Early mathematical experiences: Observing young Black and White children's everyday activities

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Abstract:

Children's early mathematical experiences play an enormous role in the development of their understanding of mathematics, and serve as a foundation for their cognitive development. In this descriptive study, we observed the naturally occurring mathematical activities engaged in by thirty-nine 3-year-olds, equally divided by race/ethnicity and social class. We observed each child for 18 hours over the course of a single week, in such a way as to cover the equivalent of a complete day in its life. The children varied a good deal in the extent to which they were observed engaging in mathematical activities, but the variation was not explicable by race/ethnicity or class. For comparative purposes, we also report on the literacy-related activities in which the children were engaged.

Keywords: Ethnicity | Social class | Everyday activities | Math | Literacy

Article:

A generation or more ago, the first things that children were expected to know early on in their school careers were the "three Rs" of reading, "'riting," and "'rithmetic." Ideas about early education have changed a good deal since then, but no one denies the importance of early mathematical understanding as a foundation for important skills. Indeed, as Ginsburg, Klein, and Starkey (1998) pointed out, "We live in a society in which mathematical knowledge is commonly portrayed as vitally important for economic success, and indeed for everyday functioning" (p. 402). For Piaget, some of the major aspects of cognitive development during the preoperational and concrete operational stages have to do with logico-mathematical experience and understanding (Piaget, 1970, Piaget, 1980). For reasons both practical and theoretical it is therefore not surprising that there is a very large literature on toddlers' and preschoolers' understanding of number and arithmetical reasoning (Fuson, 1988, Gelman & Gallistel, 1978, Ginsburg et al., 1998). The focus of this body of literature is primarily on young children's understanding of number and other mathematical concepts (Briars & Siegler, 1984, Fuson & Hall, 1983, Gelman & Meck, 1983, Potter & Levy, 1968, Silverman & Rose, 1980, Wynn, 1990, Wynn, 1998), based on experimental studies conducted in laboratories.

Thus, despite Ginsburg and colleagues' assertion that we have "a rich understanding of the ways in which children construct an informal knowledge of mathematics in the everyday environment" (1998, pp. 401–402), virtually all of this information comes from experimental studies or those involving short-term observations of carefully structured episodes of child or child–mother interaction with mathematical objects. There is a dearth of research focusing on how much, and under what conditions, young children focus on things mathematical (counting, playing with mathematical shapes, telling time, estimating distance) in the course of their typically occurring everyday activities. This study helps to fill this gap, by examining the mathematical activities in which children of preschool age engaged during a single week in their lives.

1. Theory and review of literature

As far as Piaget (1941/1952) was concerned, mathematical understanding comes from children's active involvement with ordinary objects, rather than from formal teaching of mathematics. Children "invent" or construct their understanding of mathematics, as is the case with all understanding. Of course, there has to be support from the objects themselves (it helps if they lend themselves to acting and thinking mathematically). Piaget also did not ignore the role that can be played by the social world (Freitas, 2003), although he placed more emphasis on the role of peers than of adults (DeVries, 1997, Kamii, 1985; Piaget, 1970, Piaget, 1977; Tudge & Winterhoff, 1993).

Vygotsky (1935/1978) also wrote about children's early experience with mathematics, noting that long before they enter school "children have their own preschool arithmetic" (p. 84) learned in the course of their interactions with others, particularly others who are more competent in culturally valued skills and concepts. In the course of their activities with others "they have had to deal with operations of division, addition, subtraction, and determination of size" (p. 84). A few years earlier, foreshadowing some of Gelman and Gallistel's (1978) work by half a century, Vygotsky (1929/1994) wrote that

> The first stage [of a child's arithmetical ability] is formed by the natural arithmetical endowment of the child, i.e., his operation of quantities before he knows how to count. We include here the immediate conception of quantity, the comparison of greater and smaller groups, the recognition of some quantitative groups. (p. 67)

There are thus good theoretical grounds for believing that it is important to examine the types of mathematical experiences that children have before going to school, whether those experiences occur naturally in the course of play and exploration (a position associated with Piaget) or in conjunction with more experienced partners or with artifacts designed to help children become more competent in a culturally valued domain (a view attributable to Vygotsky).

Ginsburg and his colleagues (1998) presented a good summary of children's early informal mathematical knowledge, focusing on enumeration, number relations, simple arithmetic reasoning, subitizing and counting, and informal addition, subtraction, and division. By the age of three and four, children have a good deal of mathematical competence. It is noticeable, however, that all of the studies discussed by Ginsburg et al. (1998) rely on presenting children with specific tasks in experimental or quasi-experimental settings. These types of methods are, of course, excellent at finding out *what* children can and cannot do at various ages, but they do not allow us to understand the types of experiences that children have had that allow them to attain their various mathematical competencies. What information do we have on typically occurring mathematics experiences?

As Fuson (1988, p. 15) noted, there is "little research on the kind and range of experiences young children have with number words," a view echoed more recently by Starkey and Klein (2000) in relation to mathematical activities in general. With the exception of some of the work in the sociocultural tradition (Greenfield & Lave, 1982, Lave, 1988, Nunes, 1995, Nunes, 1999, Saxe, 1991; Schliemann, Carraher, & Ceci, 1997), most of the research that describes mathematical experiences outside the laboratory is based on observations involving children engaged in rather structured tasks or in short periods of free play involving mathematical objects (e.g., Durkin, Shire, Riem, Crowther, & Rutter, 1986; Wagner & Walters, 1982). One notable exception is the work of Seo and Ginsburg (2004), in which preschoolers were videotaped during unstructured free play; careful study of the videotapes revealed a wealth of mathematical experiences, although apparently neither the primary focus of the child's attention nor of the adults in the childcare centers where the observations were conducted.

Saxe, Guberman, and Gearhart (1987), by contrast, were interested in children's mathematical activities of which mothers were aware, in addition to collecting data in structured situations involving mathematical objects. Primarily on the basis of mothers' reports, Saxe and his colleagues noted that children engaged in some mathematics activity each week, including activities that the children themselves initiated. Rogoff (1987), commenting on these findings, concluded that middle- and working-class preschoolers are "heavily involved" at home in games and activities using number. However, Plewis, Mooney, and Creeser (1990), in a study that was also based on parental reports of their children's mathematical experiences, found that 6-year-olds were engaging, on average, in only about 15 minutes of mathematical activity during the three separate days on which parents were asked to complete a time-budget analysis of their children's activities. Moreover, 70% of the 200 respondents reported that their children had engaged in no mathematical experiences during those days.

There is some evidence that social class differences may be implicated in the extent to which children are involved in mathematical experiences. For example, Starkey, Klein, and their colleagues (Starkey & Klein, 2000, Starkey et al., 1999) found that middle-class parents reported providing more mathematics activities to their children than did working-class parents, and Saxe and his colleagues (1987) found that middle-class mothers reported that their children engaged in more complex mathematical experiences more often than did working-class mothers. However, Ginsburg and Russell (1981) found no significant variation on performance for a variety of mathematical tasks for children from working- versus middle-class families, and Ginsburg et al. (1998) reported that although "many economically disadvantaged children enter school less than fully prepared to learn formal mathematics" (p. 425) the data provide little evidence that children from different socioeconomic groups have had significantly different mathematical experiences. Low-income mothers, however, tend to believe that preschool teachers are responsible for providing instruction in mathematics (Holloway, Rambaud, Fuller, & Eggers-Pierola, 1995; Starkey & Klein, 2000).

Part of the problem with this variability of findings may stem from the fact that the methods for collecting data are very different. On the one hand, we have a wealth of data derived from experimental and structured studies showing that young children must have had a great number of different mathematical experiences because their abilities are many and varied. On the other hand, we have research based on parental reports that suggests that the extent of these experiences may in fact be quite limited. As Gelman and Massey (1987) pointed out, laboratory studies may be fine for showing what mothers do in a situation in which mathematics is the agenda, and in which there are no other activities available. However, in real life, mothers may be much less involved. By way of evidence, Gelman and Massey referred to Gelman and Greeno's (unpublished) observational study of parents and children in a section of museum devoted to numbers. This study revealed a very different picture of what parents and children do than typical studies of parents and children involved in mathematical tasks—the mothers interacted with their children very little, and the children themselves, including those of preschool age, spent very little of their time actually dealing with numbers.

The trouble with parental reports is that parents may miss a lot of mathematical activities—those when they are busy with other things, or when the child is at some distance from the parent. Reliance on parental accounts, rather than direct observations of, or conversations with, children, has other disadvantages. As the sociologists of childhood have argued, children's own experiences are devalued when parents are the primary sources of information (Hogan, Etz, & Tudge, 1999; Tudge & Hogan, in press). Moreover, those experiences of which parents are either unaware or view as unimportant are left unreported. Similarly, careful study of videotaped observations of children engaged in free play in childcare centers can reveal many instances of spontaneous classification, enumeration, judgments about size and shape, and so on (Seo & Ginsburg, 2004), without the teachers necessarily being aware of the children doing anything other than playing.

It is worth noting the contrast with the study of early literacy practices, many of which rely on extensive observation in and around the everyday situations in which children naturally find themselves (Hart & Risley, 1995, Heath, 1983; Snow, Barnes, Chandler, Goodman, & Hemphill, 1991; Vernon-Feagans, 1996). There are, of course, many other studies that rely on parental reports of their children's engagement in early literacy (e.g., Bennett, Weigel, & Martin, 2002) and on experimental research designed to evaluate the ways in which parents read with their children (Sonnenschein & Munsterman, 2002). However, perhaps because reading is so visually apparent and speaking so audible, it may lend itself more readily to direct observation than does mathematics, an activity that may occur in more subtle ways. Parents and teachers in child-care settings may thus be more likely to become involved with the children in their literacy activities than those dealing with mathematics.

To summarize, unlike the situation pertaining to early literacy experiences, research on children's mathematics has relied primarily on experimental or quasi-experimental studies and data on parental involvement with children in mathematics has derived either from these types of structured studies or from parental reports of their activities with children. This is true both for explicit assistance with mathematics (lessons, for example) and for engagement with children in play that may involve mathematics more incidentally. There is thus a paucity of information on young children's everyday experiences with mathematics, despite the prevailing view that the ways in which children come to think about mathematics is heavily dependent on the types of mathematical experiences they have had.

For this reason, our primary goal in this paper is to assess the extent to which young children are engaged in mathematics in the course of their everyday activities in the settings in which they are typically situated, and to examine the variation, if any, by ethnicity or social class. As is true of the data based on parental reports, our focus is on the type of mathematical activity that a parent, or teacher in childcare center, might be likely to notice when it is already occurring or that she or he might introduce to child. Our focus is not on those mathematical experiences that are "hidden" (a child thinking about number, dimension, weight, logic, etc., in the course of play but without making it explicit) or brief (a child saying "more" in order to get extra juice) but on those that might be the deliberate objects of attention. In particular, we focus on academic lessons (like a parent, sibling, or teacher deliberately teaching counting) and play with academic objects, namely artifacts deliberately designed to encourage mathematical thinking (such as a child playing with magnetic numbers). A second goal is to compare children's involvement in mathematics-related activities with their involvement in activities involving the acquisition and use of literacy. The third goal is to describe the types of mathematics- and literacy-related activities in which the children are involved.

2. Methods

2.1. Participants

Participants consisted of 39 preschoolers, 20 White and 19 Black, (11 White middle class: mean=36.6 months, SD=7.0; nine White working class: mean=36.9 months, SD=4.5; nine Black middle class: mean=38.3 months, SD=5.7; 10 Black working class: mean=39.8 months, SD=6.4). To be classified as "middle class," families had to meet Hollingshead (1975) education and occupation criteria for minor or major professionals (scores ranging from 40 to 66), whereas to be classified as "working class," families had to meet Hollingshead criteria for skilled or semi-skilled workers (20–39). Full details on the participants are included in Table 1.

Table 1. Participant characteristics

Characteristics	**White families**	**Black families**
Families contacted	46	50
Did not meet requirements	12	15
Declined to participate (% rejected)	14 (30.4%)	16 (32%)
Recruited	20	19
Middle class participants	11	9
Hollingshead *M* (S.D.)	52.1 (8.0)	50.2 (4.3)
Working class participants	9	10
Hollingshead *M* (S.D.)	28.9 (4.8)	28.6 (4.0)
Target child living with two parents	19	10
Children in family (range)	1–5	1–5
Target child with older siblings	12	9
Full-time child care	6	9
Part-time child care	12	0
No child care (with mother or relative)	2	10

We used a community-based approach to recruitment, in which we selected communities that were likely to differ by ethnicity/race and social class background of parents. From each community we recruited as many as possible of the families with a child of the relevant age from those families that met our requirement of social class and ethnic/racial background. For this study only families of European American or African American descent were recruited. They were drawn from four areas, relatively small in size (1–2 square miles), in a medium-sized southeastern city in the United States. A list was generated from the birth records of all children born in that area between 2 and 4 years earlier. Letters were sent to all families who appeared still to be living in the area (information derived from the telephone book and/or city records), and were followed by a screening call. In order to participate, the family still had to be living in the area, and had to fit the Hollingshead (1975) education and occupation criteria.

2.2. Observations

Families were asked to keep their daily routines unchanged as much as possible during the observation period. Each child was observed, wherever he or she was situated (home, childcare center, at friends' homes, in public spaces such as shops, parks, etc.), for 20 hours over the course of one week (the final 2 hours were videotaped, rather than coded live, and are not included in these analyses). Observation times were set by the observer in such a way that the equivalent of one entire waking day was covered. One observation period was scheduled starting from before the child woke, another period scheduled for the end of day, and the remaining periods spread over the remaining hours. Observations were continuous in 2–4 hours blocks, but activities were time sampled during 30-second "windows" every 6 minutes. During the intervening 5.5 min, observers coded the activities and wrote field notes describing the activities.

Children were coded as being "involved in" the activities if they were physically participating (e.g., playing a game involving shapes or looking at a book) or were observing (e.g., watching others play or listening to another child being read to). For a child to be coded as engaged in an activity, including mathematical activity, the child had to appear to be focused on that activity. For example, if a child were asked to take silverware to the table he or she would be coded as engaged in a type of work. The activity could also be coded as engagement in a mathematical lesson if, for example, someone pointed out to the child that four people were going to be eating and so he or she would need four forks. However, if mathematics were not the focus of attention, no mathematical activity would be coded.

A list of the major categories of activities in which children were involved (lessons, work, play, conversation, and other), some sub-categories, and their definitions, appears as Table 2. It was possible for a child to be coded as being involved in more than one activity simultaneously. The observers also wrote brief field notes describing what had occurred during each 30-second window and, as time permitted, wrote "non-window" field notes describing activities that occurred at other times. Field-note data for this paper are drawn solely from the window notes, as they describe the time-sampled activities, although examples of the types of lessons or play will be also be drawn, simply for illustrative purposes, from the non-window field notes.

Table 2. Definitions of major activities

Lessons	Deliberate attempts to impart or elicit information relating to:
Academic	School (spelling, counting, learning shapes, comparing quantities, colors, etc.);
Skill/nature	How things work, why things happen;
Interpersonal	Appropriate behavior with others, etiquette, etc.;
Religious	Religious or spiritual matters.
Work	Household activities (cooking, cleaning, repairing, etc.), shopping, etc.
Play, entertainment	Activities engaged in for their own enjoyment, including:
Academic	Play with academic object (looking at a book, playing with shapes, numbers, etc.), with no lesson involved;
Role-play	Play involving evidence that a role is being assumed, whether prosaic (mother shopping), mythical (super-hero), or object (animal);
Toys	Objects designed specifically for play or manipulation by children;
Other play	Objects not designed specifically for children, such as household objects, natural objects, or no object at all (rough and tumble, chase);
TV, entertainment	Watching TV, listening to radio, going to a ball-game, circus, etc.
Conversation	Talk with a sustained or focused topic about things not the current focus of engagement.
Other	Activities such as sleeping, eating, bathing, etc. and those that were uncodable.

For this paper, two sub-categories of activities are particularly relevant—*academic lessons* and *play with academic objects*. We defined *lessons*, generally, as explicit attempts to impart or elicit information, and academic lessons were defined as those involving competencies in the areas of literacy, mathematics, colors, etc. *Play*, as seen in Table 2, included exploration and entertainment, and involved a large number of sub-categories. We defined *play with academic obje*cts as playing with (or exploring or being entertained by) such things as books, numbers, shapes or other things that appear to have academic relevance, without any explicit lesson being involved. Thus, if a child were reading with her father, if she were playing with magnetic numbers or shapes on the refrigerator, or if she were counting (either objects or simply counting aloud) we coded play with an academic object. If her father asked her what a certain word was, helped her recognize her letters, showed her the order of the numbers, or talked about the shapes, we coded involvement in an academic lesson. A lesson and play with an academic object could both occur and be coded within the same coding window.

Observers were ethnically matched to families that they observed. Observer training involved live observations of children from families with a preschool child and from videotaped observations of these children, with discussion of disagreements until agreement was reached. Reliability was assessed using videotaped observations both before data collection and during data collection. Coders had to attain (and retain) a minimum of 75% agreement on all codes.

Although the coding scheme did not distinguish between different types of academic lessons or different types of academic play, the field notes written immediately after coding each window allowed us to determine the type of lesson and the type of play. Four codes were derived from each of these activities, according to whether the activity involved literacy, mathematics (involving number, shape, distance, time, etc.), "other" (lessons about recognizing sounds, memory games, etc.), and a category for notes that provided insufficient data for us to determine what type of academic lesson or play had been occurring. All of the relevant field notes were coded, blind, by the authors, yielding kappas of 0.93 for academic lessons and 0.82 for play with academic objects. Disagreements were discussed until resolved.

3. Results

During the 18 hours of observations of each child, we gathered approximately 180 30-second observations (White middle class mean=178.6, SD=2.5; White working class mean=177.8, SD=2.7; Black middle class mean=187.3, SD=2.7; Black working class mean=181.9, SD=2.6). We divided the settings into four categories: in and around the child's home, in someone else's home, in a formal childcare center, and in some public space. As shown in Table 3, all four groups of children were most likely to be observed in and around the home (more than half of the observations). About 15% of the observations were conducted in a childcare center and another 15% in someone else's home (in most cases a grandmother's house or a family childcare setting). The remaining 10% of observations took place in public spaces, such as grocery stores, parks, and libraries.

Table 3. Mean observations in settings, by race/ethnicity and social class

Group	Home: *M* (SD)	Other's home: *M* (SD)	Childcare center: *M* (SD)	Public place: *M* (SD)
White				
Middle class (11)	118.2 (26.5)	8.6 (12.6)	36.4 (29.7)	15.5 (17.3)
Working class (9)	119.4 (34.7)	16.9 (31.2)	25.0 (34.5)	16.4 (16.3)
Black				
Middle class (9)	106.8 (43.2)	33.6 (43.7)	19.6 (38.9)	21.2 (21.8)
Working class (10)	79.1 (40.7)	30.5 (41.8)	33.0 (38.0)	20.4 (16.1)

Table 4 displays the children's involvement in the four major groups of activity (*lessons*, *work*, *play*, and *conversation*). As one should expect, given the age of these children, in the large majority of observations children were involved in one sort or another of *play* (including exploration and entertainment). The remaining three types of activities featured much less frequently. Middle-class children, both White and Black, were somewhat more likely than working-class children to be involved in *lessons*, and White middle-class children were approximately twice as likely as all other groups to be involved in *conversation*.

Table 4. Mean engagement in activities, by race/ethnicity and social class

Group	Lessons: *M* (SD)	Work: *M* (SD)	Play: *M* (SD)	Conversation: *M* (SD)
White				
Middle class (11)	13.1 (6.7)	13.3 (9.3)	81.1 (20.5)	24.7 (11.5)
Working Class (9)	9.6 (3.5)	14.7 (3.5)	111.0 (20.8)	13.6 (6.5)
Black				
Middle class (9)	11.2 (6.3)	20.0 (14.2)	116.4 (23.2)	10.7 (9.5)
Working class (10)	8.1 (3.9)	16.5 (7.7)	112.2 (20.8)	11.9 (11.4)

Of most interest to us were the lessons and the play that involved mathematics. However, we will also provide data about the lessons and play involving literacy, to provide a comparison with the other two components of the "Three Rs." We have no specific hypotheses to test, believing that our data provide a useful descriptive purpose. For this reason we have displayed our data graphically, showing the percentage of children in each of our four groups (White and Black children from either middle- or working-class backgrounds) who were involved in mathematics lessons and play (Fig. 1, Fig. 2) and literacy lessons and play (Fig. 3, Fig. 4), categorized by number of observations.

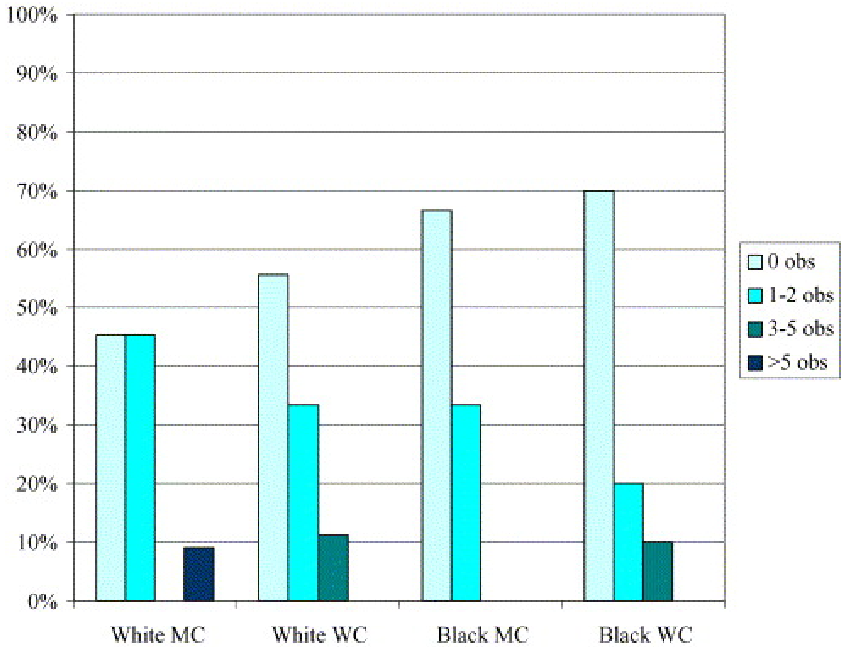

Fig. 1. Percentage of children in each race/ethnicity and social class group engaged in mathematics lessons by number of observations.

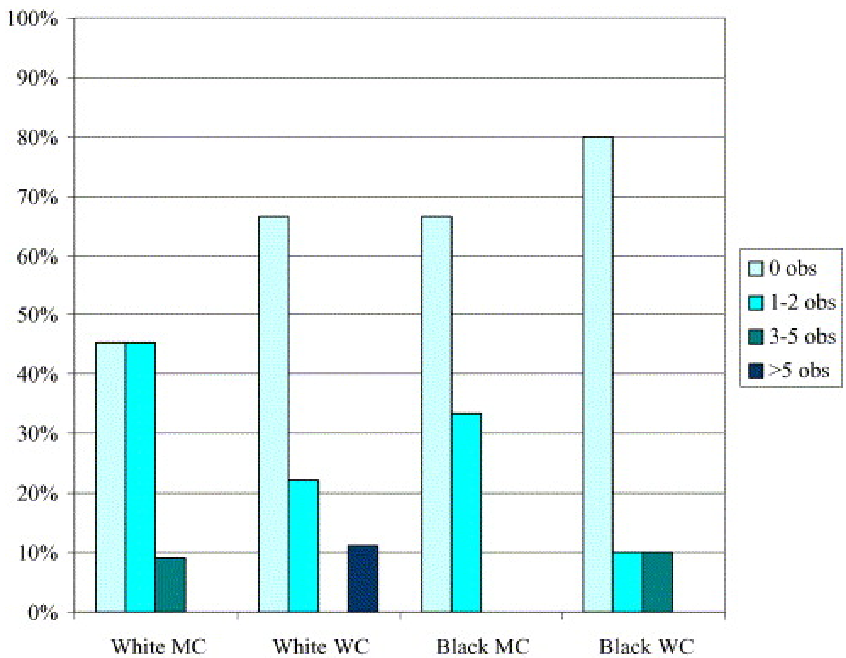

Fig. 2. Percentage of children in each race/ethnicity and social class group engaged in mathematics play by number of observations.

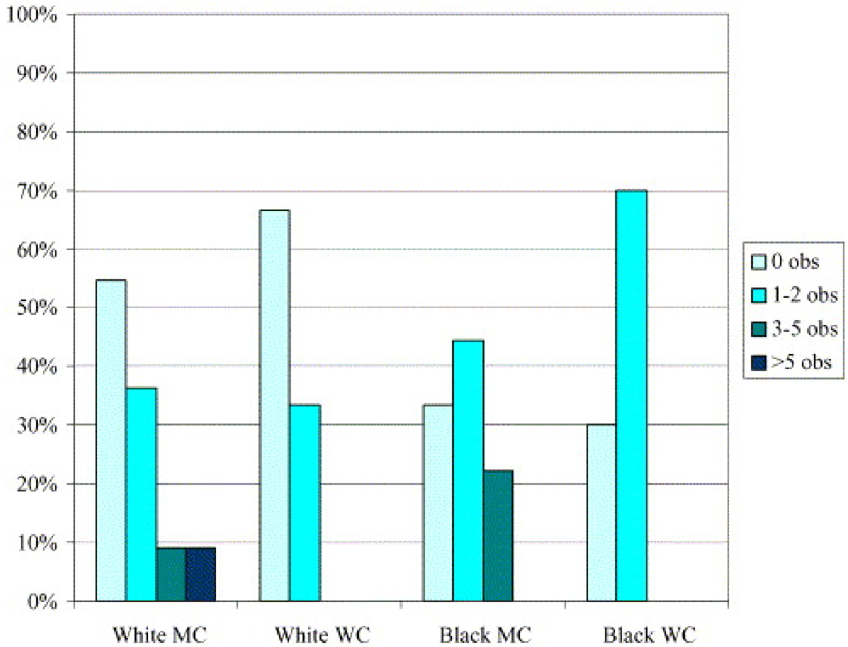

Fig. 3. Percentage of children in each race/ethnicity and social class group engaged in literacy lessons by number of observations.

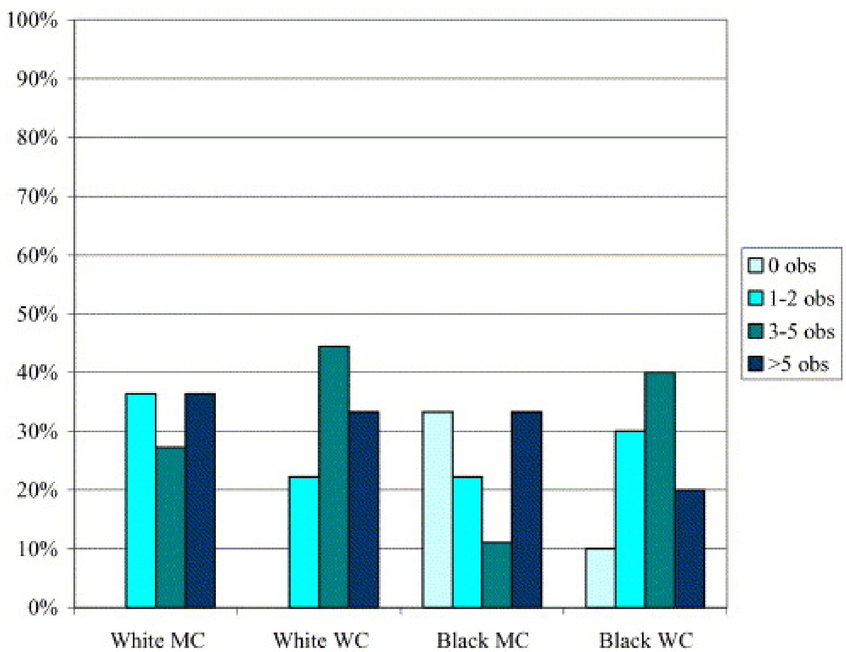

Fig. 4. Percentage of children in each race/ethnicity and social class group engaged in literacy play by number of observations.

These children did not engage in many mathematics lessons, averaging less than one observation over the entire 180 observations (White middle class mean=1.36, SD=2.1; White working class mean=0.67, SD=1.0; Black middle class mean=0.33, SD=0.5; Black working class mean=0.70, SD=1.6). There were also few lessons that focused on literacy (averaging one observation) (White middle class mean=1.0, SD=1.6; White working class mean=0.44, SD=0.7; Black middle class mean=1.78, SD=2.0; Black working class mean=0.80 SD=0.6). We also examined play with mathematics or literacy academic objects. Again, mathematics-related play was infrequent, averaging fewer than 1 observation out of 180 (White middle class mean=0.82, SD=1.0; White working class mean=1.56, SD=3.6; Black middle class mean=0.44, SD=0.7; Black working class mean=0.50, SD=1.3). There was a good deal more evidence of engaging with books and writing, however, with over five observations on average (White middle class mean=5.73, SD=5.3; White working class mean=5.78, SD=5.6; Black middle class mean=5.0, SD=7.9; Black working class mean=4.80, SD=5.5).

It is clear that these children, on average, spent a rather small proportion of their daily activity engaged in mathematics activities and not much more time in literacy activities. However, it is equally clear that there was a great deal of individual variation in the extent to which these children engaged in lessons or play involving mathematics or reading; the SDs are typically as large as or larger than the means. As shown in Fig. 1, approximately 60% of the 39 children were never observed involved in a mathematics lesson (23) or playing with mathematics-related objects (25), as seen in Fig. 2. Several were involved in quite a few lessons or play, however, including a White middle-class boy who was observed in seven mathematics lessons and a Black working-class boy who was observed five times in a mathematics lesson. A White working-class boy was observed 11 times engaging in play with mathematical objects (though only once in a mathematics-related lesson).

The situation was not greatly different with regard to lessons involving literacy. As seen in Fig. 3, 18 of the 39 children (45%) were never observed being given (or requesting) information about words or letters and an additional 18 children received one or two such lessons. The remaining three children (a White middle-class girl and two Black middle-class boys) each had five literacy lessons. However, these children were observed far more frequently involved in some type of play with literacy (see Fig. 4), occasionally writing or playing with letters, but most often either looking at books or being read to. All of the White children and 15 of the 19 Black children were observed at least once in literacy play, and 12 of the children (30%) were observed with books or writing six or more times, including one Black middle-class girl (25 observations), a Black working-class boy (19 observations), one White middle-class girl (19 observations), and two White working-class boys (18 and 12 observations, respectively).

One possible explanation for these variations is that children who were more likely to be exposed to mathematics or to literacy spent more time in a formal childcare center than either at home or in family childcare. This possibility was not supported by our data. Among the seven White children (four middle class, three working class) who were observed more than 20% of the time in a formal childcare center only one had engaged in as many as four lessons (two literacy and two mathematics), with the rest involved in no lessons (four children), a single lesson (one child), and two lessons (one child). Among the Black children, of the three who had been involved in the most lessons, two had been observed almost exclusively in and around the home, although the third had spent a little more than 20% of his time in a childcare center. The children who had spent at least 20% of their time in family childcare were involved in almost no lessons.

There was thus no evidence to support the speculation that children were more likely to receive lessons in childcare centers than in the home. Nonetheless, centers set up specifically for children might be places in which children are more likely to find play materials that are designed to encourage mathematics or literacy development. As was true of lessons, however, the data did not provide strong support for this view. Among the White children, none of the three children who were most often observed reading or playing with mathematical materials were observed in a childcare center or in family childcare. The situation was different among the Black children, however; the two children who had spent the most time being observed reading had both been observed at least 20% of their time in a formal childcare center.

Given the wide range of individual variation, we felt it would be useful to extend our analysis of these children's engagement in mathematics and literacy activities by describing the kinds of interactions or encounters children had with numbers and letters as recorded in the observers' field notes, gathered both during and outside the observational windows. We used the notes about what occurred during observation windows to organize mathematics and literacy activities into categories that would more precisely describe the various ways in which numbers and letters were part of children's naturally occurring activities in their everyday environments (see Table 5, Table 6, Table 7, Table 8). Because the observers did not collect the non-window notes in a systematic fashion, they were not included in our analyses, but they did contain some interesting examples of the types of activities defined in the categories. We have noted the few cases in which we used non-window notes for illustration purposes with an asterisk in Table 5, Table 6, Table 7, Table 8.

Table 5. Categories of mathematics-related lessons

Category	Focus of lesson	Example	Number of children
Numbering objects	Counting items in the environment; asking "how many?" questions	WC Black boy is at childcare center; it is lunchtime. Teacher asks child to count his goldfish crackers and child begins counting. Teacher tells him to use his fingers and helps him count and put the ones he's done with to the side.	9
About numbers	Teaching/learning number recognition, how to write numbers, etc.	WC Black boy is at home; mother is combing older sister's hair while child is working in a book. Mother asks him what number is on the page and child says "10," and mother says, "correct."	4
Basic mathematics	Teaching/learning introductory mathematics operations	MC White girl is at home playing cards with mother and brother. They count the cards and say the numbers … this is less than that (e.g., 3 is less than 7), etc. They are talking about what the cards are called (A is for Ace, 9 goes between 10 and 8), etc.*	3
Identifying shapes	Naming shapes; teaching/learning shapes	MC Black girl is at home playing a matching game on the computer. Mother says, "now which one has a purple shirt on? Which shape is he wearing? Is it a circle, square, or triangle?" Child says triangle. Mother trying to help child get the concept of different [shapes].*	2
Number sequence	Counting, generally speaking	MC White boy is in kitchen working on a puzzle. Mother helps him with one piece of the puzzle. He wants her to come help with more …. She comes around to him, "There's one. What comes after one? … Two" etc. She points to the numbers and says their names and he repeats after her.*	1

Table 5 shows that the most commonly observed mathematics lesson involved numbering objects. Puzzles, toys, television, computer programs, and other games offered convenient opportunities for adults to engage children in these sorts of exercises, and for children to elicit them themselves. Turning to mathematics-related play activities (Table 6), it was also interesting to note the ways in which children interacted with numbers when imparting or eliciting information was not the goal. As was the case with mathematics-related lessons, children's most common interaction with mathematics in play was via objects (such as toys, puzzles, books, computer programs) that had numbers as a central feature, although playing with shapes was a close second.

Table 6. Categories of mathematics-related play

Category	**Focus of play**	**Example**	**Number of children**
Number games	Interaction with a toy, game, book, etc., whose central feature is numbers	WC Black boy is at childcare center. He and a male peer play with a toy tape measure. Teacher helps them measure the table.*	7
Playing with shapes	Interaction with a toy, game, book, etc. whose central feature is shapes	WC White boy, his brother, and a friend are looking at a book. The brother and friend are naming shapes, "circle, circle, circle, square, square …."	6
Numbering for fun	Counting objects, or counting in general, where lessons are not the objective	WC White boy is playing with older sister. She starts shuffling UNO cards and humming. child watches closely. Sister tells him to count. He does, to 28.	4

Table 7. Categories of literacy-related lessons

Category	**Focus of lesson**	**Example**	**Number of children**
Labeling/ explaining	Getting child to identify/name objects in books and to explain parts of a story (i.e., reading comprehension)	WC White girl tells mother, "I want to read a book." Mother starts reading a book. Mother pointing to pictures and asking where the puppies are.	14
Spelling	How to spell words and names; identifying the first letter of words and names	MC Black boy is at home, playing a computer game. Part of the game asks the child to click on his name. Mother asks, "where's your name?" Child points to something. Mother says, "no, does it have a 'T' in it? Find a 'T' … okay how about the other letters? Find the last three letters of your name."	8
About letters	Providing information about letters—how to write them, differences between lower-case and capital, etc.	MC White girl is at home in her mother's bedroom, where mother is reading her a book. Child points to something on the page and asks, "what's that?" Mother responds, "That's a big 'H' and a little 'h.' Child says, "but they're both different." Mother says, "teachers call them 'upper case' and 'lower case'. "	7
Linking books to the world	Using reading to teach about how things work, aspects of the world, or life in general	MC White girl is at the public library with her mother and brother. Mother is reading child a book about running away, because child tried to run away herself. The book tells about the dangers and loneliness of running away.	5
Enhancing the vocabulary	Defining new words; teaching proper grammar	MC Black girl is at her grandmother's house playing outside with grandmother and older sister. They are taking turns throwing a ball to one another. Child throws the ball to her grandmother and says, "there is ares." Grandmother says, "there it is. Say 'there it is'. " Child tries to say it. Grandmother repeats again, "there it is, there it is."	3

Table 7 shows the five categories of lessons related to literacy that were coded from the field notes. The most commonly observed lessons with regard to literacy activities were those involving labeling or identifying, for example, objects, letters, or the storyline as a book was being read. Approximately one third of the sample was involved in this type of lesson. Table 8 outlines the categories of literacy-related play. Fully 60% of the sample was observed engaging in reading for fun.

Table 8. Categories of literacy-related play

Category	Focus of play	Example	Number of children
Reading for fun	Reading stories for entertainment	MC White boy is at home, and it is bedtime. Mother is reading to him in preparation for sleep.	23
Literacy-related toys	Interaction with a toy or game with a focus on letters/ reading; using books as toys	MC Black boy is at home sitting at the computer. He is playing a game in which he has to match letters or numbers together.	10
Writing for fun	Writing words or letters for entertainment	WC Black girl is at childcare center, sitting at a table with several peers. The children are coloring. She says, "I can write my name" to no one in particular, and begins to write her name and call out the letters aloud.	5
ABCs	Singing or practicing the alphabet	WC Black girl is at family childcare. She is dancing around the kitchen floor and starts singing ABCs, imitating a male peer who had sung them earlier.	2

4. Discussion

The study presented in this paper provides a window into children's early experiences and addresses a gap in the literature on young children's mathematical experiences. Little research to date has focused on the everyday, naturally occurring mathematics activities in which children engage, especially in the context of explicit lessons and in the course of play with artifacts designed to encourage mathematical thinking. There is a legitimate need for knowing the sorts of activities children get involved in outside of structured environments with clearly set goals. Most previous studies have used structured situations with specific instructions about the kinds of activities participants were to engage in. As Gelman and Massey's (1987) eye-opening museum study showed, however, assumptions about the ways people behave and the activities in which they engage may not be supported when the conditions of interaction have not been artificially constrained.

One of the issues that emerged clearly from our findings was the fact that many of the children were little or never involved in explicit mathematics activities, whether in the course of lessons or play with artifacts designed to encourage mathematical experiences. Admittedly, we could not know what the children were thinking when they were playing with materials, particularly when alone. It could well be that there was a good deal of learning about numbers happening while a child sat on a rug decorated with numbers, perhaps just looking or counting silently, or while he or she walked up steps, possibly numbering them while doing so. In such instances, we might surmise that children were practicing their existing knowledge about numbers, but they could equally well be thinking about something else entirely. Likewise, in children's play with their toys and games they might have been thinking about mathematical properties of those objects, but without verbalization it would be impossible to know. Thus we may have underestimated the extent to which the children were doing (or thinking) things mathematical. It is clear from the work of Seo and Ginsburg (2004) involving videotaped free play in child-care centers that careful observation can reveal a good deal of mathematical activity that may not be immediately apparent to the teachers in those centers—a child putting different-sized blocks away into receptacles of equivalent size may indeed be learning about shape, although the child's focus could just as easily be on color or texture, or simply on the fact that this is a task he or she would prefer not to be doing. Furthermore, unlike Saxe and his colleagues (1987), we have not analyzed our data in terms of the complexity of the mathematical activities in which the children were involved, and our field note data are not detailed enough to allow that. So we are really talking about how often children are involved in explicit mathematics, not the complexity of their activities.

We do not believe that this limited degree of involvement necessarily means that parents and teachers had no interest in engaging their children in mathematics-related activities, or that the children themselves were uninterested in these activities. However the fact that the children were more involved in literacy is perhaps reflective of cultural norms in the U.S., where there is a great deal of emphasis placed on the importance of reading, particularly related to children's development and education. Slogans like "Reading is Fundamental" adorn school walls and can be heard on television commercials; there are children's television shows entirely devoted to the importance of reading, such as *The Reading Rainbow* and *Between the Lions*. We are not aware of any such programs devoted to mathematics at this age level. As we stated earlier, it could simply be that reading lends itself more readily to direct observation than does mathematics. After all, numbers are just as much a part of everyday activities as letters, from looking at dates on a calendar to checking the time on a clock to counting money. But there seems to be more emphasis placed on the need for children to learn to read. Data derived from interviews with the parents of these children (Doucet, 2000) reveal that the parents were indeed more focused on helping their children learn to read than on helping their mathematical understanding.

In considering children's involvement both in lessons and in playing with mathematics- and literacy-related artifacts it would be wrong to focus entirely on what parents and other adults do; we must also bear in mind the role that children themselves play in initiating their everyday activities, by asking questions about numbers, choosing to look at a book, playing with objects that may help them understand a mathematical concept, and so forth. Piaget of course stressed children's own activity with the world, but so too did Vygotsky, with his focus not simply on adults helping children learn but also on children's experiences with the artifacts that the culture makes available (Tudge & Scrimsher, 2003). It is thus worth noting that the few children who were more involved in literacy- and mathematics-related activities may have been more curious, active, or inquisitive than the others. For example, the only White child to be involved in more than 10 mathematics play activities (a working-class boy) was also among the few to be involved in more than 10 literacy play activities.

Although we spent a total of 18 hours observing each child across the equivalent of an entire day, because we only coded activities every 5.5 minutes for 30 seconds, our coded observations only constitute 90 actual minutes. Assuming that time-sampling methods allow generalization over the time sampled, we can estimate the number of mathematics and literacy experiences children have over an entire week. For example, if children experience just one activity involving a mathematical object or a lesson every 90 minutes they would be expected to have approximately 10 mathematical experiences every day, or 70 during the week. Although this figure would appear to support the view that children are "heavily involved" in activities involving numbers, it would be well to recall, similar to Plewis et al.'s (1990) findings, that approximately 60% of the children were never observed engaged in any mathematical lesson or in play with mathematical objects. Some children, by contrast, were involved in many more such experiences, and further research should be undertaken to ascertain the extent of and reasons for such variation.

Taken together, the findings we have reported here provide interesting insights into the early mathematical experiences of young children. As a number of authors (Harkness & Super, 1995, Tudge et al., 1999) have argued, the regularly occurring, everyday activities of daily life are important to study in and of themselves because of what they can tell us about culturally appropriate practices:

> The activities that routinely take place within different settings are key to understanding parents' cultural construction of child life and development. Activities, routines, or cultural practices involved in the care and rearing of children instantiate cultural themes of importance to parents, and in this way they communicate cultural messages. (Harkness & Super, 1995, p. 226)

The messages that some parents appear to be giving their children is that mathematics is important; they provide their children with mathematical experiences and with lessons in mathematics. However, other parents do not seem to provide the same level of experiences, and in general the children were more heavily involved in activities involving literacy than in those involving mathematics. People working with children in childcare centers and in family childcare arrangements also did not show much evidence of providing the children in their care with many mathematical experiences. If it is indeed correct that working-class parents look to preschool settings to provide their children with mathematics experiences (Holloway et al., 1995, Starkey & Klein, 2000), our data suggest that they are mistaken—we found no evidence that children are more likely to be engaged in mathematical activities (at least of the type that are likely to be obvious to either parents or teachers) in formal childcare centers than at home.

One conclusion that might be drawn is that the provision of mathematical experiences to 3-year-olds is not an important cultural practice, at least with some of the parents whose children we studied. Nonetheless, a good deal of data has suggested that children of preschool age have developed a wide range of mathematical concepts. Perhaps, as Piaget argued, exploration in and of the world is sufficient to allow children to attain the foundations that they will later build on when they enter formal school, without a great deal of adult input. On the other hand, in keeping with Vygotsky's thesis, many of the children in this study were involved in explicit lessons and had opportunities to interact with artifacts designed to encourage mathematics. In any event, there is certainly room for parents and other important people in children's lives to enhance children's opportunities for mathematical experiences.

We are not suggesting that either parents or teachers should provide their children with formal lessons in mathematics; rather, that they pay more attention to ways in which they can expand on what the children are already doing. It seems clear that close observation, of the type done by Seo and Ginsburg (2004), reveals many instances of mathematics experiences that could be made more explicit and amplified in ways that would help the children develop mathematically. Similarly, the types of "lessons" we observed were simply those in which information about mathematics was either given to children or requested by children—information or questions about the number of objects, about size or shape, or about time. These are the sorts of things that can occur quite naturally in the course of children's play, and which can help them think in more formal ways about mathematics. Parents seem to do this far more naturally with literacy activities, whether reading to children or pointing out the signs or messages that appear in stores or on TV. It would be helpful if both teachers and parents paid equal attention to the naturally occurring mathematical experiences that children just as regularly encounter.

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References

Bennett, K. K., Weigel, D. J., & Martin, S. S. (2002). Children's acquisition of early literacy skills: Examining family contributions. *Early Childhood Research Quarterly*, *17*, 295–317.

Briars, D., & Siegler, R. S. (1984). A featural analysis of preschoolers' counting knowledge. *Developmental Psychology*, *20*, 607–618.

DeVries, R. (1997, March). Piaget's social theory. *Educational Researcher*, 4–17.

Doucet, F. (2000). *The transition to school in middle-class and working-class African American families: A study of beliefs, values, and practices.* Unpublished doctoral dissertation, University of North Carolina at Greensboro.

Durkin, K., Shire, B., Riem, R., Crowther, R. D., & Rutter, D. R. (1986). The social and linguistic context of early number word use. *British Journal of Developmental Psychology*, *4*, 269–288.

Freitas, L. B. D. (2003). *A moral na obra de Jean Piaget: Um projeto inacabado* [*Morality in the works of Jean Piaget: An unrealized project*]. São Paulo, Brazil: Cortez Editora.

Fuson, K. C. (1988). *Children's counting and concepts of number*. New York: Springer-Verlag.

Fuson, K. C., & Hall, J. W. (1983). The acquisition of early number word meanings: A conceptual analysis and review. In H. P. Ginsburg (Ed.), *The development of mathematical thinking* (pp. 49–107). New York: Academic Press.

Gelman, R., & Gallistel, C. R. (1978). *The child's understanding of number.* Cambridge, MA: Harvard University Press.

Gelman, R., & Massey, C. M. (1987). The cultural unconscious as contributor to the supporting environments for cognitive development. *Monographs of the Society for Research in Child Development, 52*(2, Serial No. 216), 138–152.

Gelman, R., & Meck, E. (1983). Preschoolers' counting: Principles before skill. *Cognition*, *13*, 343–359.

Ginsburg, H. P., Klein, A., & Starkey, P. (1998). The development of children's mathematical thinking: Connecting research with practice. In I. E. Sigel, K. A. Renninger (Vol. Eds.), & W. Damon (Series Ed.), *Handbook of child psychology: Vol. 4. Child psychology in practice* (pp. 401–476). New York: Wiley.

Ginsburg, H. P., & Russell, R. L. (1981). Social class and racial influences on early mathematical thinking. *Monographs of the Society for Research in Child Development, 46*(6, Serial No. 193).

Greenfield, P. M., & Lave, J. (1982). Cognitive aspects of informal education. In D. A. Wagner & H. W. Stevenson (Eds.), *Cultural perspectives on child development* (pp. 181–207). San Francisco: Freeman.

Harkness, S., & Super, C. M. (1995). Culture and parenting. In M. H. Bornstein (Ed.), *Handbook of parenting: Vol. 2. Biology and ecology of parenting* (pp. 211–234). Mahwah, NJ: Erlbaum.

Hart, B., & Risley, T. R. (1995). *Meaningful differences in the everyday experiences of young American children*. Baltimore, MD: Brookes Publishing.

Heath, S. B. (1983).*Ways with words: Language, life, and work in communities and classrooms*. New York: Cambridge University Press.

Hogan, D., Etz, K., & Tudge, J. (1999). Reconsidering the role of children in family research: Conceptual and methodological issues. In F. M. Berardo (Series Ed.) & C. Shehan (Vol. Ed.), *Contemporary perspectives on family research: Vol. 1. Through the eyes of the child: Re-visioning children as active agents of family life* (pp. 93–105). Stamford, CT: JAI Press.

Hollingshead, A. B. (1975). *Four factor index of social status* (Working paper). New Haven, CT: Yale University.

Holloway, S. D., Rambaud, M. F., Fuller, B., & Eggers-Pierola, C. (1995). What is "appropriate practice" at home and in child care?: Low-income mothers' views on preparing their children for school. *Early Childhood Research Quarterly*, *10*, 451–473.

Kamii, C. K. (1985). *Young children reinvent arithmetic: Implications of Piaget's theory.* New York: Teachers College Press.

Lave, J. (1988). *Cognition in practice: Mind, mathematics, and culture in everyday life*. New York: Cambridge University Press.

Nunes, T. (1995). Cultural practices and the conception of individual differences: Theoretical and empirical considerations. *New Directions for Child Development*, *67*, 90–103.

Nunes, T. (1999). Mathematics learning as the socialization of the mind. *Mind, Culture, and Activity*, *6*(1), 33–52.

Piaget, J. (1952). *The child's conception of number.* New York: Norton. (Original work published 1941).

Piaget, J. (1970). *Science of education and the psychology of the child*. New York: Orion.

Piaget, J. (1977). *Etudes sociologiques* [*Sociological studies*]. Geneva, Switzerland: Librairie Droz. (Original work published 1928 and 1945).

Piaget, J. (1980). *The equilibration of cognitive structures: The central problem of intellectual development.* Chicago: The University of Chicago Press. (Original work published 1975).

Plewis, I., Mooney, A., & Creeser, R. (1990). Time on educational activities at home and educational progress in infant school. *British Journal of Educational Psychology*, *60*, 330–337.

Potter, M. C., & Levy, E. I. (1968). Spatial enumeration without counting. *Child Development*, *39*, 265–272.

Rogoff, B. (1987). Specifying the development of a cognitive skill in its interactional and cultural context. *Monographs of the Society for Research in Child Development, 52*(2, Serial No. 216), 153–159.

Saxe, G. B. (1991). *Culture and cognitive development: Studies in mathematical understanding*. Hillsdale, NJ: Erlbaum.

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).

Schliemann, A. D., Carraher, D. W., & Ceci, S. J. (1997). Everyday cognition. In J. W. Berry, P. R. Dasen, & T. S. Sarasthwati (Eds.), *Handbook of cross-cultural psychology: Vol. 2. Basic processes and human development* (pp. 177–216). Boston: Allyn and Bacon.

Seo, K.-H., & Ginsburg, H. P. (2004). What is developmentally appropriate in early childhood mathematics education? Lessons from new research. In D. H. Clements, J. Sarama, & A.-M. DiBiase (Eds.), *Engaging young children in mathematics: Standards for early childhood mathematics education* (pp. 91–104). Hillsdale, NJ: Erlbaum.

Silverman, I. W., & Rose, A. P. (1980). Subitizing and counting skills in 3-year-olds. *Developmental Psychology*, *16*, 539–540.

Snow, C. E., Barnes, W. S., Chandler, J., Goodman, I. F., & Hemphill, L. (1991). *Unfulfilled expectations: Home and school influences on literacy*. Cambridge, MA: Harvard University Press.

Sonnenschein, S., & Munsterman, K. (2002). The influence of home-based reading interactions on 5-year-olds' reading motivations and early literacy development. *Early Childhood Research Quarterly*, *17*, 318–337.

Starkey, P., & Klein, A. (2000). Fostering parental support for children's mathematical development: An intervention with Head Start families. *Early Education and Development*, *11*, 659–680.

Starkey, P., Klein, A., Chang, I., Dong, Q., Pang, L., & Zhou, Y. (1999, April). *Environmental supports for young children's mathematical development in China and the United States.* Paper presented at the biennial meetings of the Society for Research in Child Development, Albuquerque, NM.

Tudge, J. R. H.,&Hogan, D. M. (in press). Accessing children's experiences: An ecological approach to observations of everyday life. In S. M. Greene & D. M. Hogan (Eds.), *Researching children's experiences: Approaches and methods*. London: Sage.

Tudge, J., Hogan, D., Lee, S., Meltsas, M., Tammeveski, P., Kulakova, N., Snezhkova, I., Putnam, S. (1999). Cultural heterogeneity: Parental values and beliefs and their preschoolers' activities in the United States, South Korea, Russia, and Estonia. In A. Göncü (Ed.), *Children's engagement in the world* (pp. 62–96). New York: Cambridge University Press.

Tudge, J. R. H., & Scrimsher, S. (2003). Lev S. Vygotsky on education: A cultural-historical, interpersonal, and individual approach to development. In B. J. Zimmerman & D. H. Schunk (Eds.), *Educational psychology: A century of contributions* (pp. 207–228). Mahwah, NJ: Lawrence Erlbaum Associates.

Tudge, J. R. H., & Winterhoff, P. A. (1993). Vygotsky, Piaget, and Bandura: Perspectives on the relations between the social world and cognitive development. *Human Development*, *36*, 61–81.

Vernon-Feagans, L. (1996). *Children's talk in communities and classrooms*. Oxford: Blackwell.

Vygotsky, L. S. (1978). Interaction between learning and development. In M. Cole, V. John-Steiner, S. Scribner,&E. Souberman (Eds.), *Mind in Society: The development of higher psychological processes* (pp. 79–91). London: Harvard. (Original work published 1935).

Vygotsky, L. S. (1994). The problem of the cultural development of the child. In: R. Van der Veer & J. Valsiner (Eds.), *The Vygotsky reader* (pp. 57–72). Oxford: Blackwell. (Original work published 1929).

Wagner, S. H.,&Walters, J. (1982). A longitudinal analysis of early number concepts: From numbers to number. In G. E. Forman (Ed.), *Action and thought: From sensorimotor schemes to symbolic operations* (pp. 137–161). New York: Academic Press.

Wynn, K. (1990). Children's understanding of counting. *Cognition*, *36*, 155–193.

Wynn, K. (1998). Psychological foundations of number: Numerical competence in human infants. *Trends in Cognitive Sciences*, *2*, 296–303.