2017; Sonnenschein, Metzger, & Thompson, 2016; Vandermaas-Peeler, Nelson, Bumpass, & Sassine, 2009). It is possible that these parent characteristics, as well as parents' own math anxiety and their beliefs and expectations regarding their children's math learning, contribute to the extent to which parents use prompts to engage children in number talk. We did not observe a relation between parents' education and number talk—either statements or prompts—in the current study, but this may be due to the sample size and generally high level of education among the parents in the study. Similarly, we did not analyze parent beliefs about math due to the sample size; however, this will be an important area of research in the future. Furthermore, it will be worthwhile to investigate whether parents' use of prompts in the context of number are reflective of more general patterns in how they communicate and ask questions of their children.

Parents may be unsure about how to support young children's math skills, particularly in comparison with supporting early reading skills (Cannon & Ginsburg, 2008). Consequently, many parents may

benefit from guidance that helps them to recognize opportunities to talk about math and to engage their children in math talk. Offering guides or scripts with prompts for parents to ask during an activity has been found to increase parents' number talk and children's responses during both play and everyday activities (Berkowitz et al., 2015; Eason & Ramani, 2020; Hanner, Braham, Elliott, & Libertus, 2019; Vandermaas-Peeler, Boomgarden, et al., 2012; Vandermaas-Peeler, Ferretti, et al., 2012). Scripted questions have also led to parents asking their own additional questions focused on children's math comprehension or engagement (Eason & Ramani, 2020; Vandermaas-Peeler, Boomgarden, et al., 2012). Thus, an effective approach to enhancing parent–child number engagement may be providing some examples of how to prompt children's number talk while also encouraging parents to adapt these prompts to make them their own.

Limitations and future directions

When considering our results, it is important to recognize several limitations to generalizing our findings. First, we observed parent–child math talk during a brief interaction with a playset selected by the researchers. We know that different activity contexts and play materials may yield different quantities and qualities of parent and child number talk (e.g., Daubert, Ramani, Rowe, Eason, & Leech, 2018), and activity contexts may also influence how parents engage children in talk about math (e.g., Bjorklund, Hubertz, & Reubens, 2004). Consequently, the role of parents' number statements and prompts in facilitating children's number talk may vary across different activity contexts. Future studies should continue to examine these qualitative differences in parent–child number talk in different activity contexts as well as in naturalistic settings.

We also acknowledge that our sample was relatively homogeneous, being primarily White and highly educated. In particular, because there are early socioeconomic disparities in math achievement (e.g., Jordan & Levine, 2009) and previously observed SES differences in how parents engage in math talk (e.g., Berkowitz, Gibson, & Levine, in press; Saxe, Guberman, & Gearhart, 1987), it is critical to examine the relation between different types of parent number talk and child number engagement in diverse families. Although we do not know of evidence to suggest that the relation between parent number talk and child number talk would differ as a function of ethnicity or SES, analyses of these processes in more heterogeneous samples will be valuable for ensuring that findings can inform practices tailored to families' diverse contexts.

In addition, it is important to point out that the current study was correlational in nature, took place at only one time point, and did not include measures of child math achievement. Thus, it will be useful for future work to examine the role of parents' number prompts over time and to examine whether these prompts are positively associated with children's later math knowledge beyond the contribution of parents' number statements. Our expectation is that parents' use of number prompts is associated with stronger math achievement over time because they appear to lead to increases in both children's active engagement in talk about numbers and dynamic parent–child conversations about number. It is also possible that the unique contributions of statements and prompts change over time, and longitudinal studies would help to shed light on developmental changes. For instance, perhaps statements are more important for younger children or in contexts with novel math concepts, whereas prompts become increasingly beneficial over time. Finally, experimental studies could test our proposed mechanism of prompts supporting children's math engagement and learning by manipulating the presence of prompts in a math activity.

Conclusion

This study examined the role of prompts in facilitating children's number engagement beyond parents' provision of number words through statements. The findings indicate that whereas hearing parents' number words is associated with increased child number talk, parent prompts may further enhance children's number engagement by scaffolding children's use of more diverse and larger number words. Number prompts also may support engagement by extending and enriching dyadic conversations about number. Achievement gaps in math have lasting ramifications and emerge prior to school entry (Dowker, 2008; Duncan et al., 2007; Starkey & Klein, 2008), and children's math language

is linked to their math knowledge (Levine et al., 2010; Purpura & Reid, 2016). The current study findings suggest that encouraging parents to use number prompts as well as number statements in their conversations with young children holds promise for enhancing family engagement around math and supporting children's long-term math engagement and achievement.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgment

This research was supported by the Heising–Simons Foundation Development and Research in Early Mathematics Education (DREME) Network. The authors also thank the University of Minnesota Driven to Discover Research Facility at the Minnesota State Fair for making this project possible.

References

Berkowitz, T., Gibson, D., & Levine, S.C. (in press). Parents' math anxiety predicts early number talk with children. Journal of Cognition and Development.

Berkowitz, T., Schaeffer, M. W., Maloney, E. A., Peterson, L., Gregor, C., Levine, S. C., & Beilock, S. L. (2015). Math at home adds up to achievement in school. *Science, 350*, 196–198.

Bernier, A., Carlson, S. M., & Whipple, N. (2010). From external regulation to self-regulation: Early parenting precursors of young children's executive functioning. *Child Development, 81*, 326–339.

Bibok, M. B., Carpendale, J. I. M., & Müller, U. (2009). Parental scaffolding and the development of executive function. *New Directions for Child and Adolescent Development, 2009*, 17–34.

Bjorklund, D. F., Hubertz, M. J., & Reubens, A. C. (2004). Young children's arithmetic strategies in social context: How parents contribute to children's strategy development while playing games. *International Journal of Behavioral Development, 28*, 347–357.

Braham, E. J., Libertus, M. E., & McCrink, K. (2018). Children's spontaneous focus on number before and after guided parent-child interactions in a children's museum. *Developmental Psychology, 54*(8), 1492–1498. https://doi.org/10.1037/dev0000534.

Cannon, J., & Ginsburg, H. P. (2008). "Doing the math": Maternal beliefs about early mathematics versus language learning. *Early Education and Development, 19*, 238–260.

Casey, B. M., Lombardi, C. M., Thomson, D., Nguyen, H. N., Paz, M., Theriault, C. A., & Dearing, E. (2018). Maternal support of children's early numerical concept learning predicts preschool and first-grade math achievement. *Child Development, 89*, 156–173.

Chan, J. Y-C., Praus-Singh, T. L., & Mazzocco, Michèle M. M. (2020). Parents' and young children's attention to mathematical features varies across play materials. *Early Childhood Research Quarterly, 50*, 65–77. https://doi.org/10.1016/j.ecresq.2019.03.002.

Clements, L. J., LeMahieu, R. A., Nelson, A. E., Eason, S. H., & Dearing, E. (2021). Associations between parents' number talk and management language with young children. *Journal of Applied Developmental Psychology, 73*. https://doi.org/10.1016/j.appdev.2021.101261 101261.

Daubert, E., Ramani, G., Rowe, M., Eason, S., & Leech, K. (2018). Sum thing to talk about: Caregiver–preschooler math talk in low-income families from the United States. *Bordón, 70*(3), 115–130.

Dowker, A. (2008). Individual differences in numerical abilities in preschoolers. *Developmental Science, 11*, 650–654.

Duncan, G. J., Dowsett, C. J., Claessens, A., Magnuson, K., Huston, A. C., Klebanov, P., ... Japel, C. (2007). School readiness and later achievement. *Developmental Psychology, 43*, 1428–1446.

Eason, S. H., & Ramani, G. B. (2020). Parent–child math talk about fractions during formal learning and guided play activities. *Child Development, 91*, 546–562.

Elliott, L., Braham, E. J., & Libertus, M. E. (2017). Understanding sources of individual variability in parents' number talk with young children. *Journal of Experimental Child Psychology, 159*, 1–15.

Fletcher, K. L., Cross, J. R., Tanney, A. L., Schneider, M., & Finch, W. H. (2008). Predicting language development in children at risk: The effects of quality and frequency of caregiver reading. *Early Education and Development, 19*, 89–111.

Gauvain, M. (2001). *The social context of cognitive development*. New York: Guilford.

Gauvain, M., Beebe, H., & Zhao, S. (2011). Applying the cultural approach to cognitive development. *Journal of Cognition and Development, 12*, 121–133.

Gauvain, M., & Rogoff, B. (1989). Collaborative problem solving and children's planning skills. *Developmental Psychology, 25*, 139–151.

Geary, D. C., & vanMarle, K. (2016). Young children's core symbolic and nonsymbolic quantitative knowledge in the prediction of later mathematics achievement. *Developmental Psychology, 52*, 2130–2144.

Gentner, D., & Goldin-Meadow, S. (Eds.). (2003). *Language in mind: Advances in the study of language and thought*. Cambridge, MA: MIT Press.

Gibson, D. J., Gunderson, E. A., & Levine, S. C. (2020). Causal effects of parent number talk on preschoolers' number knowledge. *Child Development, 91*(6), e1162–e1177. https://doi.org/10.1111/cdev.13423.

Grolnick, W. S., Gurland, S. T., DeCourcey, W., & Jacob, K. (2002). Antecedents and consequences of mothers' autonomy support: An experimental investigation. *Developmental Psychology, 38*, 143–155.
Gunderson, E. A., & Levine, S. C. (2011). Some types of parent number talk count more than others: Relations between parents' input and children's cardinal-number knowledge. *Developmental Science, 14*, 1021–1032.
Hanner, E., Braham, E. J., Elliott, L., & Libertus, M. E. (2019). Promoting math talk in adult–child interactions through grocery store signs. *Mind, Brain, and Education, 13*, 110–118.
Jordan, N. C., & Levine, S. C. (2009). Socioeconomic variation, number competence, and mathematics learning difficulties in young children. *Developmental Disabilities Research Reviews, 15*, 60–68.
Kuchirko, Y., Tamis-LeMonda, C. S., Luo, R., & Liang, E. (2016). "What happened next?": Developmental changes in mothers' questions to children. *Journal of Early Childhood Literacy, 16*, 498–521.
Levine, S. C., & Baillargeon, R. (2016). Different faces of language in numerical development: Exact number and individuation. In D. Barner & A. S. Baron (Eds.), *Core knowledge and conceptual change* (pp. 127–150). New York: Oxford University Press.
Levine, S. C., Suriyakham, L. W., Rowe, M. L., Huttenlocher, J., & Gunderson, E. A. (2010). What counts in the development of young children's number knowledge? *Developmental Psychology, 46*, 1309–1319.
MacWhinney, B. (2000). *The CHILDES project: Tools for analyzing talk: Transcription format and programs (Vol. 1 3rd ed.)*. Mahwah, NJ: Lawrence Erlbaum.
Melzi, G., Schick, A. R., & Kennedy, J. L. (2011). Narrative elaboration and participation: Two dimensions of maternal elicitation style. *Child Development, 82*, 1282–1296.
Mol, S. E., Bus, A. G., de Jong, M. T., & Smeets, D. J. H. (2008). Added value of dialogic parent–child book readings: A meta-analysis. *Early Education and Development, 19*, 7–26.
Purpura, D. J., & Napoli, A. R. (2015). Early numeracy and literacy: Untangling the relation between specific components. *Mathematical Thinking and Learning, 17*, 197–218.
Purpura, D. J., Napoli, A. R., Wehrspann, E. A., & Gold, Z. S. (2017). Causal connections between mathematical language and mathematical knowledge: A dialogic reading intervention. *Journal of Research on Educational Effectiveness, 10*, 116–137.
Purpura, D. J., & Reid, E. E. (2016). Mathematics and language: Individual and group differences in mathematical language skills in young children. *Early Childhood Research Quarterly, 36*, 259–268.
Ramani, G. B., Rowe, M. L., Eason, S. H., & Leech, K. A. (2015). Math talk during informal learning activities in Head Start families. *Cognitive Development, 35*, 15–33.
Rogoff, B. (1998). Cognition as a collaborative process. In W. Damon, R. M. Lerner, D. Kuhn, & R. S. Siegler (Eds.), *Handbook of child psychology, Volume 2: Cognition, perception, and language* (pp. 679–744). New York: John Wiley.
Romeo, R. R., Leonard, J. A., Robinson, S. T., West, M. R., Mackey, A. P., Rowe, M. L., & Gabrieli, J. D. E. (2018). Beyond the 30-million-word gap: Children's conversational exposure Is associated with language-related brain function. *Psychological Science, 29*, 700–710.
Saxe, G. B., Guberman, S. R., & Gearhart, M. (1987). Social processes in early number development. Monographs of the Society for Research in Child Development, 52, (2, Serial No. 216)
Sonnenschein, S., Metzger, S., & Thompson, J. (2016). Low-income parents' socialization of their preschoolers' early reading and math skills. *Research in Human Development, 13*, 207–224.
Starkey, P., & Klein, A. (2008). Sociocultural influences on young children's mathematical knowledge. In O. Saracho & B. Spodek (Eds.), Contemporary perspectives on mathematics in early childhood education (pp. 253–276). Charlotte, NC: Information Age Publishing
Susperreguy, M. I., & Davis-Kean, P. E. (2016). Maternal math talk in the home and math skills in preschool children. *Early Education and Development, 27*, 841–857.
Vandermaas-Peeler, M., Boomgarden, E., Finn, L., & Pittard, C. (2012). Parental support of numeracy during a cooking activity with four-year-olds. *International Journal of Early Years Education, 20*, 78–93.
Vandermaas-Peeler, M., Ferretti, L., & Loving, S. (2012). Playing the Ladybug Game: Parent guidance of young children's numeracy activities. *Early Child Development and Care, 182*, 1289–1307.
Vandermaas-Peeler, M., Massey, K., & Kendall, A. (2016). Parent guidance of young children's scientific and mathematical reasoning in a science museum. *Early Childhood Education Journal, 44*, 217–224.
Vandermaas-Peeler, M., Mischka, M., & Sands, K. (2019). "What do you notice?" Parent guidance of preschoolers' inquiry in activities at home. *Early Child Development and Care, 189*, 220–232.
Vandermaas-Peeler, M., Nelson, J., Bumpass, C., & Sassine, B. (2009). Numeracy-related exchanges in joint storybook reading and play. *International Journal of Early Years Education, 17*, 67–84.
Vandermaas-Peeler, M., & Pittard, C. (2014). Influences of social context on parent guidance and low-income preschoolers' independent and guided math performance. *Early Child Development and Care, 184*, 500–521.
Vandermaas-Peeler, M., Westerberg, L., Fleishman, H., Sands, K., & Mischka, M. (2018). Parental guidance of young children's mathematics and scientific inquiry in games, cooking, and nature activities. *International Journal of Early Years Education, 26*, 369–386.
Vygotsky, L. S. (1986). Thought and language (rev. ed.) (A. Kozulin, Ed.). Cambridge, MA: MIT Press
Wertsch, J. V. (2008). From social interaction to higher psychological processes. *Human Development, 51*, 66–79.
Whitehurst, G. J., Falco, F. L., Lonigan, C. J., Fischel, J. E., DeBaryshe, B. D., Valdez-Menchaca, M. C., & Caulfield, M. (1988). Accelerating language development through picture book reading. *Developmental Psychology, 24*, 552–559.