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Measuring Number Sense with Nigerian Primary School Children from Low and Medium SES Backgrounds

Katrina A. Korb

University of Jos

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Abstract

Case and colleagues (1996) found that preschoolers interpret quantitative problems either with a verbal or protoquantitative schema. Low and medium SES children may differ in their performance on number sense tasks with the verbal but not protoquantitative schema. This study compared the performance of low and middle SES first grade Nigerian students on seven number sense tasks, administered with both pictures and numbers. Middle SES participants performed better with pictures on number transformation tasks and better with numbers on number patterns. Low SES participants had similar performance with pictures and numbers on all tasks except addition. Middle SES participants performed better than low SES participants with numbers on all tasks and with pictures on tasks with more advanced number skills.

A solid foundation of mathematical understanding is essential for young children both because it helps children construct an understanding of their environment and because it is necessary for successful performance in future mathematics courses and in science and technologically related fields (National Association for the Education of Young Children [NAEYC] & National Council for Teachers of Mathematics [NCTM], 2002). The mathematical understanding of young children has been researched from two perspectives. According to the instructional perspective, young children's mathematical understanding is described as number sense where researchers concentrate on the number skills that young children have mastered (Malofeeva, Day, Saco, Young, & Ciancio, 2004). The developmental perspective, on the other hand, investigates the schema that children use to represent and assign meaning to quantitative problems (Case & Griffin, 1990). The two perspectives of young children's mathematical understanding will be examined separately.

Number sense is the ability to flexibly reason with numbers (NCTM, 2000). A mature number sense allows young children to associate number words and Arabic numerals with the quantities that they represent. Five fundamental skills are associated with number sense (Jordan, Kaplan, Oláh, & Locuniak, 2006). Counting requires understanding that the final number in the counting sequence represents the quantity in the entire set, the cardinality principle. Second, number sense involves the ability to estimate the number of objects in a set. A third concept, number knowledge, requires the ability to coordinate quantities and make comparisons of numbers. Number sense is also represented by the ability to make transformations on numbers through addition and subtraction. Finally, children should be able to identify patterns in a series of numbers. Number sense concepts are thought to gradually develop in early childhood as children informally interact with quantities (Malofeeva et al., 2004; NCTM, 2000). According to the standards that NCTM has put forth for mathematics education, young children should have developed a foundational number sense by the end of second grade (NCTM, 2000).

From the developmental perspective, children interpret quantitative problems through a central conceptual structure. Young children's central conceptual structure undergoes a qualitative shift about the time that children enter formal education. Children in preschool have two functionally independent quantitative abilities: the verbal ability to count and a protoquantitative ability to make judgments of quantity (Case & Okamoto, 1996). By the age of four, most children can count a set of objects and understand that the final number in the counting sequence represents the quantity in the set (Gelman, 1978), representing the verbal counting schema. Second, most preschoolers understand that adding an object causes the amount of a set to increase, and removing an object causes the amount to decrease (Starkey, 1992). Preschoolers can also compare sets of objects to determine which set has more and which set has less (Barth, La Mont, Lipton, & Spelke, 2005; Huntley-Fenner & Cannon, 2000). When preschoolers make mathematical transformations and compare sets, they do not appear to use their counting abilities to solve the task (Huntley-Fenner & Cannon, 2000; Starkey, 1992), so these skills represent the protoquantitative schema.

When faced with a quantitative problem, preschool children can only interpret the problem in terms of their verbal counting schema or their protoquantitative schema (Resnick, 1989; Siegler & Robinson, 1982). For example, preschool children tend to have difficulty answering the question "Which is bigger, 9 or 5?" However, as preschoolers transition into the next stage of development, they merge their verbal counting schema and their protoquantitative schema into a new central conceptual structure where the verbal counting labels symbolize nonnumerical quantitative sets in a mental number line (Case & Okamoto, 1996). This more advanced quantitative schema is termed the unidimensional conceptual structure because children can interpret a problem in terms of only one mental number line (Okamoto, 1996).

Despite coming from different paradigms, both educationalists and developmentalists have concluded that the most foundational concept for success in subsequent mathematics is connecting number symbols with the quantities they represent (Case & Okamoto, 1996; Jordan et al., 2006). However, little research has been conducted that explicitly connects these two lines of research. Therefore, the first purpose of this study was to examine whether children just entering formal schooling represent basic number sense tasks with a verbal counting schema, a protoquantitative schema, or a merged schema. If children solve the tasks with the verbal counting schema, then performance should be higher in a condition of the task with Arabic numerals. If children solve the task with the protoquantitative schema, then the students should perform better in a condition of the task with pictures that make a quantitative set (e.g., three bananas). If children solve the task with a merged quantitative schema, then performance should be the similar in both conditions.

In this study, seven basic number sense tasks were administered.[1] Number knowledge was assessed by two tasks that required students to make judgments of more or less and a third task that compared the relative difference between numbers. Number transformation was measured by two tasks that required students to add and subtract sets of objects and a third task that required combining two sets of numbers to make a whole. Number patterns was measured by one task that required students to continue a series of numbers. All seven tasks were administered once with pictures to measure performance solving the task with the protoquantitative schema and once with numbers to measure performance solving the task with the verbal counting schema.

The Effects of Socioeconomic Status on Mathematical Understanding

While children from middle socioeconomic status (SES) backgrounds tend to develop number sense skills in the preschool years, children from low SES backgrounds do not (Griffin, Case, & Siegler, 1994). Indeed, children from low SES backgrounds tend to perform lower than their peers from middle SES backgrounds in mathematics at all levels of education (NAEYC and NCTM, 2002; Entwisle & Alexander 1990; Lee, Grigg, & Dion, 2007), as do children from developing countries (Gonzales, Williams, Jocelyn, Roey, Kastberg, & Brenwald, 2008).

However, while children from middle SES backgrounds tend to perform better than their peers from low SES backgrounds on mathematical tasks that require the verbal counting schema, research suggests that lower SES children may perform just as well as middle SES children on mathematical tasks that require the protoquantitative schema. For example, Jordan and colleagues (Jordan, Huttenocher, & Levine, 1992; see also Jordan, Huttenlocher, & Levine, 1994) administered two verbal number transformation tasks to kindergarteners that required solving story problems (e.g., Mike has two balls. Nancy gives him one more ball. How many balls does Mike have altogether?) and number-fact problems (e.g., How much is two and one?) A conceptually similar nonverbal number transformation task was also administered where children saw a set of chips that was subsequently hidden by a box. Chips were then added to or removed from the box and the children were to use their own set of chips to display the total number of chips hidden by the box. The children from low SES backgrounds performed significantly lower than the children from middle SES backgrounds on the story problems and number-fact problems. However, there was no significant difference in the performance of middle and low SES children on the nonverbal task that afforded the protoquantitative schema.

Therefore, the second purpose of this study was to examine whether children from low SES backgrounds perform as well as their peers from middle SES backgrounds on measures of number sense that afford the protoquantitative schema. To this end, this study compared the pattern of performance in the pictures and numbers conditions of the number sense tasks between middle and low SES students. SES is defined as a person's economic standing based on lifestyle, prestige, power, and control of resources (Liu, Ali, Soleck, Hopps, Dunston, Pickett, 2004) and is measured by a family's level of income, parental occupation, and the parents' level of education. Operationally, SES tends to be measured in the United States by qualification for free or reduced lunches in public school system (e.g., Gonzales et al., 2008). However, Nigeria does not have a nationwide structure of support for students from low SES backgrounds. Therefore, SES was defined in this study as the type of school that children attended. Public education in Nigeria has many infrastructure problems, including a lack of funding (students oftentimes do not even have desks to write on), teachers who oftentimes miss class without providing a substitute, and frequent teacher strikes that frequently cause 12 years of formal schooling to take 13 or more years to complete. As a result, most parents in Nigeria try to raise the money necessary to pay for the relatively more expensive fees for private schools. In this study, students who attended two private schools were classified as middle SES and students who attended two public schools were classified as low SES.

This research study expanded prior research in three ways. First, the study examined the type of schema that students use to solve common number sense tasks. Second, the study compared the performance of students from low and middle SES backgrounds on a broad range of number sense tasks. Finally, the study used a population of students from the developing country of Nigeria. Little previous research has examined how children from developing countries represent and reason with number.

Methods

Participants

Sixty students in primary 1 (e.g., first grade) participated in the study, 30 students from two public schools and 30 students from two private schools. Although primary 1 is the first level of formal schooling in Nigeria, some children attend nursery school classes for one to three years within the same school building prior to primary 1. The schools were located in the same large city in the geographic center strip of Nigeria, commonly called the Middle Belt. The majority of the population within this state is from multiple minority tribes. Participants in public schools ranged in age from six to nine years and the majority were male. Participants in private schools ranged in age from four to nine and the majority were female. Table 1 provides the demographic characteristics of the sample. Low SES students in the public schools were significantly older than the middle SES students in the private school ($t(57) = 4.57$, $p<.001$). There were also significant differences between the gender distributions of the two samples ($\chi^2(1, N = 60) = 4.27$, $p<.05$). Most of the students spoke English as a second or third language in addition to their tribal language and/or the regional language of Hausa. However, English is the language of education within the country of Nigeria and all of the schools selected for this study used English as the exclusive language of instruction.

Research Design

A 2 x 7 x 2 mixed-model research design was employed. The between-subject factor was SES with two levels, low and medium. The two within-subject factors were task with seven levels and condition with two levels, pictures and numbers. The dependent measure was the number of items correct within each condition.

Measure

The seven number sense tasks for this study were designed to assess three of the five foundational number sense skills essential for success in elementary mathematics. Table 2 provides an overview of the tasks used in this study. The tasks were designed to minimize verbal demands. As such, the directions were designed to help the participants understand the task, after which the students could solve every subsequent problem with a simple prompt. For example, the more task was presented as follows (see Figures 1a and 1b for the task stimuli). First, students were told that there were three farms and asked to count the number of zebras on each farm. Then the researcher asked which farm had the most, or the biggest number of zebras. Subsequent items required the simple prompt of “Which is the biggest?” The pictures condition of each of the tasks is described below. The numbers condition was identical except the cards with pictures were replaced by cards with numbers.

The first two tasks, more and less, assessed participants’ number knowledge by comparing the size of quantitative sets. In both tasks, three rectangular “farms” were placed in front of the student. In the more task, a set of zebras was placed in each farm and the participant was asked to point to the farm that had the most zebras. In the less task, a set of flowers was placed in each farm and participants were asked to point to the farm that had the smallest amount of flowers.

The third and fourth tasks, addition and subtraction, tested participants’ knowledge of number transformation. Two plates were placed in front of the participant. In the addition task, one set of tomatoes was placed on the participant’s plate and another set of tomatoes was placed on a second plate. Participants were asked how many tomatoes they would have if they combined the two sets. For the subtraction task, one plate was replaced by a mouth. A set of apples was placed on the participant's plate. Another set of apples with x's marked through them was placed on the mouth. Participants were asked how many apples they would have left if they ate the amount of apples in the mouth.

The equivalence task was also designed to assess knowledge of number transformation through the ability to combine quantitative parts into one whole. In this task, two plates were set out, one in front of the participant and the other in front of the researcher. One set of bananas was placed on the researcher's plate and three additional cards of bananas were placed between the two plates. Participants were told that the amount of bananas on their plate had to be the same as the amount of bananas on the researcher's plate. Participants then had to determine which two of the three quantities could be combined to match the quantity on the researcher's plate. For example, three bananas would be set on the researcher's plate while cards of one, two, and six bananas would be placed between the plates. Participants would have to place the cards with one and two bananas on their plate to match the set of three bananas on the researcher's plate.

The sixth task, comparison, was designed to be similar to the number comparison task on Griffin and colleagues' Number Knowledge test (Griffin et al., 1994) in that participants had to determine which of two quantities was closer to a third target quantity. The plates were left in front of the participant and researcher. A basket was also set out, placed equidistant above the two plates. The target quantity, represented by ears of corn, was placed in the basket while the two comparison sets of corn were placed on the plates. Participants were asked which of the two quantities on the plates (e.g., one and seven) were closest to the quantity on the basket (e.g., two).

Missing number assessed knowledge of number patterns whereby participants had to discern a pattern in a series of numbers and continue the pattern by choosing the next quantity in the series. Four to five plates were placed in a row. Sets of carrots were placed on each plate and participants were asked what amount of carrots should go on the empty plate. For example, one, two, and three carrots were placed on plates, respectively so participants were to respond that four carrots should be placed on the empty plate.

All tasks were administered twice, once with pictures to illustrate quantity, the pictures condition, and once with Arabic numerals, the numbers condition. Both the pictures and the Arabic numerals were printed on cards for participants to easily manipulate. The pictures condition was administered first for all tasks.[2] Each task used different objects in the pictures condition, such as zebras in the more task and flowers in the less task, to suggest to the participant that they were beginning a new task.

Each subtest had a total of ten items, five for the pictures condition and five for the numbers condition. The first two items in each condition were designed to have small numerosities between one and seven. The third item had middle numerosities up to 10 while the third and fourth items had large numerosities between 8 and 14. If a participant incorrectly answered three consecutive items, the researcher stopped and moved to the next condition.

Procedure

All tasks were individually administered. The seven tasks were administered on two separate days typically within the same week. More, less, addition, and subtraction were all administered on the first day while equivalence, comparison, and missing number were administered on the second day. Students completed up to three practice items for each task. If the student correctly answered the first practice item and gave an accurate rationale for their answer, then they directly moved to the test items. However, if students answered the first practice item incorrectly or were unable to give an accurate rationale, then they were given one or two additional practice items to ensure they understood the task. The same practice items were repeated when switching from the pictures to the numbers condition to ensure that the student understood the numerical version of the task. Students were given one point for each correct answer.

Results

Because of the differences in the distribution of gender between schools, a 2 x 7 x 2 ANOVA examined the effect of gender on performance with gender as a between subjects variable and the seven tasks and condition (pictures and numbers) as within subject factors. The main effect of gender was not significant ($F(1, 58) = 1.79$, *ns*), nor were any of the interactions with gender. Therefore, gender was not considered as a factor in subsequent analyses.

To examine the effects of SES on performance, a 2 x 7 x 2 mixed design ANOVA was conducted with SES as a between subjects factor and the seven tasks and the two conditions as within-subjects factors. The three way interaction was significant ($F(6, 348) = 4.16$, $p<.001$). The first follow-up analysis examined performance for middle and low SES students separately (see Figure 2 for the average performance of middle and low SES students). The task by condition interaction was significant for both the middle SES students ($F(6, 174) = 6.89$, $p<.001$) and the low SES students ($F(6, 174) = 14.16$, $p<.001$). The middle SES students performed significantly better in the pictures condition of the subtraction ($t(29) = 2.80$, $p<.01$) and equivalence task ($t(29) = 3.98$, $p<.001$). The addition task had marginal statistical significance ($t(29) = 2.02$, *p*=.052). Middle SES students performed significantly better in the numbers condition in the missing numbers task ($t(29) = -3.50$, $p<.01$). No significant results were found for more ($t(29) = -1.55$, *ns*), less ($t(29) = -0.55$, *ns*), or comparison ($t(29) = -0.42$, *ns*). On the other hand, the only significant difference between conditions for the low SES students was in the addition task where students performed significantly better in the pictures condition ($t(29) = 7.40$, $p<.001$). No significant differences were found for more ($t(29) = 0.30$, *ns*), less ($t(29) = 0.81$, *ns*), subtraction ($t(29) = -0.25$, *ns*), equivalence ($t(29) = 1.37$, *ns*), comparison ($t(29) = 0.46$, *ns*), or missing number ($t(29) = -1.72$, *ns*).

A second analysis compared the performance between low and middle SES students by condition (see Figure 3). In the numbers condition, the task by SES interaction was not significant ($F(6, 348) = 1.73$, *ns*). However, the main effect of SES was significant with middle SES students performing significantly better than the low SES students in the numbers conditions of all tasks ($F(1, 58) = 18.93$, $p<.001$). Within the pictures condition, there was a significant task by SES interaction ($F(6, 348) = 12.32$, $p<.001$). Follow-up t-tests revealed that the middle SES students performed significantly better than the low SES students in the pictures condition in the subtraction ($t(58) = 5.41$, $p<.001$), equivalence ($t(58) = 2.98$, $p<.01$), and comparison tasks ($t(58) = 3.51$, $p<.001$). The low SES students outperformed the middle SES students in the pictures condition of the addition task ($t(58) = -2.26$, $p<.05$). No significant differences were found in more ($t(58) = 1.11$, *ns*), less ($t(58) = 1.86$, *ns*), or comparison ($t(58) = 1.05$, *ns*).

Discussion

The purpose of this study was to examine the patterns of performance between low and middle SES students in pictures and numbers conditions of quantitative reasoning tasks. The performance in the two conditions was first analyzed for middle and low SES students separately due to a significant three-way interaction. Students from a middle SES background performed better in the pictures condition for the subtraction and equivalence tasks and performance in pictures condition of the addition task approached statistical significance. These three tasks assessed knowledge of number transformations and required the ability to apply a part-whole schema. The part-whole schema requires understanding that sets are additive by combining two quantities to make a larger quantity (Resnick, 1989). In the equivalence task, participants had to understand that the whole on the researcher’s plate could be made by combining two smaller sets. In the subtraction task, participants had to understand that the whole on the plate could be separated into a part that was eaten and a part that remained. The addition task could be solved by consecutively counting the two parts on the plate to arrive at the total for the whole set. With an immature schema of number, tasks that require the part-whole schema are simpler to solve with pictures (Korb, 2008). In the numbers conditions of these tasks, students must have a merged schema of quantity to understand that the Arabic numerals represent a quantitative set with that specific number of objects. The participants in this study had not yet developed that understanding of number symbols, so the pictures condition of the number transformation tasks was easier.

Students from a middle SES background performed significantly better in the numbers condition of the missing numbers task that assessed knowledge of number patterns. Items on the missing number task can be solved by applying the counting schema, which is more readily apparent in the numbers condition of the task if the students can identify the Arabic numerals. Altogether, these results replicate the finding that children in the U.S. perform significantly better in the numbers condition on tasks that afford the counting schema and significantly better in the pictures condition on tasks that afford a part-whole schema (Korb, 2008).

There were no differences in middle SES students' performance between the numbers and pictures conditions on the more, less, and comparison tasks that assessed number knowledge. As these participants demonstrated that they had not yet merged their verbal counting and protoquantitative schemas by their performance on the number transformation tasks, young children must be able to solve number knowledge tasks with either their verbal counting or protoquantitative schema. Indeed, two tasks on the Number Sense Test developed by Malofeeva and colleagues required students to make more and less judgments on sets of objects and numerals (Malofeeva et al., 2004). The preschool children in Malofeeva's study appeared to have similar performance in both tasks.

To summarize, participants from a middle SES background performed better on the number transformation tasks with pictures that afforded a protoquantitative schema. The task that assessed number patterns was easier for middle SES participants when presented with numbers that afforded using a verbal counting schema. There were no differences in performance between the pictures and numbers condition of the tasks that assessed number knowledge.

In contrast, students from a low SES background only performed significantly better in the pictures condition of the addition task. One possible explanation for this result could be that the students from a low SES background have merged their verbal counting and protoquantitative schemas and are therefore able to solve all quantitative tasks using either schema. However, since students from a low SES background performed considerably lower than students from a middle SES background in most tasks, this explanation is unlikely. Instead, students from a low SES background likely had developed fewer quantitative skills than students from a middle SES background. As demonstrated from their performance on the pictorial condition of the addition task, students from a low SES background were competent at counting two sets of objects. They also were able to determine which quantity is more or less with both pictures and numbers.[3] Students from a low SES background performed near the floor level on all of the other number sense tasks. As other researchers have suggested (e.g., Ginsburg & Russell, 1981), the skills of counting and determining more and less in a set of objects might be foundational mathematical abilities that are learned relatively easily by all children regardless of their environmental setting. However, learning the skills necessary for performing more advanced quantitative tasks require much more experience with quantities than these children from a low SES background received. For example, the subtraction task that required understanding reversibility was particularly difficult for students from a low SES background. These children had difficulty understanding that objects could be removed from the set so they would often either answer with the original number or would add the two sets together. This result contrasts with Starkey's (1992) conclusion that young children can easily recognize that removing an object causes the size of the set to decrease.

The second analysis compared performance between middle and low SES students on the number sense tasks. Because of the interaction between SES level and condition, the numbers and pictures conditions were analyzed separately. Students from a middle SES background performed significantly better than students from a low SES background in the numbers condition on all tasks. Conversely, low SES students performed just as well as the middle SES students in the pictures conditions of the more, less, and missing number tasks, and performed better than the middle SES in the pictures condition of the addition task. This result is similar to the study where Jordan and colleagues (Jordan et al., 1992) found that American low SES children performed as well as middle SES children on the nonverbal condition of a basic quantitative reasoning task but performed significantly lower in the verbal conditions. However, the current study also found that middle SES students outperformed low SES students on the subtraction, equivalence, and comparison tasks. All of these tasks require application of more advanced quantitative concepts such as reversibility for the subtraction task, part-whole for the equivalence task, and the relationship between numbers for the comparison task. As previously mentioned, students from a low SES background had very low performance in both the pictures and numbers condition on the tasks that required more advanced quantitative abilities. Therefore, the conclusion that children from a low SES background perform as well as children from a middle SES background on quantitative tasks with concrete objects is limited to only the most basic quantitative reasoning tasks.

Children from a low SES background outperformed the children from a middle SES background in the pictures condition of the addition task. Perhaps the only experience that children from a low SES background have with quantities is counting, so these students had over-practiced this skill whereas students from a middle SES background have more experience with a wider range of quantitative tasks. Indeed, Saxe (Saxe, Guberman, & Gearhart, 1987) found that in American families, middle SES parents engage their children in more complex interactions with quantity.

One limitation of the present study was that SES was defined by the type of school that the participants attended. The findings of this study may therefore be the result of the differential quality of educational experiences that the two types of schools provide. However, the data was collected shortly after the students began their formal schooling.[4] Therefore, differential effects of formal schooling were likely minimal. Second, as these results replicate findings from other studies that compare performance between pictures and numbers of American children on a more limited range of tasks (e.g., Jordan et al., 1992; Korb, 2008; Malofeeva et al., 2004), findings on the additional tasks included in this study likely transfer to American children although further research should examine this question. A third consideration of this study was the factor of age. Despite being almost two years younger, the middle SES students still outperformed the low SES students on many of the number sense tasks. This highlights the conclusion that complex interactions with numbers, and not simply maturation, are crucial for number development.

In conclusion, this study highlights two important findings. First, considerable differences exist between the performance of young children from low and middle SES backgrounds in their mathematical understanding. Second, different number sense tasks afforded different schemas for solving. Children in this sample showed little evidence of a merged conceptual structure of number where they were just as proficient in the tasks using both pictures and numbers. Educational programs have been developed that directly teach the merged conceptual structure (see Griffin, 2004). Particularly the children from low SES backgrounds in Nigeria would benefit from these programs as they do not appear to be getting complex interactions with quantity at home.

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Footnotes

[1]As the skills of counting and estimation can only be tested by giving objects to be counted or estimated, these two skills were not included in this research study.

[2]Four participants in one of the public schools did not understand the practice items in the pictures condition of the more and comparison tasks. In these instances, the practice items in the numbers condition were next introduced. After the students completed the numbers condition, then the researcher went back to administer the pictures condition.

[3]While no statistical differences were found, low SES students had slightly better performance on the more and less tasks in the picture condition while middle SES students had slightly better performance in the number condition. This explains why the middle SES students performed significantly better than the low SES students in the numbers conditions on these two tasks but no statistical differences were found between the pictures and numbers conditions for just the low SES students.

[4]Classes in Nigeria typically begin in October. Shortly after classes began this year, a violent crisis in the community in which the data was collected caused all schools to close for over a month. Therefore, most students only completed three to four months of formal schooling prior to data collection.

Table 1

Demographic Characteristics of the Sample

	Frequency		Age in Years		
Grade	Male	Female	Mean[a]	Minimum	Maximum
			Public		
School 1	11	8	7.00	6	9
School 2	8	3	7.06	6	9
Public Total	19	11	7.02		
			Private		
School 1	6	14	6.02	4	9
School 2	5	5	5.04	5	6
Private Total	11	19	5.10		
Total	30	30	6.06		

[a]Age is in years.months

Table 2

Overview of the Number Sense Tasks

Subtest	Pictures Used	Prompt
More	Zebras on 3 farms	Which farm is the biggest?
Less	Flowers on 3 farms	Which farm is the smallest?
Addition	Tomatoes on 2 plates	How many tomatoes will you have if you combine these plates?
Subtraction	Apples on a plate and mouth	How many apples will you have if you eat this many? (Point to the mouth)
Equivalence	Bananas and 2 plates	I have this many bananas. Which of these sets of bananas can you put on your plate so you have the same amount of bananas as I have?
Number Comparison	Corn on 2 plates and a basket	Which amount on our plates is closer to the amount in the basket?
Missing Number	Carrots on 4 to 5 plates	How many carrots should go here?

Figure Captions

Figure 1a. Stimuli for the pictures condition of the more task. Participants point to the farm that has the most zebras.

Figure 1b. Stimuli for the numbers condition of the more task. Participants point to the farm that has the biggest number.

Figure 2. Average performance on the number sense tasks as a function of socioeconomic status. When comparing conditions within SES level, the middle SES participants performed significantly better in the pictures condition on the subtraction and equivalence tasks and significantly better in the numbers condition of the missing number task. The low SES participants performed significantly better in the pictures condition of the addition task.

Figure 3. Average performance on the number sense tasks as a function of condition. The middle SES participants performed significantly better than the low SES participants in all numbers conditions. The middle SES participants performed significantly better than the low SES participants in the pictures condition of the subtraction, equivalence, and comparison tasks. The low SES participants performed significantly better in the pictures condition of the addition task.

Figure 1a

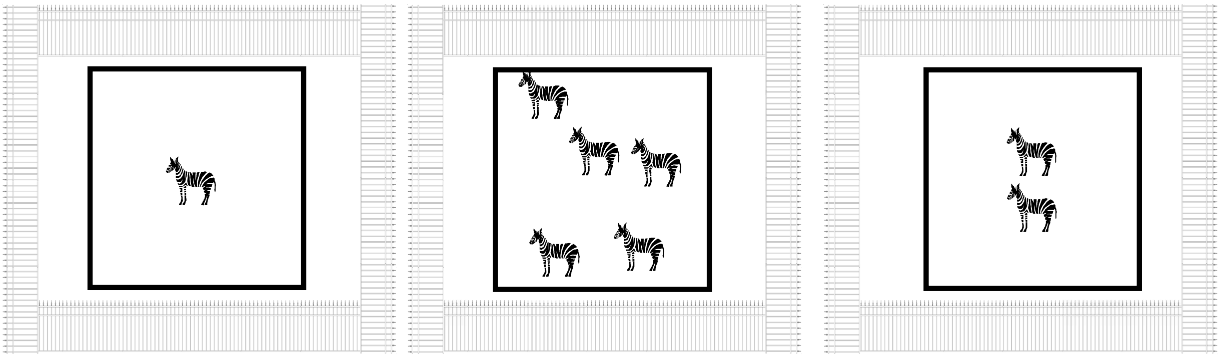


Figure 1b

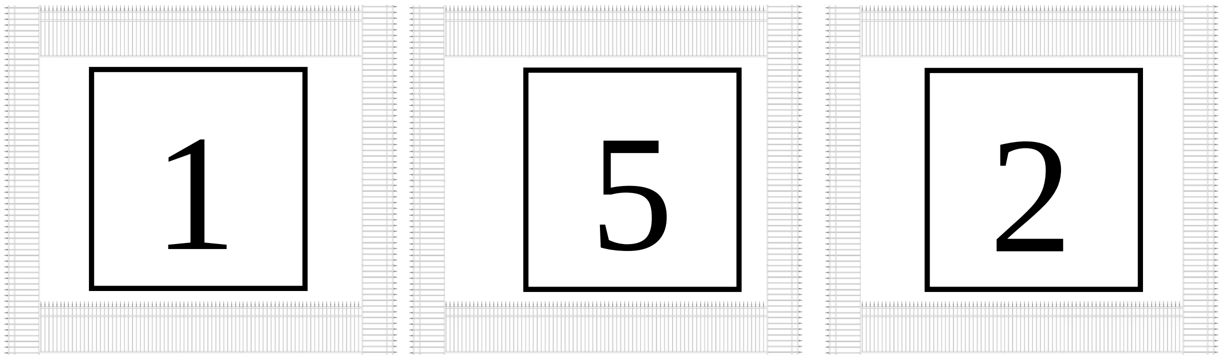
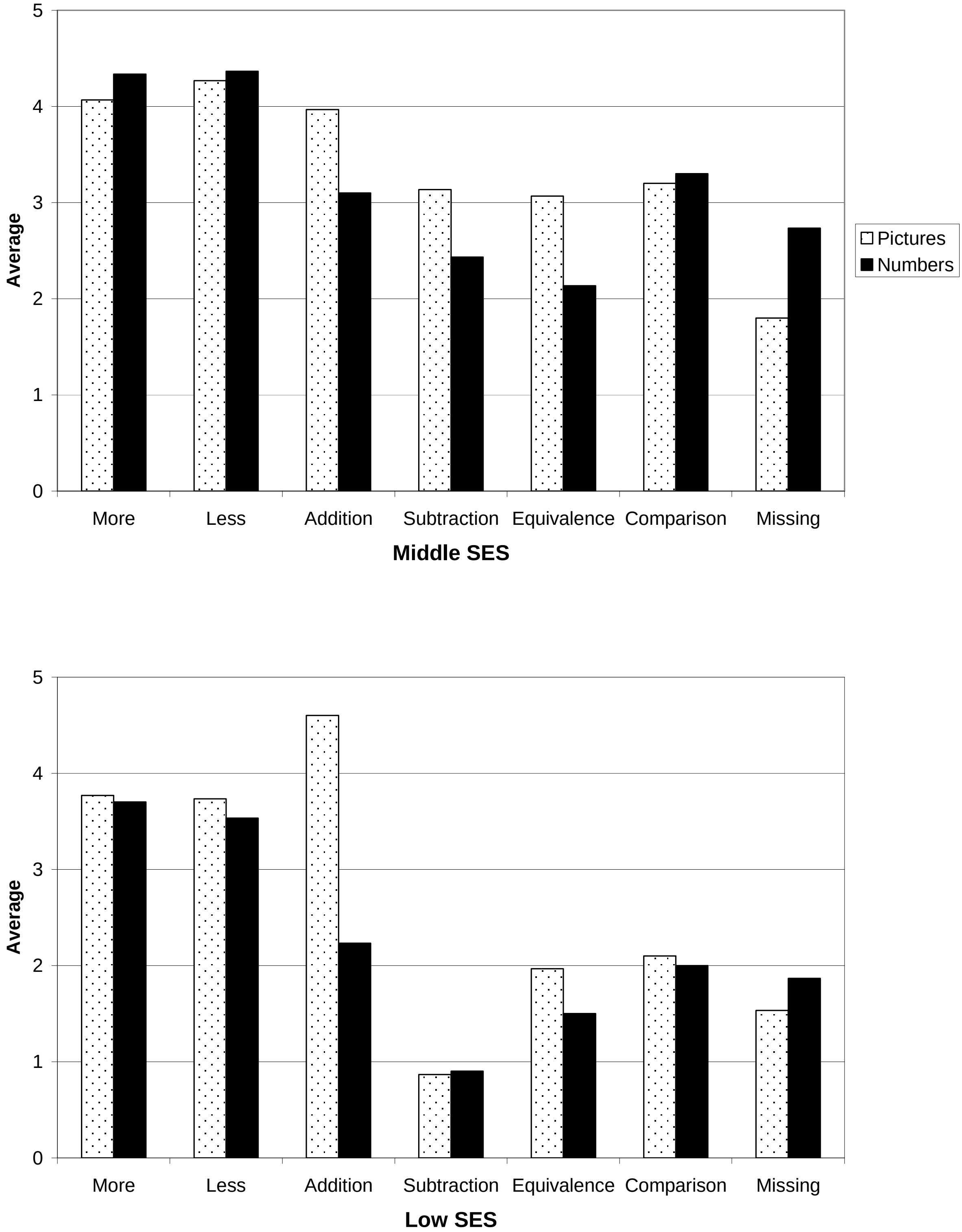


Figure 2


5
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Numbers
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Subtraction
Equivalence
Comparison
Missing
Middle SES
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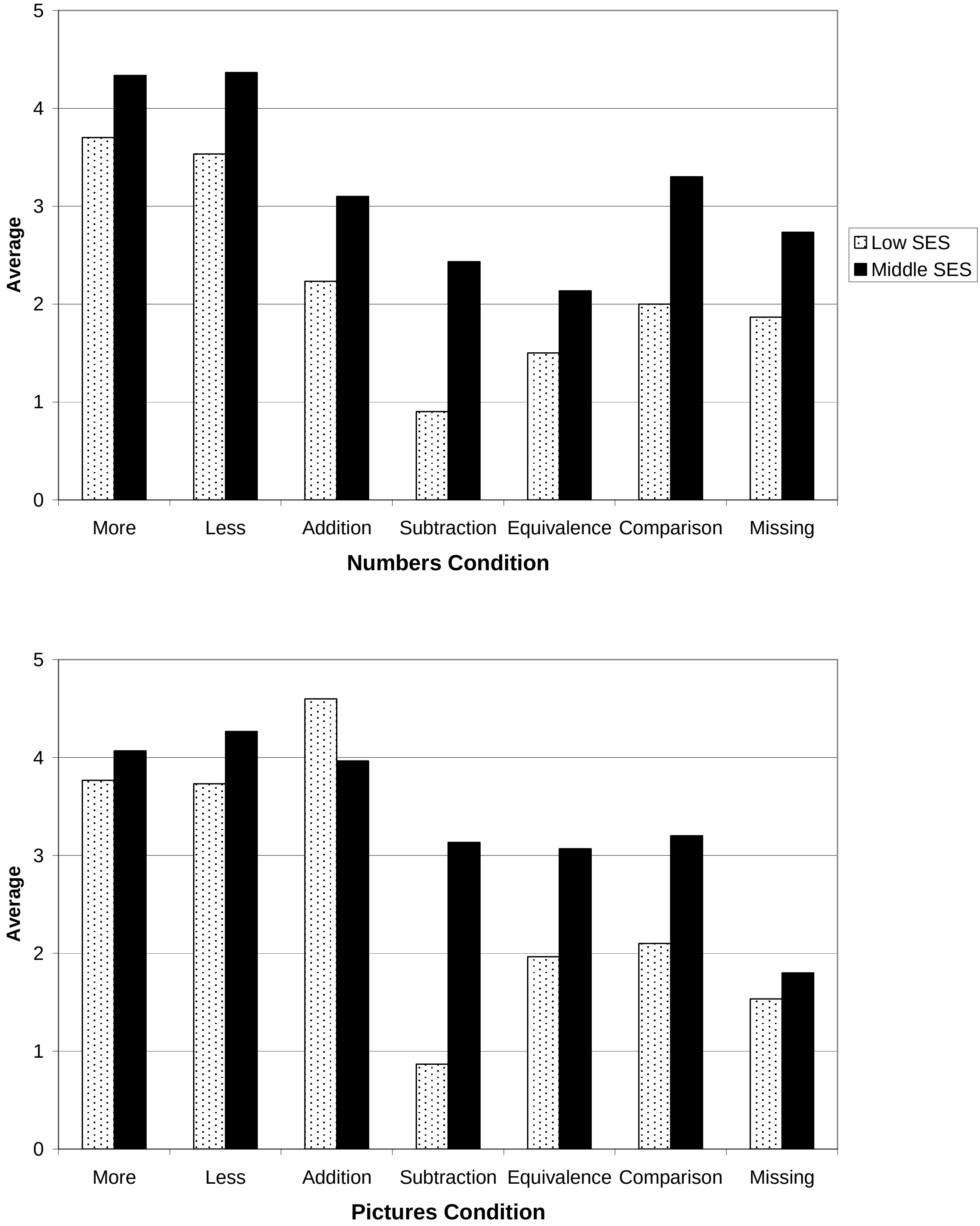
0
Average
More
Less
Addition
Subtraction
Equivalence
Comparison
Missing
Low SES

Figure 3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Comparison
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Pictures Condition