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Parent-Child Talk about Early Numeracy: The Role of Context and Parents' Math Beliefs

Keywords: parent-child; numeracy; preschoolers; card games; parent beliefs; math anxiety; mathematics

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Abstract

The goal of the study was to examine how the context of parent-child play and parents' math-related beliefs relate to parent-child talk about an early numeracy concept. Parents and their preschoolers (*n* = 46) engaged in a videotaped play session and parents were surveyed about their math-related beliefs. The findings indicate that the type of informal number activity in which parents chose to engage their children predicted how frequently parents provided input to their children about an important early numeracy concept. Additionally, parents' belief about their own math anxiety was related to the frequency of their children's exploration of the early numeracy concept during the parent-child play session. These results suggest that identifying games that facilitate specific number concepts may be an effective way for researchers to promote frequent parent input about more advanced early number concepts. The results also highlight the need for additional research on the role of parents' math-related beliefs in their support of their children's early learning and school readiness.

Early numeracy refers to conceptual and procedural knowledge of numbers which children may acquire before they begin formal schooling (Jordan, Kaplan, Ramineni & Locuniak, 2009; National Mathematics Advisory Panel, 2008; National Research Council, 2009). Early numeracy includes an understanding of counting principles and the relative size of numbers. It also includes proficiency in determining the value of small quantities, identifying numerals, and solving simple arithmetic problems (Jordan et al., 2009; National Mathematics Advisory Panel, 2008).

Children's early numeracy varies at school entry (Jordan et al, 2009; National Research Council, 2009). This is particularly important as children's early numeracy uniquely predicts their long-term academic achievement (Berkowitz et al., 2015; Jordan et al., 2009; National Research Council, 2009; Rittle-Johnson, Hofer, Fyfe & Farran, 2017; Siegler et al., 2012). For instance, Rittle-Johnson et al. (2017) found that kindergarteners' numeracy skills like non-symbolic magnitude comparison (e.g. being able to decide which of two dot arrays has the larger quantity), counting, and simple arithmetic predicted their math skills as fifth graders. In addition, children's early numeracy knowledge and skills are correlated with their later socioeconomic status and their highest level of educational attainment, controlling for their socioeconomic status at birth and their general intelligence (Ritchie & Bates, 2013). Thus, previous research has established that early numeracy is very important.

There is increasing research examining the home environment as a potential source of the variability in children's numeracy at school entry. Many researchers have attributed some of the differences in children's early numeracy to differences in the numeracy input that their parents provide (e.g. Casey et al., 2016; Gunderson & Levine, 2011; Levine, Suriyakham, Rowe, Huttenlocher & Gunderson, 2010; Ramani, Rowe, Eason & Leech, 2015; Río, Susperreguy, Strasser & Salinas, 2017; Skwarchuk, Sowinski & LeFevre, 2014; Vandermaas-Peeler, Boomgarden, Finn & Pittard, 2012; Zippert & Ramani, 2017). Studies have shown that parents can support their children's numeracy competence by engaging them in numeracy activities at home (Dearing et al., 2012; Ramani, Rowe, Eason & Leech, 2015; Río et al., 2017; Skwarchuk et al., 2014; Vandermaas-Peeler et al., 2011; Zippert & Ramani, 2017). Additionally, previous research has elucidated the importance of parents' input about numeracy concepts for their children's numeracy achievement (Casey et al., 2016; Gunderson & Levine, 2011; Levine, Suriyakham, Rowe, Huttenlocher & Gunderson, 2010; Ramani et al., 2015). For example, preschoolers whose parents provide input about numeracy concepts frequently while engaging them in number activities tend to have better numeracy skills than preschoolers whose parents talk about numeracy infrequently (Casey et al., 2016; Elliot et al., 2017; Gunderson & Levine, 2011; Ramani et al., 2015; Susperreguy & Davis-Kean, 2016).

The frequency of parents' talk about more advanced early numeracy concepts with their children may be particularly important in supporting the development of their children's early numeracy skills (Ramani et al., 2015). Advanced numeracy concepts refer to components of numeracy that are related to the ability to solve symbolic number problems such as symbolic magnitude comparison and symbolic arithmetic. Advanced number concepts build upon more foundational number concepts and skills like recitation of the counting sequence and identification of numerals. Although parents and their children engage in number activity relatively often (a few times per month to a few times per week; Lefevre et al., 2009, Ramani et al, 2015, Río et al., 2017; Skwarchuk et al., 2013), they rarely talk about more advanced early numeracy concepts like magnitude comparison and arithmetic (Ramani et al., 2015; Río et al., 2017; Vandermaas-Peeler, 2011; Zippert & Ramani, 2017). Furthermore, Skwarchuk (2009) found that parents' talk about advanced number concepts are better predictors of their children's later math achievement than their talk about foundational number concepts. Thus, it is important that parents discuss more advanced number concepts with their children.

Some parents of preschoolers seem to find engaging in dialogue about numbers, especially beyond counting, particularly challenging (Cannon & Ginsburg, 2008; Skwarchuk, 2009). For instance, over 74% of an economically diverse sample of White and Latina parents (n=37) reported that they did not know what math concepts and skills their preschoolers (M_{age} = 4 years, 5 months) should be learning or how they could effectively support their children's numeracy development (Cannon & Ginsburg, 2008). In addition, over 61% of the parents reported that they had no expectations or goals for their children's math learning (Cannon & Ginsburg, 2008). Thus, it is important that researchers examine ways to effectively help parents talk with their children about more advanced number concepts frequently. It is also important that these interventions are inexpensive, since children from low-income families tend to start school with weaker number skills than their peers (Jordan et al., 2009).

One advanced early number skill that parents should be exploring with their children is magnitude comparison. Magnitude comparison refers to an understanding of the relative size of numbers and is a critical component of children's numeracy development, according to the integrated theory of numerical development (Siegler, 2016). Additionally, the ability to compare magnitudes is particularly predictive of children's later math ability (De Smedt, Noël, Gilmore & Ansari, 2013; Rittle-Johnson et al., 2017; Siegler, 2016; Xenidou-Dervou et al., 2017). For instance, De Smedt et al. (2013) reviewed numerous articles which found that children's symbolic magnitude comparison skills (comparing the relative size of written numerals or verbally expressed numbers) uniquely predict their math achievement one to two years later.

Further, studies have demonstrated that parent-child engagement in advanced formal number activities predicts children's advanced number skills, including their symbolic magnitude comparison skills (Skwarchuk et al., 2014; Zippert & Ramani, 2017). Advanced formal number activities refer to activities like practicing simple sums and memorizing math facts in which an individual teaches advanced number skills or concepts directly. According to Cannon & Ginsburg (2008), 77% of the parents in their study reported that they prefer to engage their children in informal math activities rather than formal ones. In addition, 74% believe that math learning at home should be interesting and enjoyable for their children.

Despite the potential of informal math activities as a good context for frequent parent-child discussion of advanced number concepts, only a few studies have examined parents' talk about advanced number concepts while they engage in informal activities with their children (Vandermaas-Peeler et al., 2011; Vandermaas-Peeler et al., 2012). Both studies found that parents who did not receive guidance on incorporating numeracy as they play with their children rarely talked about advanced number concepts while doing a cooking activity and playing a board game. However, parents who received suggestions talked about advanced number concepts significantly more often than other parents. Additionally, researchers have posited that the activities in which parents and their children engage influences the amount and types of math input that parents provide (Bjorklund, Hubertz & Reubens, 2004; Vandermaas-Peeler et al., 2009; Vandermaas-Peeler et al., 2011). Thus, more research is needed to examine whether there are informal number activities that facilitate parents' advanced number talk without researcher intervention. It is probable that parents will discuss advanced number concepts more frequently with their children if they are made aware of informal activities that relate to or elicit talk about advanced number concepts.

One important factor in the variability of the frequency of parent-child number engagement is parents' math-related beliefs about themselves and their children (Cannon & Ginsburg, 2008; Elliott et al., 2017; Missall et al., 2015; Musun-Miller & Blevins-Knabe, 1998; Skwarchuk, 2009; Sonnenschein et al., 2012). Previous research suggests that parents' beliefs about the importance of math (Missall et al., 2015; Musun-Miller & Blevins-Knabe, 1998; Sonnenschein et al., 2012) and their children's math skills (Missall et al., 2015) relate to how frequently they do math activities with their children. In addition, parents' beliefs about their own level of math anxiety is negatively associated with how frequently they engage in numeracy activities with their children, including advanced activities (Río et al., 2017). Parents' preference for math and their belief about their own math ability do not seem to relate to how often they engage their children in math activities at home (Sonnenschein et al., 2012).

However, little is known about the relationship between parents' math beliefs and how frequently they talk about numbers with their children. Elliot et al. (2017) examined the relationship between parents' math-related beliefs and their overall number talk with their children. They found that parents' beliefs about their own abilities, but not their beliefs about the importance of math or their preference for math, predicted their number talk. Thus, research examining parents' beliefs about math and how frequently they support more advanced number concepts, especially given the importance of more advanced number skills like magnitude comparison (Skwarchuk et al., 2014; Zippert & Ramani, 2017; Vandermaas-Peeler et al., 2012), is needed.

Current Study

In the current study, preschool children and one of their parents were asked to play with a deck of modified playing cards. The parent-child dyads could play a suggested game or a game of their choosing. The first goal of the study was to examine the relationship between the type of game that parent-child dyads played with the deck of cards and how frequently they talked about magnitude comparison. We hypothesized that parents and children who play the suggested card game, *War*, would talk about magnitude comparison more frequently than parents and children who played a different card game. We predicted this given that the game *War* requires some magnitude comparison since it involves each player determining which of two cards has the larger quantity. Conversely, we anticipated that parents who played a different card game would not compare magnitudes frequently (in line with prior research; e.g. Vandermaas- Peeler et al., 2012). The study's second goal was to examine whether the type of card game played by parent-child dyads was predictive of their magnitude comparison talk. We hypothesized that the type of card game played would be a significant predictor or parents and children's magnitude comparison talk. Thirdly, the study aimed to examine the relationship between parents' math-related beliefs and how frequently they and their children talked about magnitude comparison while they played with cards. We hypothesized that parents' math-related beliefs would correlate with the frequency of their magnitude comparison input, but not with the frequency of their children's magnitude comparison talk.

Method

Participants

Participants were drawn from a longitudinal study of 74 children who were originally recruited at the beginning of the prekindergarten year in 2016. The children were recruited from 6 public and private preschools in a large urban city in Tennessee. Forty-seven of the 74 children in the original sample along with one of their primary caregivers participated in the present study. However, one dyad's data was unusable due to technical issues. Thus, the final sample for the present study was 46 preschoolers (*M*= 4.56 years, *SD*=.29) and one of their parents. The preschoolers were mostly girls (54%) and mostly monolingual (89%). They were 46% White, 39% African American or Black, 4% Biracial or Multiracial, 4% Middle Eastern, 4% Hispanic, and 2% Asian or Pacific Islander. Thirty-seven percent of them received at least some financial assistance at school.

Primary caregivers (henceforth referred to as parents) were 38 mothers, 7 fathers, and 1 grandmother. They identified as 49% White, 38% African American or Black, 2% Asian or Pacific Islander, 2% American Indian or Alaskan Native, 9% Biracial or Multiracial. Four percent of parents also indicated that they had Hispanic heritage. Reports on both parents of each participating child (as applicable) indicated that most of the parents had at least a 2-year degree or some college (87% of mothers and 63% of fathers). Table 1 provides additional details on parents' education.

Procedure

Parent-Child Interactions. The parent-child play sessions took place during drop-off or pick-up times at the children's preschools and were videotaped. Each dyad played with three toys separately in a randomized order. However, the present study focuses on the dyads' play with one of those toys - a deck of modified cards (see Figure 1). The cards were modified so that they had dots instead of the suits of regular playing cards. In addition, the number of dots corresponded exactly with the numerals on the cards, unlike regular cards which have additional suit motifs under the numerals. Finally, the deck included cards with the number one and did not include any face cards.

An experimenter informed parent-child-dyads that they could play one of the card games listed on a suggestion card (see Figure 1) or that they could choose and play any different card game. The experimenter left the immediate play area to give dyads privacy and returned to prompt them to stop playing with the cards after five minutes and then after 2-minutes if they requested additional time. The play sessions lasted 7.48 minutes on average (*SD*=2.9).

Video coding. Each video-recorded parent-child play session interaction was divided into ten-second intervals. Next, each interval was coded for parent and child number talk separately using a coding scheme which was adapted from Ramani et al. (2015). The codes were applied mutually exclusively and hierarchically in accordance with the order of the codes in Table 2. The coding scheme was designed so that the most advanced early number concepts (arithmetic and magnitude comparison) were listed at the top and would be captured if they occurred. Specifically, a code was applied for the most advanced number concept that each parent and child explored within each 10-second interval. If parents and/ or children talked about multiple number concepts in the same 10-second interval, the concept that was listed highest on the coding scheme was coded. A graduate student and an undergraduate research assistant double coded 20% of the parent-child interaction videos. Kappa coefficients were calculated for the coders since they are appropriate for mutually exclusive coding schemes (Cohen, 1960). The kappa coefficients ranged from acceptable to good (McHugh, 2012) for parents' (0.85-0.93) and children's (0.78-0.93) number talk. The first author coded the videos for the type of card game that dyads played.

Measures

Parent questionnaire. Parents reported their beliefs about different academic areas and provided demographic information via a questionnaire. The current study focuses on parents' math-related beliefs about themselves and their children. Parents reported on their math-related beliefs about themselves on 7-point Likert-type scales (5 items). Specifically, they rated the level of their current and previous math ability, and how important they believe being good at math is for themselves. They also reported their preference for and anxiety about math. Similarly, parents reported on their math-related beliefs about their children on 7-point Likert-type scales (6 items). Specifically, they rated their children's current, anticipated, and innate math ability. Parents also rated how important they believe being good at math is for their child (2 items) as well as their child's preference for math. Parents completed the questionnaire before (n= 33) or after (n= 6) they completed the parent-child play session or on the day of the play session (n= 7). On average, parents completed the survey within 14.41 days of their play session (*SD*=19.45).

Children's measures. Children's math abilities were measured using the Research-Based Early Mathematics Assessment Short-Form (Weiland et al., 2012). The first section of the REMA-Brief assessed children's number knowledge (13 items) while the second section assessed their geometric knowledge (6 items). Children's verbal skills were measured using the Picture Vocabulary Test from version 1.6 of the NIH Toolbox iPad application (Weintraub et al., 2013). Children's scores were age-normed standardized values.

Results

Descriptive Statistics

Fifty-seven percent of the parent-child dyads (n=26) played the card game *War*. The remaining dyads (n=20) played a variety of other card games, including *Order-Up* and *Go-Fish*. The participants who played card games other than *War* were collapsed into one group ("Other Card Game"), given how few participants played some games (see Table 3).

Parents who played *War* talked about various early numeracy concepts for 67% of the play session on average, while parents who played other card games talked about different early numeracy concepts for 54% of the play session (see table 4). An independent samples t-test demonstrated that this was significantly different, $t(44)=2.27$, $p=.03$. Conversely, both children who played *War* and those who played other card games talked about early numeracy concepts for 48% of the play session on average, $t(44)= 0.06$, $p = .95$.

Descriptive statistics for parents' math-related beliefs are presented in Table 5. Overall, parents' rated their beliefs about themselves and their children positively. Additionally, children's math and verbal ability were not correlated with parents' or children's magnitude comparison talk. Thus, they were not included in further analyses.

Type of Card Game and Relations to Frequency of Magnitude Comparison Talk

Two independent samples t-tests were conducted to examine whether there was a significant difference between the frequency of magnitude comparison talk by parents and children who played *War* and those who played other card games. Parents who played *War* provided input about magnitude comparison (M=.36, SD=.16) significantly more often than parents who played other card games (M=.07, SD=.15), $t(44)=6.07$, $p<.001$. Likewise, children who played *War* talked about magnitudes (M=.20, SD=.12) significantly more often than their peers who played other card games (M=.07, SD=.13), $t(44)=3.64$, $p=.001$. Thus, the findings support the first hypothesis.

Next, two hierarchical regressions were used to examine whether the type of card game that parents and their children played predicted their talk about magnitude comparison. Parents' magnitude comparison talk was the dependent variable in the first two-stage hierarchical regression model (see Table 6). Children's magnitude comparison talk, which was strongly correlated to parents' magnitude comparison talk, $r=.53$, $p<.001$, was entered at stage one. The model explained 28% of the variance in parents' magnitude comparison talk at stage one. The model explained 51% of the variance at stage two with the addition of the type of game played, $F(2,43)=22.61$, $p<.001$. A separate model was conducted with children's magnitude comparison talk as the dependent variable (see Table 7). Parents' magnitude comparison talk was entered at stage one and it accounted for 28% of the variance in children's magnitude comparison talk. The model explained 31% of the variance in children's magnitude comparison talk after the type of game played that dyads played was added. While the model was significant at stage two, $F(2,43)=9.72$, $p<.001$, the type of card game played was not a significant factor. Thus, the findings partially supported the second hypothesis, given that the type of card game uniquely played predicted parents' but not children's talk about magnitude comparison.

Parents' Math-Related Beliefs and Relations to Magnitude Comparison Talk

Parents' math-related beliefs about themselves were correlated with parents' and children's magnitude comparison talk to explore how they relate. As shown in Table 8, the only significant correlation found was between parents' math anxiety and their children's talk about magnitudes. Thus, the results did not support the hypothesis that parents' math-related beliefs would relate to the frequency of their input about magnitude comparison but not the frequency of their children's magnitude comparison talk.

A bivariate correlation analysis was conducted to further explore the relation between parents' math anxiety and the frequency of their children's numeracy talk. Parents' math anxiety was not significantly correlated with children's talk about number concepts besides magnitude comparison. However, parents' math anxiety was related to the frequency of children's overall numeracy talk (i.e. the average percent of intervals during which children talked about any coded number concept).

Discussion

The current study contributes to the growing literature on parents' support of children early numeracy. Parents and their children talked about numbers frequently as they interacted with modified playing cards provided by the researchers. Additionally, parents who played *War* provided early numeracy input significantly more often than parents who played a different card game. Furthermore, parents who played *War* primarily provided their preschoolers with input about magnitude comparison while previous studies have found that parents mostly provide input on cardinality, numeral identification, and counting (Casey et al., 2016; Gunderson & Levine, 2011; Levine et al., 2010; Ramani et al., 2015; Susperreguy & Davis-Kean, 2016; Vandermaas- Peeler, 2011). Similarly, children who played *War* talked about magnitude comparison more often than other early numeracy concepts.

Additionally, the current study found that the type of card game that parents chose to play with their children predicted how frequently they provided their children with input about magnitude comparison. Vandermaas-Peeler et al. (2011) postulated that activity type might relate to the frequency of parents' number talk. They found that parents who played a board game talked about numbers frequently (Vandermaas-Peeler et al., 2011) while parents in a previous study talked about numbers infrequently as they played with toys including a cash register (Vandermaas-Peeler et al., 2009). Similarly, parents talked about numbers more often while playing a board game with their children than while playing with a puzzle or reading a book. The current study directly examined the relation between card games and parents' numeracy talk and offers evidence that the context of parent-child interactions predicts parents' early numeracy input.

Furthermore, the study suggests that parents provide input about number concepts that are central to a game more frequently than other number concepts. Parents who played the card game *War* talked about magnitudes more often than parents who played other card games. The other card games that parents played (e.g. *Go Fish*) did not require magnitude comparison. Thus, identifying games that facilitate specific number concepts may be a good way for researchers to help parents talk about more advanced early number skills more frequently while they interact with their children. Furthermore, promoting frequent parent-child engagement in *War* might be an effective way to improve children's magnitude comparison skills given evidence that playing *War* improves children's magnitude comparison skills in comparison to playing a different card game (Scalise et al., 2018). In addition, parents' magnitude comparison talk predicted their children's talk about magnitude comparison. As such, researchers may be able to influence children's more talk about more advanced numeracy concepts indirectly by eliciting such talk from their parents.

The current study also contributes to the literature on the relationship between parents' math-related beliefs and parent-child engagement in talk about numbers. Elliot et al. (2017) explored the relations among parents' math-related beliefs and their talk about large numbers. They found that parents' beliefs about their own math ability, but not their preference for math or their belief about the importance of their children's early math skills, related to their own number talk. This current study did not find that parents' belief about their math ability or their other math-related beliefs were related to their own magnitude comparison talk.

However, parents' belief about their level of math anxiety was positively related to their children's magnitude comparison talk. Perhaps, the parents who reported having high math anxiety allowed their children to compare magnitudes more often than parents with lower math anxiety so that they could avoid doing so themselves. The current study is the first to examine the relationship between parents' beliefs and their children's talk about an advanced number concept. Further research should explore factors that contribute to the variability in children's number talk, especially since there is some evidence that children's number talk is related to their early number skills (Ramani et al., 2015).

Future studies should also examine how engaging in informal number activities that facilitate parent-child talk about more advanced number concepts relates to children's related numeracy skills and general math achievement.

References

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*(6257), 196–198.

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*(4), 347–357. https://doi.org/10.1080/01650250444000027.

Cannon, J., & Ginsburg, H. P. (2008). "Doing the Math": Maternal Beliefs About Early Mathematics Versus Language Learning. *Early Education & Development*, *19*(2), 238–260. https://doi.org/10.1080/10409280801963913.

Casey, B. M., Lombardi, C. M., Thomson, D., Nguyen, H. N., Paz, M., Theriault, C. A., & Dearing, E. (2016). Maternal Support of Children's Early Numerical Concept Learning Predicts Preschool and First-Grade Math Achievement. *Child Development*. https://doi.org/10.1111/cdev.12676.

Cohen, J. (1960). A coefficient of agreement for nominal scales. *Educational and Psychological Measurement*, *20*(1), 37–46.

Dearing, E., Casey, B. M., Ganley, C. M., Tillinger, M., Laski, E., & Montecillo, C. (2012). Young girls' arithmetic and spatial skills: The distal and proximal roles of family socioeconomics and home learning experiences. *Early Childhood Research Quarterly*, *27*(3), 458–470. https://doi.org/10.1016/j.ecresq.2012.01.002

De Smedt, B., Noël, M.-P., Gilmore, C., & Ansari, D. (2013). How do symbolic and non-symbolic numerical magnitude processing skills relate to individual differences in children's mathematical skills? A review of evidence from brain and behavior. *Trends in Neuroscience and Education*, *2*(2), 48–55. https://doi.org/10.1016/j.tine.2013.06.001.

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. https://doi.org/10.1016/j.jecp.2017.01.011.

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: Types of parent number talk. *Developmental Science*, *14*(5), 1021–1032. https://doi.org/10.1111/j.1467-7687.2011.01050.x.

Jordan, N. C., Kaplan, D., Ramineni, C., & Locuniak, M. N. (2009). Early math matters: Kindergarten number competence and later mathematics outcomes. *Developmental Psychology*, *45*(3), 850–867. https://doi.org/10.1037/a0014939.

LeFevre, J.-A., Skwarchuk, S.-L., Smith-Chant, B. L., Fast, L., Kamawar, D., & Bisanz, J. (2009). Home numeracy experiences and children's math performance in the early school years. *Canadian Journal of Behavioural Science/Revue Canadienne Des Sciences Du Comportement*, *41*(2), 55–66. https://doi.org/10.1037/a0014532.

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*(5), 1309–1319. https://doi.org/10.1037/a0019671.

McHugh, M. L. (2012). Interrater reliability: the kappa statistic. *Biochemia Medica*, *22*(3), 276–282.

Missall, K., Hojnoski, R. L., Caskie, G. I. L., & Repasky, P. (2015). Home Numeracy Environments of Preschoolers: Examining Relations Among Mathematical Activities, Parent Mathematical Beliefs, and Early Mathematical Skills. *Early Education and Development*, *26*(3), 356–376. https://doi.org/10.1080/10409289.2015.968243.

Musun-Miller, L., & Blevins-Knabe, B. (1998). Adults' beliefs about children and mathematics: how important is it and how do children learn about it? *Early Development and Parenting*, *7*(4), 191–202. https://doi.org/10.1002/(SICI)1099-0917(199812)7:4<191::AID-EDP181>3.0.CO;2-I.

National Mathematics Advisory Panel. (2008). *Foundations for Success: The Final Report of the National Mathematics Advisory Panel*. US Department of Education. Retrieved from https://www2.ed.gov/about/bdscomm/list/mathpanel/report/final-report.pdf

National Research Council. (2009). Mathematics Learning in Early Childhood: Paths toward Excellence and Equity (C. T. Cross, T. A. Woods, & H. Schweingruber, Eds.). National Academies Press.

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*(Supplement C), 15–33. https://doi.org/10.1016/j.cogdev.2014.11.002.

Río, M. F. del, Susperreguy, M. I., Strasser, K., & Salinas, V. (2017). Distinct Influences of Mothers and Fathers on Kindergartners' Numeracy Performance: The Role of Math Anxiety, Home Numeracy Practices, and Numeracy Expectations. *Early Education and Development*, *28*(8), 939–955. https://doi.org/10.1080/10409289.2017.1331662.

Ritchie, S. J., & Bates, T. C. (2013). Enduring Links From Childhood Mathematics and Reading Achievement to Adult Socioeconomic Status. *Psychological Science*, *24*(7), 1301–1308. https://doi.org/10.1177/0956797612466268.

Rittle-Johnson, B., Fyfe, E. R., Hofer, K. G., & Farran, D. C. (2017). Early Math Trajectories: Low-Income Children's Mathematics Knowledge From Ages 4 to 11. *Child Development*, *88*(5), 1727–1742. https://doi.org/10.1111/cdev.12662.

Scalise, N. R., Daubert, E. N., & Ramani, G. B. (2018). Narrowing the Early Mathematics Gap: A Play-Based Intervention to Promote Low-Income Preschoolers' Number Skills. *Journal of Numerical Cognition*, *3*(3), 559–581.

Siegler, R. S. (2016). Magnitude knowledge: the common core of numerical development. *Developmental Science*, *19*(3), 341–361. https://doi.org/10.1111/desc.12395.

Siegler, R. S., Duncan, G. J., Davis-Kean, P. E., Duckworth, K., Claessens, A., Engel, M., Chen, M. (2012). Early Predictors of High School Mathematics Achievement. *Psychological Science*, *23*(7), 691–697. https://doi.org/10.1177/0956797612440101

Skwarchuk, S.-L. (2009). How Do Parents Support Preschoolers' Numeracy Learning Experiences at Home? *Early Childhood Education Journal*, *37*(3), 189–197. https://doi.org/10.1007/s10643-009-0340-1.

Skwarchuk, S.-L., Sowinski, C., & LeFevre, J.-A. (2014). Formal and informal home learning activities in relation to children's early numeracy and literacy skills: The development of a home numeracy model. *Journal of Experimental Child Psychology*, *121*, 63–84. https://doi.org/10.1016/j.jecp.2013.11.006.

Sonnenschein, S., Galindo, C., Metzger, S. R., Thompson, J. A., Huang, H. C., & Lewis, H. (2012). Parents' Beliefs about Children's Math Development and Children's Participation in Math Activities [Research article]. https://doi.org/10.1155/2012/851657.

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*(6), 841–857. https://doi.org/10.1080/10409289.2016.1148480.

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*(1), 78–93. https://doi.org/10.1080/09669760.2012.663237.

Vandermaas-Peeler, M., Ferretti, L., & Loving, S. (2011). Playing the Ladybug Game : parent guidance of young children's numeracy activities. *Early Child Development and Care*, *182*(10), 1289–1307. https://doi.org/10.1080/03004430.2011.609617.

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*(1), 67–84. https://doi.org/10.1080/09669760802699910.

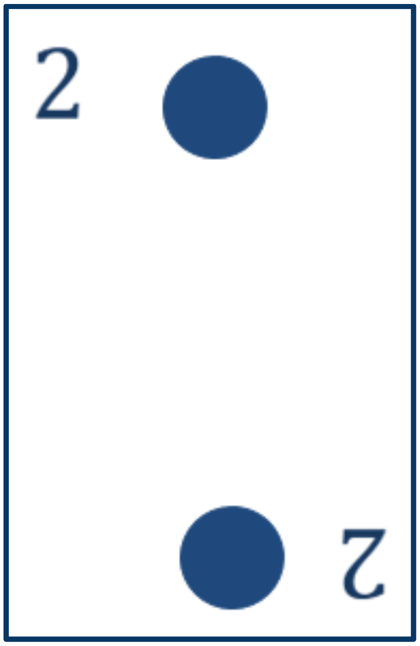
Weiland, C., Wolfe, C. B., Hurwitz, M. D., Clements, D. H., Sarama, J. H., & Yoshikawa, H. (2012). Early mathematics assessment: validation of the short form of a prekindergarten and kindergarten mathematics measure. *Educational Psychology*, *32*(3), 311–333. https://doi.org/10.1080/01443410.2011.654190.

Xenidou-Dervou, I., Molenaar, D., Ansari, D., van der Schoot, M., & van Lieshout, E. C. D. M. (2017). Nonsymbolic and symbolic magnitude comparison skills as longitudinal predictors of mathematical achievement. *Learning and Instruction*, *50*(Supplement C), 1–13. https://doi.org/10.1016/j.learninstruc.2016.11.001.

Zippert, E. L., & Ramani, G. B. (2017). Parents' Estimations of Preschoolers' Number Skills Relate to at-Home Number-Related Activity Engagement. *Infant and Child Development*, *26*(2), n/a-n/a. https://doi.org/10.1002/icd.1968.

Appendix

Figure and Tables



Cards

This bag contains simple playing cards. You may play any card game that you would like. Feel free to use our suggestions below.

Suggestions:

- War:

Divide the deck of cards evenly for each player. Each player places his/her stack of cards face down, in front of him/her. Players turns up a card at the same time and the player with the higher card (the card that has more) takes both cards and puts them face-down on the bottom of his/her stack.

- Order Up:

Each player orders cards by number. Start with three cards and then increase the number of cards.

Figure 1. Number Card and Instructions for Suggested Games

Table 1

Parents' Highest Level of Educational Attainment

Highest Level of Educational Attainment	Percentage	
	Mothers	Fathers
Elementary school	-	2.3
Some high school	4.3	7
High school diploma or GED	8.7	27.9
Some college or 2-year degree	37	23.3
Bachelor's degree	21.7	20.9
Some graduate work	-	2.3
Master's, professional or doctoral degree	28.3	16.3

Table 2

Number Coding Scheme

Code Name	Definition	Parent Example	Child Example
Arithmetic/ Complex Operations	Adds/subtracts two numbers or indicates complex operations	"What's one less than eight?" "I'll divide the pile evenly."	"Seven" [in response to parent question]
Magnitude Comparison[a]	Compares or matches two numbers/quantities	"Is seven bigger than nine?" "You're taking all my cards" [Parent acknowledges that child's card had a bigger number.] Explaining game of *War*	"Oh, I tied so this is a *War*." [Child identifies that numbers were the same.] "I win!"
Numeral Identification	Identifies a written numeral	"This is a 6."	"I got a 4"
Cardinal Values	Labels number of elements in a set or asks about quantity in a set	"Why don't I pick three cards?" "How many do you have?"	"I have five cards"
Counting Objects	Parent or child counts objects, or discusses counting objects as a strategy	"Count the dots."	"One, two, three…"
Ordinal Relations	Describes order of numbers, asking before or after questions or emphasizing "then" relations	"What comes after four?" "You're excited to do the third bag."	"Five!" [in response to parent question]
Rote Count	Parent or child counts numbers sequentially.	"Let's count to three. One, two, three…"	"One, two, three…"
Number Other	Parent or child uses numbers differently from any previously defined way.	"I hope I get an eight!"	"I want a ten"
Relative Magnitude	Parent or child makes a general statement about quantity	Quantifying words such as many and a lot	"I have a lot of cards".

Note. [a] A child's talk was coded as magnitude comparison if he/ she took cards or allowed the parent to take cards as a win without the parent prompting or declaring a win or loss.

Table 3

Frequency of Card Games/ Activities

Type of Card Game/Activity	Percentage of Participants
War	56.5
Order Up	19.6
Go Fish	6.5
Matching Numbers	10.9
Number Identification	2.2
Free Play	4.3

Note. Eight dyads chose to play multiple card games however the analyses only include the first card game that they played.

Table 4

Frequency of Number Talk by Type of Card Game Played

Frequency of Number Talk	**Parent** *M%(SD)*		**Child** *M%(SD)*	
	War	**Other Card Game**	**War**	**Other Card Game**
Total Number Talk	66.5(11.5)	54.2(24.5)	48.0(14.9)	48.0(23.2)
Arithmetic/ Complex Operations	3.1(3.9)	1.89(6.64)	0.3(1.5)	1.0(4.3)
Magnitude Comparison	35.5(16.3)	7.1(14.9)	20.3(11.9)	6.9(12.9)
Numeral Identification	10.1(9.0)	28.7(20.3)	14.2(12.9)	27.5(18.0)
Cardinal Values	5.0(4.8)	5.9(4.8)	1.5(1.7)	1.4(1.8)
Counting Objects	6.1(8.7)	2.5(5.7)	7.4(10.7)	5.0(4.3)
Ordinal Relations	1.5(2.8)	4.1(6.0)	0.5(1.1)	3.7(7.9)
Rote Count	1.7(5.7)	0.0(0.0)	1.4(1.9)	0.1(0.3)
Number Other	0.6(1.3)	1.4(2.4)	1.2(2.2)	1.0(2.4)
Relative Magnitude	3.0(2.4)	2.6(3.0)	1.1(1.8)	1.0(2.2)

Table 5

Parent Belief Ratings

Belief	Mean	SD
About Themselves		
Math Ability	5.23	1.45
Good at math in school[a]	5.36	1.64
Currently good at math[a]	5.27	1.49
Important to be good at math[b]	6.13	1.09
Like math[c]	4.71	1.84
Anxious about math[d]	3.13	2.08
About Their Children		
Math Ability	5.59	1.11
Currently good at math[a]	5.77	0.87
Innately good at math[e]	5.22	1.05
Will be good at math in the future (in kindergarten)[f]	6.50	1.0
Importance of Math	6.77	0.46
Important to be good at math[b]	6.67	0.60
Math will be useful in the future[g]	6.87	0.45
Like math[c]	6.13	1.13

Notes. Likert-type scale ranging from: [a]1 (not good at all) to 7 (very good) [b]1 (not at all important) to 7 (very important) [c]1(not at all) to 7 (very much) [d]1 (not at all anxious) to 7 (very anxious) [e]1(much less than other children) to (much more than other children) [f]1(not at all well) to 7 (very well) [g]1(not at all useful) to 7 (very useful)

Table 6

Hierarchical Regression Predicting Parent Magnitude Comparison Talk

Model Variables	B	β	*t*	R	R^2	ΔR^2
Step 1						
Child Magnitude Comparison Talk	.81	.53	4.18***	.53	.28[a]	
Step 2						
Child Magnitude Comparison Talk	.41	.27	2.23*	.72	.51[b]	.23
Type of Card Game Played	.23	.56	4.49***			

Notes. ***$p<.001$ *$p<.05$ [a] $df= (1,44)$ [b] $df= (2,43)$

Table 7

Hierarchical Regression Predicting Child Magnitude Comparison Talk

Model Variables	B	β	*t*	R	R^2	ΔR^2
Step 1						
Parent Magnitude Comparison Talk	.35	.53	4.18***	.53	.28[a]	
Step 3						
Parent Magnitude Comparison Talk	.25	.38	2.23*	.56	.31[b]	.03
Type of Card Game Played	.06	.22	1.30			

Notes. *$p<.05$ ***$p<.001$ [a] $df= (1,44)$ [b] $df= (2,43)$

Table 8

Correlations between Parent's Beliefs and Dyad's Magnitude Comparison Talk

Magnitude Comparison Talk	Good at math[a]	Important to be good at math	Like math	Anxious about math
Beliefs about themselves				
Parent	.11	.07	.11	-.02
Child	-.04	.12	.06	.36*
Beliefs about their children				
Parent	.12	-.11	.14	-
Child	-.04	-.09	-.24	-

Notes. *p<.05