Two is greater than three: effects of older siblings on parental support of preschoolers’ counting in middle-income families

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Abstract

One possible source of variation in children’s mathematical abilities upon entry to school may be the social support of early number skills children receive in the home. In the present study, we explored parental support of preschoolers’ counting in the context of an everyday activity and whether parental ability to provide aid is influenced by the presence of a school-age sibling. Thirty-five middle-class families (19 dyads and 16 triads) were videotaped as they played a board game. While there were many similarities across the two conditions in the amount and type of support parents provided, those playing the game with only a preschooler were more likely to use their turns as teaching opportunities, and to adjust their aid according to their preschooler’s mathematical abilities. Potential factors influencing these differences as well implications for research and practice are discussed.

Keywords: Counting, Siblings, Parent–child interaction, Preschoolers

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doii:10.1016/j.ecresq.2004.01.006
may lie in the kinds of social activities children experience in the home (Mix, 2002; Starkey et al., 1999).

1. Parental socialization of number knowledge

Preschoolers potentially have many opportunities to learn about number in the context of everyday activities with caregivers. According to Gelman and Massey (1987):

[Children] accompany their parents on shopping trips; hear numbers used in talk about time, birthdays, and how many presents they will or will not get; and ride in elevators with many floors. Long-distance driving and the consequent talk about how far one has gone or has yet to go “to get to grandma’s” is not uncommon. They watch the Count on the television program “Sesame Street” talk about his passion for counting different set sizes, or Zorro looking for nothing so he can count zero things, or even a puppet dressed up in a black leather jacket singing “Born to Add” set to the tune of a popular rock and roll song. (p. 142)

For many children, exposure to number names and concepts begins remarkably early. One longitudinal study originally designed to assess mother–infant conversational turn-taking found mothers using number words in their exchanges with infants beginning at 9 months of age (Durkin, Shire, Riem, Crowther, & Rutter, 1986). During the toddler years, the mothers used number words in a variety of contexts including nursery rhymes, stories, and songs, in games (“One, two, three, go!”), and incidentally in conversation (e.g., “Two sugars, please”). Mothers in this study also expressly tried to teach their toddlers to count by reciting number strings. Sometimes they alternated turns with the children and introduced the notion of cardinality by repeating the final count.

Maternal efforts to teach counting skills and other types of knowledge continue through the preschool years. Mothers interviewed on the phone about the frequency of number activities in their homes reported that they engaged in a wide variety of activities such as reciting numbers, singing number songs, writing numbers, and talking about number facts ($1 + 1 = 2$) with their preschool-aged children (Blevins-Knabe & Musun-Miller, 1996). The most commonly reported number activity across all ages was counting, with mothers devoting more time trying to teach younger ($31/2–41/2$-year-olds) than older ($41/2–51/2$-year-olds) preschoolers how to count.

Saxe, Guberman, and Gearhart (1987) found high rates of engagement and interest in number-related activities in their interviews with middle- and working-class mothers of $21/2$ and $41/2$-year-olds as well. Most mothers reported engaging in number play on a daily basis with the most common activity being games of the parents’ or children’s own inventions (e.g., counting while climbing stairs and reading the numbers on license plates). Middle-class children participated in activities that ranged across a wider range of complexity than did the working-class children. Converging findings were reported by Starkey, Klein, and their colleagues (Starkey et al., 1999), who found that middle-income parents, on average, provide a broader set of mathematical activities and did so more frequently than lower-income parents.

Together, these studies suggest that mothers of preschoolers frequently engage in number activities with their children, the complexity of the activities increases as children grow older, and that the frequency and types of number activities vary widely across families. Far less is known about how parents support preschoolers’ emerging numeracy skills in the context of these activities.
Among the few studies that have addressed this issue is a set of investigations by Saxe and colleagues (1987). The central thesis of this work, based on Vygotsky’s theory (1962, 1978) is that the early number understanding emerges first in social interaction with more capable partners and only gradually becomes internalized. To understand how this occurs, the researchers carefully examined the processes of interaction between mothers and children engaged in number activities. Importantly, they looked both at how mothers regulated preschoolers’ number use, as well as at the various ways in which the preschoolers shaped the interactions.

The set of investigations included three studies. In one of the studies, mothers were explicitly asked to teach their preschoolers a number skill (e.g., to count arrays of 5 and 13 dots). In a second study, mothers and their children were asked to play a game involving number reproduction. And in a third, mothers reported on the ways in which they had adapted everyday number activities to their children’s competencies in the past, and how they expected to do so in the future as the children’s skills improved.

The results of the three studies revealed that mothers were quite sensitive to both task difficulty and their children’s errors and made appropriate adjustments in the types of aid they offered. For example, when children made errors related to one-to-one correspondence, the help the mothers provided related to correspondence. When the preschoolers made sequencing errors, mothers responded by helping with sequencing. In turn, children usually responded appropriately to their mothers’ intervention and, as a result, reached a higher level of performance than they had when solving similar problems alone. Perhaps most interesting was the finding that, when the task was beyond children’s current capabilities, mothers were quite willing to redefine the task goal and, as a result, create a context for instruction most likely to promote understanding.

Gelman and Massey (1987) acknowledge that the types of sensitive interactions described by Saxe and colleagues can support the development of numerical understanding, but suggest that such exchanges are quite rare even in the lives of middle-income children. To support their point, Gelman and Massey describe the behavior of parents and children at a number exhibit located in a children’s museum. The particular display of interest was called “How many?”. It consisted six doors, each of which could be opened to reveal a picture underneath. Nearly one-third of the parents did not interact at all with either the display or the child and, the children with them never did more than simply open the doors and examine the pictures. Of those who did interact with a child in the exhibit, only one-third asked a “how many?” question (despite the presence of a large sign that read “HOW MANY . . .”), whereas only 25% either counted themselves, asked a child to count, or stated a cardinal value.

In sum, evidence regarding the extent of parental support of children’s early numeracy is mixed. Parents report they frequently engage in a wide range of numeracy activities with their preschoolers. Further, observational studies in controlled settings reveal that parents are often quite skilled at scaffolding children’s counting, adjusting support appropriately depending on both the child’s ability and the level of problem difficulty. However, naturalistic observations in everyday settings suggest that parents of preschoolers often fail to take advantage of opportunities to promote their children’s numeracy skills.

2. The present study

The primary aim of the present study was to assess whether and how middle-income parents support children’s counting in the context of an everyday activity—playing a board game. Based on Saxe and colleagues’ (1987) study and other investigations that have examined parental scaffolding on tasks not
involving number (e.g., Freund, 1990; Kontos, 1983; Rogoff, Ellis, & Gardner, 1984; Wood, Bruner, & Ross, 1976), we predicted that parents would be adept at adjusting the amount and type of aid provided depending on the children’s age, number skills, and problem difficulty.

A second aim of the study was to explore whether parental ability to provide aid contingent on children’s needs is influenced by social context—specifically, whether they are playing the board game alone with just a preschooler or with the preschooler and an older sibling. As Rogoff (1998) observed, our understanding of the impact of social interaction on children’s learning is based almost entirely on dyadic exchanges in settings free from distractions. In practice, parent–child intellectual exchanges often include one or more siblings and occur in the context of ongoing activity.

Research suggests that the quality of caregiver–child interactions decreases as the number of people involved in the activity grows. For example, conversations between mothers and young children are less individualized when a sibling is present (Barton & Tomasello, 1991; Tomasello, Mau, & Kruger, 1986). Studies of nursery school teachers also reveal that teachers adopt more directive instructional styles when working with several children as compared to the approach adopted when working one-on-one with a single child (Schaffer & Liddell, 1984; Sfigaki & Houndoumadi, 1997). Further, instructional exchanges involving older siblings are almost certain to entail more directives, given the well-established predilection for children to “teach by doing” (Astington & Pelletier, 1996; Azmitia, 1996; Ellis & Rogoff, 1986; Pérez-Granados & Callanan, 1997).

3. Method

3.1. Participants

Parents responded to fliers announcing a “Sibling Learning Project” distributed to preschools serving primarily middle-SES families located in a large university community. Of the 35 families who participated, most identified themselves as Caucasian; 1 family was Indian-American, and 2 were Hispanic. There were 19 dyads composed of a parent and a preschooler and 16 triads composed of a parent, preschooler, and school age sibling. The preschoolers were 4–0 years of age (range = 3–5 to 4–9). The school-age siblings averaged 6 years and 3 months of age. They were all at least 2 years older than their preschool siblings (M difference = 2–4, range = 2–0 to 3–3) and were enrolled in either kindergarten or first grade.

Of the 19 preschoolers in the dyadic condition, 9 were male and 10 were female. The sibling pairs in the triadic condition included 4 brother pairs, 3 sister pairs, 7 older brother younger/sister pairs, and 2 older sister/younger brother pairs.

Thirty-three of the 35 parents were mothers. Two fathers participated in the dyadic condition; both identified themselves as the primary caregiver. We provided a $10 donation to the preschools for each family that participated in the study.

3.2. Procedure

During participant recruitment, parents were told that the focus of the study was on sibling interaction and children’s learning. The researchers explained the study design, which required that some families would participate with just the target preschooler while others would participate with a preschooler and
Fig. 1. The Picnic Game.

an older sibling. When necessary, a research assistant accompanied the experimenter to play with siblings not participating in the study.

Each family participated in two sessions in their home. During the first session, the experimenter videotaped families engaged in a variety of activities including fantasy play, beanbag toss, drawing, snack, and a board game. This paper describes interactions surrounding the board game (The Picnic Game), which was the final activity in the 75-min session. In the second session, children completed mathematical reasoning and language assessments. The second session occurred within 2 weeks following the videotaped session.

3.3. Materials

3.3.1. The Picnic Game

The Picnic Game is a board game (20″ × 20″) that resembles manufactured games such as Monopoly (see Fig. 1). The object of the game is to collect items for a picnic. Each player is outfitted with a different “menu” that depicts the specific items they are to retrieve. Opportunities to collect items are determined as players move along spaces placed around the perimeter of the board.

To begin, each player selects a game piece (marker), a menu, and a plate. All players begin on the same square and take turns moving along the 32 spaces. At the beginning of each turn, the player selects a card from a stack of 24 cards. The number of picnic ants on the selected card indicates the number of spaces one needs to move along the board (see Fig. 2). The stack includes 4 cards for each number 1 through 6. Upon landing on a space, the player checks to see if the particular items depicted on the space match those on their “menu.” Each menu lists 6 food items: one of one item, 2 of another, 3 of a third
and so forth. The items are represented by stickers (e.g., one ketchup bottle, two ice cream cones, three corn-on-cobs, four apples, five hamburgers, and six drinks).

If the items on the space correspond to those on the player’s menu, the player checks to see whether she had already retrieved the items during a previous turn. If the player needs the items, she retrieves the specified number from an array of plastic foods. Please note that the number of items on the space is always equal to the number of items on the menu (see Figs. 1 and 2). If one lands on a space that contains food items either previously retrieved or not on one’s menu, the person does not collect any items and it becomes the next player’s turn.

The experimenter relayed the instructions by modeling a sample turn including all phases of the game (e.g., selecting a card, moving the requisite number of spaces, and retrieving food items). The experimenter modeled the various steps of a turn until all participants reported they understood.

The game was designed for at least two players. Since this required that parents in the dyadic condition play the game, we asked parents in triads to play as well. Beyond this requirement, parents had considerable discretion in how to structure the game. For example, some allowed “cheating,” others modified the rules in other ways, and parents were free to decide how and when to end the game. The experimenter told families they could continue until every player had retrieved all the items listed on his or her “menu.” However, how quickly this could be achieved depended on chance and so the experimenter told the parents they were free to end the game at any time. Only two families played until all players had obtained all of the items; 22 families played until one player (usually a child) retrieved all of her items, and 11 stopped the game before any player had all of the picnic items listed on the menus. Ending the game early did not prove to be a problem, in part because some of the plastic foods are especially attractive (e.g., ice cream cones) and children were sometimes more interested in obtaining those specific items rather than all of them.
3.3.2. Assessments
Children’s mathematical language and language abilities were assessed with the Test of Early Mathematical Ability (TEMA-2; Ginsburg & Baroody, 1990), and the Expressive One Word Picture Vocabulary Test-Revised (EOWPVT-R; Gardner, 1990), respectively.

3.4. Coding of videotaped interactions

Turns were divided into three phases: counting the items on the card to determine the number of spaces to move, moving the marker, and retrieving picnic items. Each phase was coded first for the types of counting strategies used by the preschoolers and their older siblings as well as the types of counting errors made. The type of strategy employed signified an individual counting act. Counts that were aborted and started over were coded as two distinct acts. Coding categories were based on Fuson (1988).

3.4.1. Counting strategies
We coded subitize when the counter announced the number of items on the card in less than 1 s or immediately acted on the count by moving the marker or retrieving a food item. In covert counting, the counter paused 1 s or more before announcing or acting on the count. Covert counting was usually accompanied by lip or eye movements, indicating that the child was counting silently. In count out, the counter announced the numbers out loud with no physical component. Covert count with gesture involved a silent count accompanied by pointing, movement of the marker, or picking up food items. In count out with gesture the counter counted out loud while pointing, moving the marker, or picking up items.

3.4.2. Counting errors
Children made several types of counting errors. These errors included multiple count, in which the counter counted an item more than once, and skip count, in which the number words were announced in correct sequence, but at least one number was omitted (e.g., “1, 2, 4, 5”). Misorder occurred when number words were announced in an incorrect sequence (e.g., “1, 2, 8, 4”). Children sometimes counted too many or too few items. Failure to stop involved counting beyond the number of items, whereas skip item, stop early was coded when children failed to count all items.

A final type of error was unique to the movement of the marker along the board. Children were often confused about where to begin counting. Errors ensued because children began counting from the current space on the board rather than adding on and counting the next space as “one.”

3.4.3. Types of parental/older sibling aid
We also coded the types of assistance parents and older siblings offered during another’s turn. One type of aid was checking that the child’s count was accurate. Other types of aid structured children’s counting acts. In demonstrates counting, the parent or sibling performed the count in advance of the child followed by the child executing the count by him or herself (e.g., “One (points), two (points), three (points), four (points) . . . ok, now you do it”). During joint counting, the parent or older sibling and preschooler executed the count together. Sometimes one partner counted verbally while the other physically executed the count (e.g., “Here, one” (points); child says, “one”; “two” (points); child says, “two”; “three” (points); child says, “three” . . . ). Other times, the partners counted in unison. In the most directive type of aid, count for child, the parent or older sibling assumed another player’s turn and counted for them.
3.4.4. Parental teaching behaviors

Parents sometimes used their own turns as opportunities to teach their children about numbers or counting. In **parent announces number**, the parent stated the relevant number, be it the number of ants on the card they picked, the number of spaces they needed to move, or the number of food items they were to retrieve. A variant of this behavior was **parent announces number with visual support**. Here, the parent both stated the number and showed the card or held up food items for the child to see. In **parent models counting**, the parent counted out loud while either pointing to items on the card, moving the marker along the board, or retrieving items. **Asks child to count** was coded when the parent asked the child to count for them.

3.5. Reliability of coded variables

Two independent coders coded children’s counting strategies, counting errors and parental intervention. Inter-observer agreement for counting strategies, counting errors, parental aid, and parental teaching was 99, 92, 98, and 98%, respectively. Cohen’s (1960) *kappa* coefficients were all above 0.90. Disagreements were resolved through discussion.

4. Results

4.1. Preliminary analyses

4.1.1. Length of session

The game lasted approximately 20 min with participants taking an average of 15 turns each. Although the amount of time spent playing the game varied widely from family to family, the number of minutes families in dyads versus triads spent playing the game did not differ (dyad *M* = 20.96, range = 13.12–38.58; triad *M* = 19.83, range = 11.95–31.85). Similarly, while the number of turns varied across families, preschoolers in the dyads and triads took a comparable number of turns (dyad *M* = 15.69, range = 11–25; triad *M* = 14.63, range = 7–20).

4.1.2. Age and ability of child participants

The preschoolers in the two conditions were comparable in age (dyad *M* = 4–0, range = 3–6 to 4–9; triad *M* = 4–0, range = 3–5 to 4–9). Preschoolers in the two conditions also achieved similar scores on the mathematical and language assessments. The mean score on the TEMA-2 was 10.41 for preschoolers in the dyadic condition, with scores ranging from 0 to 22. In the triadic condition, the mean score was 10.87 with a range from 3 to 16. Mean scores corresponded to the 52nd percentile, suggesting that the mathematical skills of preschoolers in the sample were about average.

Mean scores on the EOWPVT-R were 41.71 (range = 16–57) and 40.07 (range = 20–66) for the preschoolers in the dyadic and triadic conditions, respectively. The mean scores suggest that children in the sample were about 1 year advanced in language abilities on average.

The mean mathematical and language assessment scores for the older siblings in the triads were 36.20 (range = 20–50) and 75 (range = 43–95), respectively. The mean score on the TEMA-2 corresponded to the 86th percentile for 6-year-olds, whereas the language scores correspond to age equivalent of 10–3 years.
4.1.3. Gender differences

We tested for gender differences on variables known to influence the amount and type of aid provided by parents. There were no gender differences in children’s age or performance on the TEMA-2 or EOWPVT-R, and males and females were equally likely to ask for help. There were also no gender differences in either the number of times parents intervened in children’s counting, nor in the amount of instruction provided.

4.2. Parental adjustment of aid and instruction

In this section we examine whether parents adjusted the amount and type of aid and instruction provided based on child age, errors, and problem difficulty (number size).

4.2.1. Age

To examine the impact of child age on parental intervention, we compared the amount of aid parents offered to preschoolers and to their older siblings. As expected, parents offered aid more often to preschoolers than to their older siblings. They made more counting errors \( (M = 11.31; \text{S.D.} = 5.58) \) than the older siblings \( (M = 2.3; \text{S.D.} = 2.0) \), \( t(15) = 5.92, P < 0.001 \), and asked for help more often (although requests were infrequent for both age groups) \( (\text{preschooler} \ M = 3.5, \text{S.D.} = 3.7; \text{older sibling} \ M = 0.88, \text{S.D.} = 0.96), t(15) = 3.18, P < 0.01 \).

The preschoolers also relied more heavily on less mature counting strategies. Seventy-two percent of the preschoolers’ counting episodes involved counting aloud, accompanied by pointing, moving the marker, or handling objects. The older siblings used this strategy only 45% of the time, \( t(15) = 5.30, P < 0.001 \).

4.2.2. Errors

To determine whether parents provided help more often following or prior to an error, we conducted a 2 (group: dyad or triad) × 2 (timing: before error or after error) ANOVA. Group was a between-subjects factor and timing was a within-subjects factor. The analysis revealed that parents were more likely to provide help following a counting error than before an error occurred, \( F(1, 33) = 53.15, P < 0.001 \). The means frequencies with which parents in the dyadic condition offered help before and after an error were 2.16 and 5.95, respectively. Comparable means for parents in the triadic condition were 1.38 and 3.81. The condition differences were not significant.

4.2.3. Number size

We conducted a 2 (group) × 2 (number size) mixed factorial design with repeated measures on the second factor ANOVA to determine whether the amount and type of help and instruction parents offered varied depending on whether the preschooler was using small numbers \( (1, 2, \text{and} 3) \) or large numbers. Researchers use mixed factorial ANOVA with repeated measures to assess how children’s strategy choices vary across different problem demands (Crowley & Siegler, 1993; Siegler, 1995). In the present study, we apply this analytic technique to parents’ decisions to offer help under varying conditions. These include counting episodes with an error and those without, and episodes involving large numbers versus small numbers.
numbers (4, 5, and 6). Group (dyad or triad) was a between-group factor while number size (small or large) was a within-subjects factor. Parents in both conditions were far more likely to provide aid when the preschooler drew a large rather than a small number, $F(1, 33) = 41.65, P < 0.001$. The mean frequency with which parents in the dyadic condition offered help on large and small numbers was 8.42 and 4.05, respectively. Comparable means for parents in the triadic condition were 6.06 and 4.05, respectively. Comparable means for parents in the triadic condition were 6.06 and 4.05, respectively. Comparable means for parents in the triadic condition were 6.06 and 4.05, respectively. Comparable means for parents in the triadic condition were 6.06 and 4.05, respectively.

Parents were more likely to check the accuracy of the preschoolers’ counts on large numbers compared to small numbers, $F(1, 33) = 5.89, P < 0.05$. On this measure, there was also an effect of condition with parents in dyads checking counts more frequently than parents in the triad condition (dyad: large number $M = 14.37$, small number $M = 12.37$; triad: large number $M = 8.94$, small number $M = 7.00$), $F(1, 33) = 9.04, P < 0.01$. It should be noted, however, that older siblings in the triad condition sometimes checked the preschoolers’ counts ($M = 2.44$; S.D. = 2.03).

Interestingly, parents used their own turns as teaching opportunities more often when they drew a large number as opposed to a small one, $F(1, 33) = 22.40, P < 0.001$. There was a condition effect as well, with parents in the dyadic condition doing so more often than parents in the triadic condition (dyad: large number $M = 23.32$, small number $M = 17.13$; triad: large number $M = 15.84$, small number $M = 12.44$), $F(1, 33) = 5.45, P < 0.05$. Three of the four coded teaching behaviors were higher when large numbers were involved: announcing the number, modeling counting, and asking the child to count for the parent, $F(1, 33) = 13.16, P < 0.001$; $F(1, 33) = 55.56, P < 0.001$; $F = 5.06, P < 0.05$.

4.3. The preschoolers’ experience in dyads and triads

4.3.1. Errors and strategies

Preschoolers in the two conditions made a comparable number of errors and relied on the different counting strategies to the same degree. Children in dyads made an average of 15 errors whereas children in triads made an average of 11 errors. This corresponded to about 25% of the preschoolers’ counting in both conditions. While this may seem like a relatively high figure given the size of the numbers involved (1–6), children could easily make several counting errors when executing a single count involving a large number or when first learning how to count the spaces along the board.

The distribution of counting types among the four strategies (subitize, covert, covert and gesture, count out and gesture) was nearly identical across groups with children in dyads and triads counting out loud and pointing (or using some other physical means of keeping track of the count) during 71 and 73% of the episodes, respectively.

4.3.2. Number of counting opportunities

There was, however, a difference between the conditions in the sheer amount of counting children performed, $r(33) = 3.68, P < 0.001$. Preschoolers in dyads counted an average of 62 times, whereas those in triads counted only 40 times. This difference was reflected in more instances of all types of counting except covert counting (subitize, $M = 5.26$ versus 2.19, $r(33) = 2.89, P < 0.01$, covert count with gesture $M = 8.37$ versus 3.94, $r(33) = 2.52, P < 0.05$, count out and gesture $M = 45.16$ versus 30.75, $r(33) = 2.49, P < 0.01$). As we discuss below, the difference in counting opportunities between the two conditions is due to the fact that parents in the dyadic condition were more likely to let their children count for them during their own turns, combined with a tendency for siblings and, to a lesser extent parents in the triadic condition, to count for the preschooler.
4.3.3. Parental teaching
Recall that parents engaged in four types of teaching behavior during their own turns. These behaviors included announcing number, announcing number while showing what they were counting, modeling counting, and asking the child to count for them. A 2 (group) × 4 (teaching behavior) between-subjects MANOVA revealed that parents in the dyadic condition engaged in these behaviors at higher rates than those in triads, $F(4, 30) = 3.76, P < 0.05$. Univariate tests revealed differences between conditions in the frequency with which parents announced number with visual support, $F(1, 33) = 8.44, P < 0.01$ and asked their child to count for them, $F(1, 33) = 3.97, P < 0.06$.

4.3.4. Parental intervention
Parents in dyads and triads provided comparable amounts of help and generally helped in the same way (see Table 1). The only difference between the conditions was in the number of times parents checked the accuracy of their children’s counts. As noted earlier, parents in the dyadic condition checked counts more often than those in the triadic condition, $t(33) = 3.01, P < 0.01$.

Despite the similarities in parental intervention across the two conditions, it is important to recall that preschoolers in the dyadic condition engaged in more counting than those in triads.

Given that preschoolers in dyads engaged in more counting, but parents in dyads and triads offered assistance with counting at similar rates, we might expect that preschoolers in dyads counted independently during a greater proportion of episodes than preschoolers in triads. Condition differences in proportion of counting episodes with aid approached significance, $t(33) = -1.71, P < 0.10$. Preschoolers in dyads counted without aid from the parent 83% of the time whereas those in triads did so during 75% of their counting acts.

4.3.5. Sensitivity of parental intervention
In this section, we examine whether parents in dyads and triads were equally sensitive to the preschoolers’ needs. Recall that that preschoolers in the dyads and triads had comparable (if wide-ranging) scores on the TEMA-2. They also made a comparable number of counting errors during the game (dyad $M = 15$; triad $M = 11$). The proportion of counting attempts marked by errors were also similar (dyad $M = 0.24$; triad $M = 0.30$).

Given that preschoolers in the two groups were equally capable mathematically, we would predict that children in both groups would benefit from similar types of parental intervention; that is, little or no help on simple counts with increased support on more difficult counts. And indeed, as reported earlier, parents in both conditions were more likely to offer aid when preschoolers drew large rather than small numbers and after an error than before. However, the fact that parents in triads tended to intervene in the preschoolers’ counting more often than those in dyads suggests they may have offered more help than in dyads.

To test this possibility, we examined the relationship between parental intervention and children’s counting errors and mathematical assessment scores in the two conditions. Across both conditions, we would expect a strong correlation between the amount of help parents provided and the preschoolers’ mathematical competence as measured by the TEMA-2 and their counting errors while playing the game—with parents offering more aid to preschoolers of lower mathematical ability. In fact, there are striking differences in the strength of the correlations between aid and ability in the two conditions.

Among dyads, amount of parental intervention was significantly correlated with both preschoolers’ counting errors ($r = 0.60, P < 0.01$) and their scores on the TEMA-2 ($r = -0.89, P < 0.001$). Among
Table 1
Mean frequencies of parental aid and instruction in dyads and triads

<table>
<thead>
<tr>
<th>Parent behavior</th>
<th>Dyads (n = 19)</th>
<th>Triads (n = 16)</th>
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<tr>
<td>Models count</td>
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<td></td>
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<tr>
<td><em>M</em></td>
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<td>S.D.</td>
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<td>2.06</td>
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<td><em>M</em></td>
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<td>7.56</td>
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<tr>
<td>S.D.</td>
<td>7.30</td>
<td>6.92</td>
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<tr>
<td>Counts for child</td>
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<tr>
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<td>7.81</td>
</tr>
<tr>
<td>S.D.</td>
<td>7.85</td>
<td>8.63</td>
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<tr>
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<td>26.74</td>
<td>15.94</td>
</tr>
<tr>
<td>S.D.</td>
<td>9.69</td>
<td>11.57</td>
</tr>
<tr>
<td>Announces number</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>M</em></td>
<td>11.63</td>
<td>11.56</td>
</tr>
<tr>
<td>S.D.</td>
<td>5.20</td>
<td>5.49</td>
</tr>
<tr>
<td>Shows card*</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>M</em></td>
<td>5.05</td>
<td>1.50</td>
</tr>
<tr>
<td>S.D.</td>
<td>4.54</td>
<td>1.97</td>
</tr>
<tr>
<td>Models count (own turn)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>M</em></td>
<td>16.84</td>
<td>14.81</td>
</tr>
<tr>
<td>S.D.</td>
<td>8.12</td>
<td>6.07</td>
</tr>
<tr>
<td>Asks child to count</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>M</em></td>
<td>5.63</td>
<td>1.69</td>
</tr>
<tr>
<td>S.D.</td>
<td>7.50</td>
<td>2.70</td>
</tr>
<tr>
<td>Total teaching*</td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>M</em></td>
<td>39.16</td>
<td>12.11</td>
</tr>
<tr>
<td>S.D.</td>
<td>29.56</td>
<td>12.13</td>
</tr>
</tbody>
</table>

*Significant differences between means for parents in dyads and triads at *P* < 0.05.

Triads, in contrast, amount of parental intervention was unrelated to preschoolers’ counting errors (*r* = 0.11) and only weakly related to their mathematical assessment scores (*r* = −0.44, *P* < 0.10). Across the conditions, the difference between the correlations between parental intervention and preschoolers’ mathematical ability was, of course, also significant, *Z* = −2.57, *P* = 0.01. The pattern of results is similar when proportion scores are used. These findings suggest that parents in triads were less likely than those in dyads to offer support contingent on need. However, these results must be interpreted cautiously given the significant variability across a variety of measures in both conditions.
4.3.6. Intervention by older siblings

Preschoolers’ in triads also received help when counting from their older siblings; however, siblings offered help less often than did parents, \( t(15) = 2.47, P < 0.05 \) (sibling \( M = 8.25, \text{S.D.} = 6.60 \); parent \( M = 16.69, \text{S.D.} = 10.07 \)). One reason for the low rates of aid on the part of the older siblings is that some parents actively restricted them siblings from offering help. In this sample, 9 of the 16 older siblings were restricted from offering aid at least once by the parents. These restrictions often occurred early on and set the ground rules for the remainder of the game. Because siblings provided so little help, their help reduced the proportion of episodes during which preschoolers in triads counted without aid from 75 to 74%. The amount of assistance received by preschoolers in the triadic condition remained comparable to that of children in the dyadic condition even when the sibling help was added (triad \( M = 24.56, \text{S.D.} = 10.73 \) and dyad \( M = 19.74, \text{S.D.} = 12.58 \)).

The type of help provided in the two conditions does differ, however, when the aid provided by parents and siblings are combined. We predicted that, when siblings did provide help, it would be more directive in nature than that offered by parents. Sixty-five percent of the help provided by siblings involved taking over and counting for the preschooler. This compared to 47% of the assistance provided by parents in the triadic condition, \( t(15) = 2.07, P < 0.06 \). In total, 51% of the assistance provided to the preschooler in the triadic condition involved someone counting for them. This compares to 29% of the help provided to preschoolers in the dyadic condition, \( t(33) = 2.86, P < 0.01 \).

5. Discussion

Previous studies based primarily on parental report have revealed that parents frequently engage in number activities in the home with children during the years prior to formal schooling. In addition, observations of parents interacting with children on such tasks to be quite skilled at adapting the level of help provided depending on children’s need and the difficulty of the problem. This observational study contributes to the existing research by demonstrating that parents take advantage of the opportunities provided by a complex, everyday activity such as playing a board game to promote children’s counting skills, and that they do so with considerable sensitivity to children’s ability and to the size of the numbers involved even without being specifically asked to “teach” children about number. The findings also show, however, that the likelihood of providing responsive aid declines when a second child is included in the interaction.

The strongest evidence that parents actively promote preschoolers’ counting is the way in which parents used their own turns as teaching opportunities. Parents in both the dyadic and triadic conditions frequently announced the number on their cards and counted out loud, often supplementing the count with some type of gesture. Clearly, the parents did not need to use these strategies to produce accurate counts for themselves. These behaviors do conform to the script of the way board games are generally played (presumably to show that one is not cheating). However, the fact that parents were more likely to engage in these behaviors when they drew larger numbers suggests that they did so during all phases of their turns and not just when moving the marker, suggests parents perceived there to be educational benefits to making their counting transparent. Reciting strings of numbers, pointing, and emphasizing the final count are likely to reinforce preschoolers’ understanding of number sequence, one-to-one correspondence, and cardinality.

Parents also used their own turns to give preschoolers additional practice counting. Parents sometimes seemed to do so because it was simply easier than counting themselves. For example, a parent might...
prefer to ask a child to retrieve the food items for them instead of reaching over and getting the items themselves (especially if pregnant or seated with a child leaning into them). Nonetheless, parents often asked the preschoolers to count for them even when it came at some cost (e.g., the extra time required for the child to count the card), and they were more likely to do so when they drew a large as opposed to a small number. Again, this suggests that parents were cognizant of the potential benefits of having children practice counting larger numbers.

There were marked similarities in the ways in which parents in dyads and triads helped their preschoolers count. Parents in both conditions were more likely to provide aid following errors than before, intervene and offer instruction on larger numbers than small, and to support preschoolers’ counting by counting with or for them than by modeling how to count. Parents playing the game with two children were, however, somewhat more likely to intervene in their preschoolers’ counting than parents playing with just one child. Moreover, there is some evidence that the help provided by parents in dyads was more responsive to children’s needs than that provided by parents in triads. Among dyads, there was a very strong relationship between the amount of aid provided by parents and the preschoolers’ mathematical competence; this relationship was lacking among families in triads.

There are at least two differences between the conditions that make it difficult for caregivers playing with two or more children to be as sensitive to their children’s needs as those playing with a single child. One difference is the cognitive load placed on the parent (Zussman, 1980). Parents playing the game with two children faced greater demands than those playing with just one child. In addition to monitoring and structuring the preschoolers’ counting, the parent had to restrict the older sibling from intervening too often or too intrusively in the younger child’s turns, and respond satisfactorily to the attentional bids of both children.

A second difference has to do with the social aspects of playing the game. Because the game was not challenging for the older siblings, parents in the triadic condition may have intervened in the younger children’s counting (and opted not to offer the preschooler additional opportunities to count) in order to propel the game alone and thereby maintain the older child’s interest as well as control his or her frustration. Some parents may have also felt compelled to help their preschoolers attain the same level of performance as the older sibling even if it meant counting for them, perhaps to preempt conflict. Others may also have felt it inappropriate to offer too many additional counting opportunities to the preschoolers, as it may have been interpreted by the older siblings as favoritism.

5.1. Implications for research and practice

Our nation’s growing commitment to ensure that all children begin school ready to learn has led to a renewed interest among researchers and policy-makers alike in the ways that children’s home environments support the development of skills necessary to be successful in kindergarten and beyond. Increasingly, these skills include counting and other types of numerical understanding. The results of this study add to a expanding body of evidence that young children’s everyday experiences include numerous opportunities to learn about number, parents are motivated to promote their children’s numeracy skills, and that under optimal conditions (which may sometimes include modeling and training) parents are remarkably adept at structuring tasks so as to advance children’s numeracy skills (Starkey & Klein, 2000).

At the same time, our results lend credence to those skeptics who question the extent of the impact of parent–child interaction on children’s emerging number skills. To date, virtually all studies of
caregiver–child interaction on number tasks have focused on one-on-one interactions. This model is not an accurate reflection of the experiences preschoolers have in any type of group care. As Gelman and Massey (1987) observed, it may also not be a realistic portrayal of the experiences most children have in the home.

The fact that we were able to detect declines in the ability of parents to offer aid responsive to children’s needs with the mere addition of another sibling in this sample is quite telling in that, in many ways, we were dealing with a “best case scenario.” Not only were our parents highly educated, but also most were recruited from a cooperative half-day preschool that required parents to spend several hours in the classroom each week. Consequently, this sample of parents may have had an unusually high level of interest in and enthusiasm for engaging in educational activities with young children.

Although the sociocultural perspective on cognitive development has attracted considerable interest among the early childhood research community in recent years, this perspective has largely been interpreted within the framework of Vygotsky’s writings. As a consequence, empirical work within this perspective has focused almost entirely on one-on-one adult–child interactions in which the goal of the exchange is to foster children’s cognitive skills.

There are two limitations to this narrow focus. One limitation is that much of what parents and children do together is not explicitly designed to promote children’s cognitive abilities. Rather, children’s development is often a byproduct of participating in activities designed to achieve some other goal (Rogoff, 2003). These goals are diverse and include economic ones as well as amusement and social solidarity. To fully appreciate the social origins of children’s numeracy, it is important to study not only interactions in which adults intentionally teach children about number, but the other contexts in which children happen to be exposed to number and related concepts.

A second limitation is that many of young children’s interactions with adults are not one-on-one but occur in the presence of siblings or friends or classmates. As the present study suggests, these interactions may differ in important ways from the highly sensitive instructional exchanges depicted in the literature. Understanding how these experiences contribute to children’s growing understanding of number should also be a priority of researchers invested in understanding the social origins of children’s thinking.

The results also have implications for interventions aimed at promoting parental involvement in children’s early learning. Specifically, efforts to promote children’s number skills by encouraging parents to engage in number activities in the home may yield weaker gains than expected unless we remain sensitive to the context in which those activities are most likely to occur. Activities designed with one-on-one tutoring in mind may, in reality, end up involving several children. One straightforward recommendation, of course, is that parents set aside time to work with children individually. For a variety of practical and cultural reasons, parents may not always act on this advice. Alternatively, parent training could include strategies for maximizing learning when multiple children are involved. Designing activities specifically so that older siblings can be recruited to support young children’s learning would also be useful, particularly in cultural communities in which siblings, rather than adults, are children’s usual caregivers (Farver, 1999).

Acknowledgements

This article is based on a master’s submitted to the University of Florida in partial fulfillment of the requirements for the degree of Master of Science. Portions of this work were presented at the biennial
meetings of the Society for Research in Child Development, Albuquerque, NM, April 1999, and the Conference on Human Development, Memphis, TN, April 2000. This study was supported in part by a National Institute of Child Health and Human Development predoctoral traineeship awarded to the Department of Psychology, University of Florida (National Research Service Award T32HD07318).

The authors thank Renata Cerqueira, Michelle Harwood, and Crista Wetherington for their assistance with data collection and coding. We would also like to thank the families who participated in the study and Herbert Ginsburg, Susan Golbeck, and two anonymous reviewers for their helpful comments.

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