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ABSTRACT

This paper uses a structural model with a large random sample of urban children to explain children's competence in math concepts and computation at the time they begin first grade. These two aspects of math ability respond differently to environmental resources, with math concepts much more responsive to family factors before formal schooling begins than is computation. In this sample blacks and whites are equivalent in terms of computational and verbal skills as measured by the California Achievement Test (CAT) at the start of grade one. However, black boys equal white boys and white girls in terms of math concepts (reasoning skills) but black girls are about one quarter of a standard deviation lower than others in terms of math concepts on the CAT. Both black and white children of all socioeconomic levels respond to parents' psychological resources: net of ability or other factors, children score higher if parents expect them to do well. Socioeconomic resources in the home also help both groups. In particular, the parent's being a high school graduate as opposed to a drop-out is important. When parents' material and psychological resources are taken into account, family configuration (solo motherhood vs. other types) has no discernible effects on either type of math performance. There are 48 references listed. (Author/DC)

Center for Research On Elementary & Middle Schools

Report No. 34

March, 1989

BEGINNING SCHOOL MATH COMPETENCE: MINORITY AND MAJORITY COMPARISONS

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This report, prepared by Elementary School Program, examines children's competence in math concepts and computation at the time they begin first grade, using data from the Beginning School Study (BSS). Related studies using these data include CREMS Reports 8, 9, and 28.

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Abstract

This paper uses a structural model with a large random sample of urban children to explain children's competence in math concepts and computation at the time they begin first grade. These two aspects of math ability respond differently to environmental resources, with math concepts (reasoning) much more responsive to family factors before formal schooling begins than is computation. In this sample blacks and whites are equivalent in terms of computational and verbal skills as measured by the California Achievement Test at the start of grade one. However, black boys equal white boys and white girls in terms of math concepts (reasoning skills) but black girls are about one quarter of a standard deviation lower than others in terms of math concepts on the CAT. Both black and white children of all socioeconomic levels respond to parents' psychological resources: net of ability or other factors, children score higher if parents expect them to do well. Socioeconomic resources in the home also help both groups. In particular, the parent's being a high school graduate as opposed to a drop-out is important. When parents' material and psychological resources are taken into account, family configuration (solo motherhood vs. other types) has no discernible effects on either type of math performance.

Introduction

Among the most significant concerns on the national agenda is the gap in math achievement that separates blacks from whites. Although it is decreasing (Jones, 1984), at the end of high school the difference still amounts to close to one standard deviation (Dorsey, Mullis, Lindquist, & Chambers, 1988). The cleavage, though, begins long before--in fact, it begins as far back as school records can be traced (Coleman, Campbell, Hobson, McPartland, Mood, Weinfeld, & York, 1966; Jones, Burton, & Davenport, 1982).

Blacks' relatively lower achievement in math is not in dispute, then, but its causes are unclear. Some think that changes in math instruction and curriculum may hold the key to solving this problem, so one approach is to suggest modifications in teaching methods and school organization. Many efforts of this sort are under way (see Romberg, 1984 for recommendations). Others take their cue from sociological studies of status attainment, and they propose examining the nature of the achievement process itself. How do social structure, the social climate of achievement, and life course trajectories help explain minority/majority differences in achievement? So far most studies in this vein focus on the general achievement of black and white youth at the high school level (e.g., Portes & Wilson, 1976; DeBord, Griffin, & Clark, 1977; Kerckhoff & Campbell, 1977). The only broad-based study of a national probability sample that examines math in particular is apparently one by Jones et al. (1982), which focuses on general math achievement of 13- and 17-year-olds. There are relatively few studies of ethnic differences in math achievement at the elementary level (see Lockheed, Brooks-Gunn, Casserly, & McAloon, 1985), and to our knowledge no broad-based studies of the process of math achievement at the point of school entry even though the math skills children possess when they start school set the stage and thereby help or hinder math performance for several years to come. This paper aims to fill part of that gap.

Mathematics is a hierarchically arranged subject, with each step drawing upon skills laid down in the preceding steps, so a logical place to begin research on differences in children's math achievement is at the point of school entry. Also, it seems prudent to examine the separate strands of early development in mathematics because later on gender differences appear in some domains and not others (Benbow & Stanley, 1980). Given this agenda, in this paper we will investigate how family background and youngsters' personal characteristics affect development of mathematical skills before their formal schooling begins.

Little is generally known about the genesis of math skills, but recent studies suggest that ethnic differences in children's sub-skills in mathematics at the point of school entry are small. Ginsburg & Russell (1981), in an intensive study of social class and racial differences in the mathematical thinking of preschoolers (4.3 to 4.5 years old) who resided in the Washington-Baltimore area, concluded that the "pre-mathematics" abilities of minority children appeared equal to those of majority group children. In related work, traditional African children and American children seemed to develop similar understandings and misunderstandings and to invent the same kinds of problem solving strategies (Ginsburg, Posner, & Russell, 1981). Likewise, kindergarten children in Taiwan and the U.S. performed at roughly the same levels in mathematics. Japanese children, however, exceeded both Americans and Taiwanese by about .5 standard deviations (Stevenson, Lee, & Stigler, 1986) while Korean kindergartens lagged behind those in the U.S. (Song & Ginsburg, 1987). All in all, though, this body of research suggests that cross-national differences in children's pre-math skills are relatively small.

Our Beginning School Study (BSS) archive pertains to a random sample of Baltimore 6-year-olds studied in 1982. It likewise reveals small differences in children's math skills across minority/majority boundaries. On the California Achievement Test (CAT) Form C Level 11 battery, the computation subtest (and a verbal composite test) show no significant black/white differences for these children at the time they began first grade. The math concepts subtest shows that white children's scores exceeded those of blacks by a small but significant margin (about a quarter of a standard deviation).

Comparison of test scores in the BSS sample at the point of school entry, then, reveals a small margin in reasoning (concepts) favoring whites and no difference in computation. The resources available to the black children and white children in this sample are not the same, though, because in Baltimore, as in most other parts of the country, blacks are less advantaged economically than whites. Also even if the children's developmental levels were exactly the same at the point of school entry, there is no assurance that they have developed along the same lines up to that point. In other work (Entwisle & Alexander, in press), for example, we found that white parents and black parents expected their children to perform at about the same level in math, but white children were more responsive to their parents' expectations than were black children. To understand differences in children's math performance, it is therefore necessary to look at two issues: differences in the resources that support such growth and possible differences in how growth occurs in the two groups (differences in process).

The rest of this paper addresses these issues. It is organized as follows. We will first outline a conceptual model to account for children's math capabilities at the time they begin formal schooling. This model is a version of a more elaborate structural model developed earlier (see Entwisle & Hayduk, 1982) and it postulates influences known to be important for young children. For instance, the parent's expectation for the child's performance in math is included because such parent expectations are known to affect children before their formal schooling starts through day-to-day household activities in which parents convey their expectations directly and indirectly (Saxe, Guberman, & Gearheart, 1987).

Second, we will describe the data archive. As mentioned, it is based on a large random sample of Baltimore children and their parents. There is information on family background and related factors obtained directly from parents around the time the children enrolled in first grade.

Finally, we will estimate the model twice, once to explain children's reasoning skills, and again to explain their computation skills. As mentioned, later in life these two aspects of math performance seem distinct and the reader will see that, although these outcomes are correlated, their developmental trajectories are somewhat different.

This modeling strategy thus takes account of the material and psychological resources available to both groups of children and investigates whether they employ the resources available to them in similar ways to support cognitive growth.

The Model

Previous work (Entwisle, Alexander, Cadigan, & Pallas, 1986; Entwisle & Hayduk, 1982) provides a comprehensive structural model to explain children's cognitive growth in mathematics in the primary grades. This model will be streamlined here to conserve space and to emphasize the role of "family" factors. Three major categories of family factors will be considered: psychological, material and structural. The only outcomes to be considered will be children's California Achievement Test scores in math concepts and computation at the beginning of first grade (see Figure 1).

The first block of variables in the model includes characteristics of the child and preschool experience before formal schooling begins. Race and sex are of primary interest for this analysis because of minority-majority and gender differences in math achievement among older children. The two variables that take account of preschool experience measure the amount of the child's prekindergarten and kindergarten experience, and are "control" variables. We wish to take account of any differences in preschool experience when making cross-race comparisons.

Family support of children's cognitive growth could take two general forms, the psychological and material. These two kinds of supports are conceptualized separately and entered separately into the model because we wish to estimate the extent to which each may affect performance.

Parents' psychological resources are also included in the first block of the model; they are represented by the parent's expectations for the child's first math mark and the parent's estimate of the child's general ability to do schoolwork. Considerable prior work documents the potency of these two variables for affecting the school performance of primary age children (see especially Alexander & Entwisle, in press; also Entwisle & Hayduk, 1982; Hess, Holloway, Dickson, & Price, 1984; Stevenson & Newman, 1986).

Parents' material resources are also measured by two variables, one being the parent's educational attainment level. Parents' education affects children's school attainment at both the elementary and secondary levels (Alwin & Thornton, 1984), and affects the child's cognitive development before school entry as well (Saxe et al., 1987). The second indicator of parent's material resources is whether the child is eligible for a meal subsidy. Not receiving a meal subsidy is correlated with parent's educational level (.50 for blacks and .54 for whites) but its effects on children's performance are distinct from those of parent's educational level, especially for blacks.

Variables representing material resources appear in the second block (Figure 1) so we can see the extent to which their effects may overlap effects of psychological support variables in the first block. For example, if parents with more education are more likely to be those with high expectations we want to take account of this redundance.

Family configuration is often assumed to affect children's math performance, and a number of mechanisms have been invoked. One is the importance of a male role model in establishing sex role identity for boys. Another is the presumed greater exposure to analytical styles of thinking for children of both sexes if a male is present in the household. Additionally, families having more adults to interact with children could provide an advantage because solo mothers may have less time to interact with children than do mothers who reside in multiple adult households (see Hetherington, Camara, & Featherman, 1983; Kellam, Ensminger, & Turner, 1977). In addition, single female heads of households are likely to experience other stresses like household moves (McLanahan, 1983). Accordingly, family type appears as a dummy variable in a third block and children are designated as coming from mother only, mother plus other adult, or mother-father homes. Again, since family configuration differs by race it is important to estimate its effects with the other prior variables taken into account, especially economic resources.

As implied above, we will estimate the model in stages (Figure 1). We will first examine the joint effects of sex, race, preschool experience, and parents' psychological supports, then add years of parent education and the meal subsidy. These proxies for material resources could act independently of psychological resources or they could act in concert. If the two kinds of resources overlap, one implication is that parents who have more material resources (books, money for trips, and the like) are also those whose beliefs and expectations for their children are more optimistic. Psychological supports without home resources might be relatively ineffective because the needed materials (books, magazines, trips, games) to support learning would be absent. Similarly, the presence of material resources might be of little consequence without the parent's encouragement and demonstration of how to put them to use.

The dummy variables representing family type, added after the other family variables, will provide some indication of the relative importance of socioeconomic status vs. family configuration per se. It is important to "standardize" for socioeconomic status before searching out effects of family type because in studies of IQ or general intelligence, differences accounted for by family type are very small when income is controlled (Hetherington et al., 1983).

Additionally, the child's verbal CAT score will appear as an "extra" control variable in a final block in the model. Justification for this is best deferred until later.

The Sample

The Beginning School Study (BSS), initiated in the fall of 1982 in Baltimore City, is based on a stratified selection of schools in the city system that ensured a sample about equally divided by race and representative of all socioeconomic levels in the system. Kindergarten rosters for 1981-82 in 20 randomly selected schools served as initial lists, supplemented by class rosters in the fall. Both rosters were used to draw random samples of children from each first grade classroom in the selected schools in September 1982. Less than 3% of the children thus selected were excluded because of parent refusals. By this means 825 Baltimore City first graders were randomly selected. After giving permission for their first grade child to participate in the research, 785 of the parents (usually the mother) agreed to be interviewed.

Analyses to be presented here concern test scores obtained at the beginning of first grade for a birth cohort of children, those who were 6 years 11 months or less at the end of December 1982. The sample is limited to children 6.9 years or younger in December 1982, and excludes children who had repeated kindergarten or those who were repeating first grade in 1982-83. It is also limited to those for whom we have complete test information and information on all other variables in the analysis through the end of second grade. The child's age is not included as a predictor here owing to its lack of influence on achievement outcomes in several preliminary analyses. Means and variances for the "core" sample of 390 children included in these analyses are extremely close to means and variances for the total sample. Parents provided data through interviews at or before the beginning of first grade. For about 2% of the parent expectation and parent ability variables, missing values on individual items were imputed separately according to whether the child later passed or failed first grade. Comparisons between this "core sample" and all the children for whom test scores were available in the fall of 1982 shows virtually the same distribution on all variables employed in this analysis for the "core" sample as for the full sample. All schools followed the same curriculum.

Procedure

A parent was interviewed at home in summer/early fall, usually by an interviewer whose race matched that of the respondent. When necessary, interviewers read questions to parents, answered questions parents asked, and interpreted the marking standards used by the school. All parent interviews were completed well before the end of the first marking period in the fall. More than half the children had some school experience before kindergarten (nursery school, day care, prekindergarten, etc), and a large majority of children attended kindergarten for half a day for the year preceding first grade.

Variables

Race. Race was coded "0" for white, "1" for black. The few (7) Indian and Oriental youngsters in the sample were coded "0".

Sex. Sex was coded "0" for boys, "1" for girls.

Prekindergarten experience.--The parent was asked: "Did your child go to any school (nursery school or day care) before kindergarten?" This item was coded 1 for "Yes", and 0 for "No".

Kindergarten experience.--The parent was asked: "Did your child attend kindergarten?" Answers were coded "4" for one full year with full-day sessions, "3" for one full year with half-day sessions, "2" for one half year or less with half-day sessions, or "1" for not at all.

Meal subsidy.--This variable is "1" if children received no subsidy, "0" otherwise. Subsidies can be full or partial and are based on family income and size at the end of first grade (July 1, 1983). A family of four, for example, with a yearly income of $12,870 was eligible for full subsidy, while one with an income of $18,315 was eligible for partial subsidy.

Parent's Ability Estimate. In the summer/fall parents were asked: "How do you think your child compares with other children in his/her school in terms of ability to do school work?" Answers were coded from "1" (among the poorest) to "5" (among the best).

Parent's Expectations. Parents' expectations were parents' "best guesses" for their child's first mark in mathematics, coded "4" for Excellent, "3" for Good, "2" for Satisfactory and "1" for Unsatisfactory.

Parent's Educational Attainment. This information was obtained directly from parents: less than a high school graduate, "0"; high school graduate, "1"; more than high school graduate, "2". There are sizeable correlations reported between children's school performance and mother's education or family income (.47 and .37 respectively) (Jencks, Bartlett, Cocoran, Crouse, Eaglesfield, Jackson, McClelland, Mueser, Olneck, Schwartz, Ward, & Williams, 1979). Mother's education is a proxy for socioeconomic status that is particularly relevant in the BSS where there are many solo-mother families.

California Achievement Test Scores. In October 1982, testing in Baltimore schools provided California Achievement Test scores, Level 11 Form C, for 2 mathematics subtests, concepts and computation. The verbal CAT score used here is a composite of 4 subtests (phonic analysis, vocabulary, comprehension and language).

Test-retest reliabilities over short intervals for Level 11 are reported to be .63 for computation and .80 for concepts. Kuder-Richardson 20 reliabilities for grade 1.2, approximately the point when tests used here were given, are .80 and .83, respectively (CAT Technical Bulletin, 1979). The test norms, intended to apply to all public school districts with 11 or more students, are 238 (S.D. 29) computation and 299 (S.D. 32) concepts, values close to those in this sample (Table 1).

Family Type. Three family configurations are distinguished using dummy variables: "mother-father," which includes all mother-father families (those with a stepfather or a biological father and mother-father families with other adults present); "mother-other," which are father-absent families with other adults (grandmothers, etc.) present; and "mother only" (baseline).

Results

Table 1, which gives information for children grouped by parent's education level, shows that black-white differences in computation scores are small and inconsistent except for children whose parents have some post-secondary education. In families where parents are high school drop-outs, scores for blacks and whites are 7 points apart, with blacks exceeding whites. For children whose parents have some post-secondary education, though, where white parents have almost two more years of education than do black parents, whites' scores exceed blacks' by a substantial margin (23 points).

For math concepts (reasoning), the picture is much the same. For children whose parents are high school drop-outs, blacks outperform whites by a small margin (2 points) while those in the middle education category are 5 points apart, with whites higher. Again, though, race differences for children whose parents have some post-secondary education are pronounced, and favor whites by 29 points.

These "raw" differences obviously require some interpretation in light of the differences in parent education. Another indicator of possible socioeconomic disparity between minority and majority children is that when the parent has some post-secondary education, 49% of the black children as compared to only 8% of the white children received some meal subsidy. Beyond this, differences by family type complicate the picture because about 73% of white children come from mother-father households compared to 47% of black children.

A look at other resources shows them to be more similar for children of the two racial groups. Verbal test scores are very close (283 vs. 285), prekindergarten and kindergarten attendance is virtually identical, and parent's expectation for the child's first mark in math is close to a B (2.8 for blacks and whites). Parents of both groups see their children as somewhat "better than average" in terms of ability to do schoolwork (3.8 for blacks and 3.6 for whites).

Overall then, the parent's level of material resources and family configuration tend to favor whites but variables classified as psychological resources of the two groups look fairly comparable.

Regression analyses

To explore the trends in Table 1, models to explain math reasoning

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Table 1 about here

(concepts) and math computation were estimated for the total sample, and then, because of a significant interaction between race and parent education, models were estimated separately for blacks and whites. In this style of analysis, including a variable leads to statistical control of that variable. For example, if we include family type, we equalize groups in terms of the effect of this variable on outcomes. This strategy thus provides a powerful means for comparing two groups of children when available resources are not equivalent.

Other things equal, whites show a small but significant net advantage in reasoning (8 to 9 points) compared to blacks (last panel of Table 2). Whites also have somewhat higher computation scores than blacks

(Table 4), but the small total effect for race (5 points) drops below the level of significance when other controls are added. Therefore, black children and white children would be judged virtually equivalent in terms of computational skills at the point of school entry when other factors in the model are adjusted for.

In the remainder of this paper, we will take up the findings related to students' reasoning abilities (Tables 2 and 3), then their computational abilities (Tables 4 and 5), and finally contrast the two.

Tables 2 and 3 about here

Reasoning

Although minority status does have total effects of modest size on reasoning scores (standardized coefficient of -.15), other variables have significant and larger total effects. These include the amount of the child's kindergarten experience, the parent's expectation, the parent's educational level, and the child's verbal CAT score. We need to comment on the verbal CAT score first.

Including the verbal CAT score has two main advantages. One is that reasoning ability or math "concept" skills at any age, but especially at early ages, could depend on verbal skills--children who have trouble communicating could give the appearance of reasoning poorly even though their skills were excellent, and black children might suffer more in this regard than white for a number of reasons, including dialect. In this sense the CAT verbal score partials out effects of other cognitive skills that are related to, but not the same as math reasoning (concept) skills.

Secondly, the verbal score can be thought of as equating children with respect to "general level of cognitive ability," so including it provides a way to sidestep issues related to genetic differences that are complex, controversial, and cannot be addressed here in any satisfactory way. If race or other factors remain significant with the verbal CAT score is included in the model, we assume that these factors affect math reasoning net of children's general ability levels.

Adding verbal scores to the model could "overcontrol," however, because the same family background and personal factors that shape math performance probably shape verbal performance as well. Fortunately, though, Table 2 shows that the pattern of significant findings for children's math reasoning skills remains virtually the same with and without the verbal score included. The only exception, a diminution in effect of the parent's ability estimate, seems quite reasonable because if parent judgments are veridical, they should overlap with effects of verbal ability tests. Note that the parent's expectation remains a significant and substantial predictor of children's math reasoning even with the verbal CAT score added, which is rather persuasive evidence that the parent's expectation represents a kind of psychological influence that is distinct from the general ability estimate.

Continuing in Table 2 for the combined sample, we see that more kindergarten experience boosts children's reasoning scores. The total effect (12 points) exceeds that for race. This effect can be traced mainly to children's attending full-day as opposed to half-day kindergarten. The majority of children (71%) in this sample attended half-day sessions, but of those who attended a full day, 64% were children of parents who had some post-secondary education. Effects of kindergarten and parent education thus overlap and will be teased apart. Table 3, where models are estimated separately by parent education groups, allows us to do this.

The psychological supports parents offer children also strongly affected their scores in reasoning (about 16 score points for each point increase in the mark the parent expects). Parents who think their children will receive a high math mark in first grade or who will do well compared to other children in schoolwork probably have held high opinions of their children all along and have conveyed these opinions to children during the preschool years. At the time they were asked (summer/early fall of 1982), these parents had no objective information (math test scores or marks) on which to base their opinions.

Parents with high expectations are those who encourage their preschool children to engage in number games (Saxe et al., 1987), and in our sample parents with higher expectations have more education (significant zero-order correlation .28). White parents in this sample who had higher expectations also saw that the child went to the library during the summer and took books home, and read to the child on a daily basis. In black families parents with higher expectations tended to engage in these same activities but not to a statistically significant degree.

Material supports in the home (here indexed by parent education and the meal subsidy) also have some significant effects--over 7 points for education in terms of total effects (Table 2).

Two further findings deserve comment. One is the negatively signed effect of sex, which means that boys tended to outperform girls, although not significantly. (At age 13 there is no significant difference by sex in composite math scores [Jones et al., 1982]). The other is that family type has very little influence. Families with fathers present do not have children whose reasoning scores exceed those of children from solo-mother families. This is a key finding because several theories (Block, 1983) and some data (Ginsburg & Russell, 1981) suggest that cognitive development in math will profit from having a male in the household or having an intact family. As a further check, when the model was estimated separately for children of the two sexes (data not presented here for reasons of space) father presence had negligible effects on reasoning skills for boys or girls of either race.

More black than white children came from solo-mother homes in this sample, but up to the point of school entry, being in a solo-mother home apparently does not compromise development of children's math reasoning abilities, other things equal. Note, however, that economic circumstances do affect math reasoning skills at the start of grade one. This is a common finding (Garfinkel & McLanahan, 1986) and points up the need to take careful account of socioeconomic differences when evaluating effects of family type.

Contrasts between blacks and whites

Moving on to consider how these patterns may be played out differently for minority and majority youngsters, we see that effects of parents' material resources are quite different for black children as compared to white. Parent education is a potent influence on white children's math reasoning capability, accounting for almost 10 points per education category even with the verbal CAT score included (middle panel of Table 2). By contrast, total effects of parent education for blacks (first panel of Table 2) are considerably smaller, and negligible when other factors (the meal subsidy) are taken into account. Total effects of the meal subsidy are influential <u>only</u> for blacks, and this pattern shows up even more clearly in Table 3. More blacks received meal subsidies, as already noted, even when parents had some post-secondary education.

The metric coefficients for parent education and the meal subsidy combined account for about the same number of score points for blacks as for whites in Table 2, though. This suggests that the material resources of both groups are implicated to about the same extent in explaining outcomes. The significant interaction between parent education and race (omitted from Table 2) signifies that the influence of parent education is less for blacks, though, and here we see exactly how much weaker it is.

To clarify how material resources affect children's performance, the model was estimated by separate parent education groups (Table 3), and children whose parents have a high school education or less are compared with those whose parents have a high school education or more. Note that high school graduate parents are included in both groups to provide a sufficient case base. Paradoxically, parent education effects are very small for both blacks and whites when parents have a high school education or better, so the large difference in years of education between blacks and whites in Table 1 for parents in the top education category is probably not very important in explaining black/white differences in children's scores. But parent education has large effects of about the same magnitude for whites as for blacks for the "low" groups. Parents' dropping out as compared to finishing high school, then, is important for explaining increments in children's math reasoning skills for all children who come from relatively less advantaged backgrounds. A parent's high school diploma is a solid resource irrespective of race, and children of drop-outs are at a disadvantage irrespective of race (Tables 3 and 5).

The large effects of kindergarten attendance for whites but not for blacks in Table 2 are problematic. Table 3 shows large effects for whites who come from high-education homes, but not for blacks from high-education homes. The differences by race in effects of kindergarten when children of high-school-graduate parents are compared with those of parents having some college seem to be due mainly to confounding, however. Parents with some post-secondary education tended to be those who sent their children to full-day kindergarten sessions, but among these there are proportionately many more whites than blacks (80% vs. 50%, respectively). Both white parents and black parents sent their children to public kindergartens in the same school where children enrolled in first grade, so differences by race cannot be attributed to white parents' use of private or other types of preschools.

Black boys outperformed black girls in math reasoning (Tables 2 and 3) but white boys did not outperform white girls. Since gender differences for blacks do not fully emerge until parents' economic resources are taken into account, perhaps boys' math development is more sensitive to economic deprivation than is girls'. Such a finding is consistent with literature indicating that young boys are more adversely affected by negative life circumstances than are girls (Zaslow & Hayes, 1986). Exactly how much emphasis to place on this small gender effect is problematic. It will be followed up as these children are tracked through the early years of elementary school.

Finally, as commonly observed, the model explains more variance in whites' performance than in blacks'. The consistently tighter bundling of positive characteristics for whites as compared to blacks is represented by the higher likelihood of full-day kindergarten attendance for whites whose parents have some post-secondary education, mentioned above; also white parents with more education are likely to have higher performance expectations than blacks (zero-order correlations are .46 for whites, .06 for blacks). This "bundling" phenomenon may stem from racial disability as well as cause it, though. Perhaps white parents' ability estimates account for their mark expectations to a greater extent than do blacks' because blacks are intuitively aware of a lesser correspondence between cognitive growth and black children's marks (Entwisle & Alexander, 1988). There could also be inversions in expectations because of parents' perceptions. Less advantaged blacks may hold relatively high expectations for their children because they perceive their children's chances at education and upward mobility to be better than those they themselves encountered, while more advantaged blacks, who have already experienced some mobility, may be thinking in terms of barriers and discrimination they continue to encounter as they try to achieve further mobility.

Computation

The findings for children's competence in computational skills are much simpler: children of the two races have equivalent skills in computation at the time of school entry when differences in socioeconomic status and other factors are taken into account. There is again a significant interaction between parent education and race, but in contrast to reasoning, there are no significant gender differences in computation for either blacks or whites (Tables 4 and 5).

Tables 4 and 5 about here

Again splitting the groups by parent education (Table 5) informs our understanding of kindergarten effects because, just as for reasoning, kindergarten effects occur mainly for white children whose parents have the most education.

Parent expectation effects are again large for children of both groups, and again parents' education is significant only for whites (Table 4). There is no racial difference in effects of meal subsidy, though, and again no effects of family type.

To the extent we can explain children's computational skills at the start of grade one--and this is marginal--there is no disability by race or sex and effects of parent resources are greatly attenuated.

Discussion

The contrast between the meager findings for computation and the rich findings for reasoning skills points up the wisdom of estimating models for the two outcomes separately. This divergence, though, makes it hard to compare the findings here with other research because most other research is based on composite math scores.

A major advantage in studying children's performance at the point of school entry is that children's cognitive histories are relatively abbreviated, so there is a clearer window on growth processes. As we show here, minority and majority children in the BSS were equivalent in terms of verbal performance and math computational skills at the point of school entry and only a few points apart in reasoning. By the end of first grade, though, other analyses of this sample show they differed significantly by race on all three dimensions with socioeconomic status and other relevant variables taken into account (Alexander & Entwisle, in press). Thus, over first grade in this sample the cleavage by race found in other studies (Jones, Burton, & Davenport, 1984) begins to develop. This is rather persuasive evidence that school-based factors play a considerable role in explaining later performance differences.

It bears repeating that the findings reported here pertain to a large random sample of children in an urban school system. Much research on children at this age focuses on small convenience samples. There is no difference in computation and the average black/white net difference in reasoning scores at school entry is small--about 8 points, or one-quarter of a standard deviation. Furthermore, the effects of parents' psychological and material resources are both greater than effects of race at this point in the life cycle. It is especially important policy-wise that parent psychological supports are the most influential of the variables considered, and parent expectations for performance in math are potent sources of influence for black students as well as for white. A number of recent efforts to involve parents in their children's schooling are encouraging (Epstein, 1984, 1988; Epstein & Becker, 1982; Fuerst, 1977; Hewison & Tizard, 1980), but all parents should be alert to the important role they can have in their children's schooling before formal schooling even begins.

Although minority-majority differences in children's math skills are small or absent here, effects of <u>social class</u> are not absent. Like Saxe et al. (1987) and others, we find parents' economic resources to be a potent influence on children's pre-math skills and these resources strongly favor whites. To appreciate this point, note that for a black child the parent's being a high school graduate rather than a drop-out <u>and</u> being well enough off to finesse the meal subsidy is worth about 19 points in the child's math reasoning score (more than double the direct effect of race--8 points--in Table 2). The perplexingly small effect of parent education for blacks considered as a group (Table 2) tends to obscure the fact that parent education matters a great deal if we compare children of high school graduates vs. children of drop-outs (Table 3). For blacks a parent's high school diploma is almost as important a resource as it is for whites.

<u>Family Type</u>

The literature is rich with allusions to ways family type could affect development of math competence and family type is often invoked to explain blacks' lower school performance because more blacks than whites are being raised in solo-parent homes. As mentioned, there are at least three explanations offered for this: one, absence of the father is thought to undermine boys' sex-role identity; two, absence of a male presence could reduce exposure to analytical thinking; last, parental supervision is important for children's achievement and a single parent has less time to spend with children than do two parents (or two adults). The data here, however, contradict the notion that young boys' math skills at the point of school entry are sensitive to father presence, or the notion that family type affects achievement of either sex directly with socioeconomic factors controlled. Furthermore, family type effects were searched for in several supplementary analyses. Number of siblings was added to the total model and had no significant effects for either math skill. Elsewhere (Thompson, Alexander, & Entwisle, in press) we found that black solo mothers had significantly lower expectations than did black mothers in other kinds of families, but effects on children's performance were small. Here effects of family type on parent expectations are not statistically significant, about two-tenths of a point in terms of parent expectation increments. In other samples where socioeconomic variables are not as well controlled as here, effects of family type may be exaggerated, or effects of family type may emerge as children get older.

Kindergarten

Except in some rural areas, public kindergartens are now almost universal in the U.S. but there is little solid evidence about how kindergarten affects children. Most of the scientific debate about preschool education has centered on programs for 4-year olds--Headstart and the like. Questions have surfaced recently in some areas of the country, though, about the advisability of including a great deal of academic work in the kindergarten curriculum. The worry is about "burn-out": that too much early emphasis on academics will undercut children's performance in the higher grades.

Such questions are not addressed directly in this paper but conclusions here run counter to "burn-out." Prior research with the BSS shows that more kindergarten attendance generally improved children's test scores at the beginning of first grade and helped them get better marks in first grade, especially if they were black (Entwisle, Alexander, Cadigan, & Pallas, 1987). Kindergarten did not lead to differences in children's adjustment (self-expectations for performance or deportment) but did predict better attendance in first grade. Attendance is an especially important factor in black children's cognitive growth, and other studies show that it is also important in the long run as a precursor of school drop-out (Stroup & Robins, 1972).

Disappointingly, however, here full-day kindergarten did not boost either blacks' reasoning or their computation scores when other variables were taken into account. This is not to say that kindergarten has no positive effects--only that the evidence here does not support advocating full-day as compared to half-day sessions for improving math pre-skills.

Gender Differences

The significant difference favoring black males over black females in reasoning is provocative, and other information in the BSS archive suggests that this gender difference is not a statistical fluke or regression artifact. (Within the black sample the difference favoring boys over girls appears irrespective of parent education--6 points for boys whose parents have not completed high school, 7 points for boys whose parents just finished high school, and 12 points for boys whose parents had more than a high school education.) There is no difference between white males and females, and no difference between males of the two races in reasoning skills. Black females score lower than white females, though, and lower than black males. The gender difference in reasoning can thus "explain" the overall race gap at this point in children's development, and the fact that the gender effect increases in size when the verbal CAT score is added to the model suggests that "gender" may be the preferred interpretation rather than "race."

Gender differences in mathematics ability have been much more vigorously researched than race differences, but remain controversial. Although gender differences seem to be decreasing (Feingold, 1988), small gender differences in math-related skills are reported for older children irrespective of ethnicity (Marshall, 1984).

Gender differences in children's math performance are frequently seen in middle childhood and can be at least partly attributed to parent expectations (Parsons, Kaczala, & Meece, 1982; Entwisle & Baker, 1983; Baker & Entwisle, 1987) and actions (Astin, 1974). Mothers think their sons will do better in math than their daughters, and this apparently causes sons to see themselves as better in math than daughters, even though the objective evidence (marks and test scores) indicate children of the two sexes are the same. Also, parents do more to encourage mathematics skills in sons than in daughters—parents of boys are more likely to buy mathematics toys and games, for instance. Parent expectations cannot readily explain the gender difference observed in the BSS, however, because black parents of sons do not expect them to do better in math or see them as having more ability in math than do black parents of daughters.

Benbow & Stanley (1980) found that gender differences in talented adolescents lay mainly in math reasoning skills, and this is consistent with the kind of gender difference in concepts scores observed here. Not much of the prior evidence about gender pertains to blacks, though. Jones et al. (1982, p. 31) reported no gender differences in math scores at age 13 for blacks, and Lockheed et al., (1985) in a review of findings for youngsters in grades 4 through 8, reported "little evidence to support a sex by ethnicity interaction" (p. 18). As noted, however, most studies pertain to composite math measures, so a gender difference in math subskills like the one seen here could easily be obscured.

We are left with a simple story. There is a negligible difference by race in children's computational skills at the point of school entry and a small difference (around a quarter of a standard deviation) favoring whites in math reasoning concepts. This difference in reasoning may just as well represent a gender gap, however, because black boys score at the same level as white boys and white girls. Only black girls score lower. Family type does not affect math scores of children of either sex or either race at this age, but parents' expectations are a potent influence on children's math skills at the point of school entry. This kind of parental psychological resource is equally potent for blacks and whites and holds for all socioeconomic levels.

The next item on our agenda is to examine the nature of growth in math reasoning and math computation over the first two school years, because racial differences in test scores emerge over this period. We will continue to pay particular attention to differences in the nature of growth in the two domains because reasoning shows more differentiation in terms of background resources and these are the same distinctions that later on are the critical ones in terms of school tracking.

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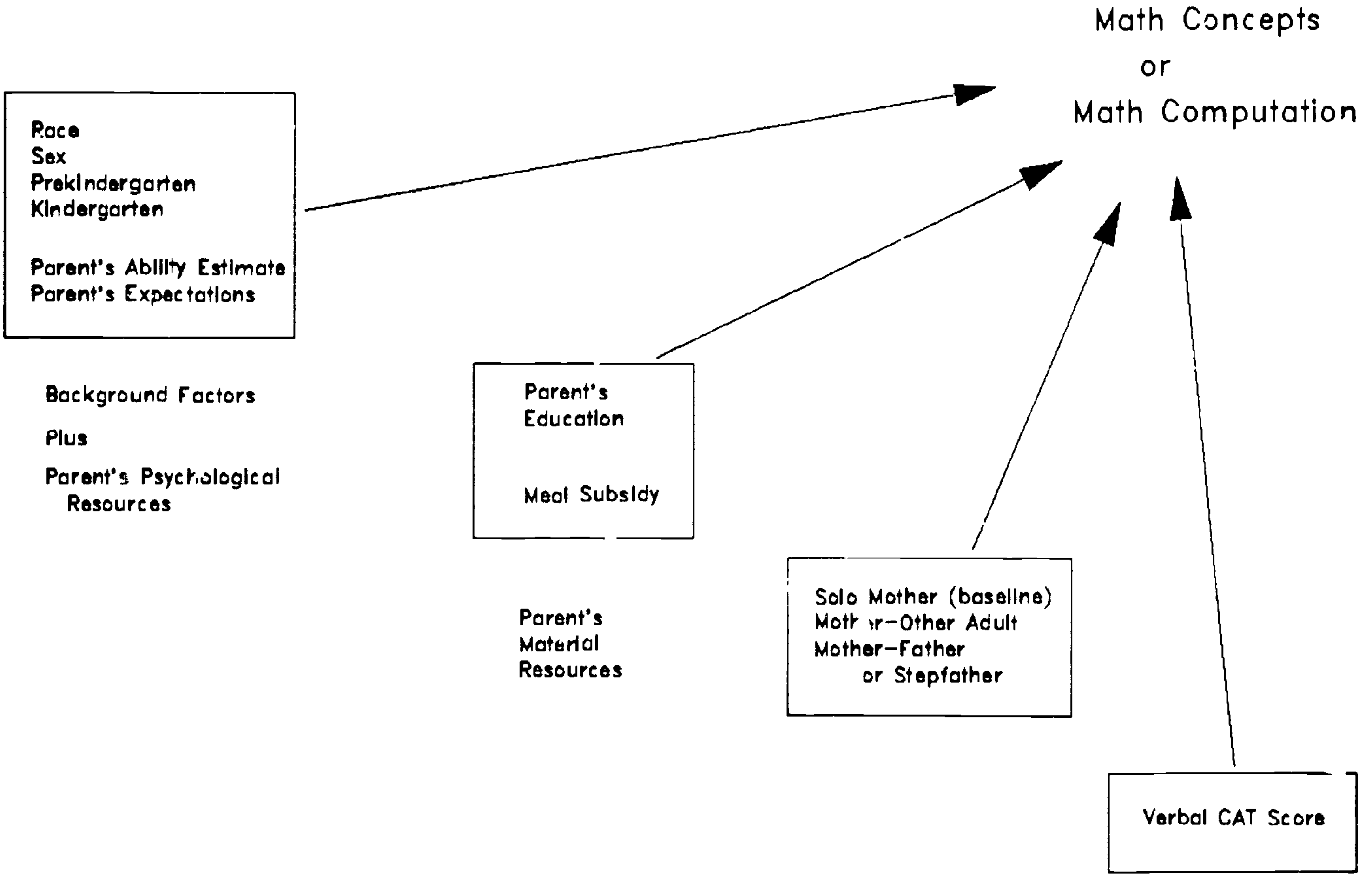
Math Concepts
or
Math Computation
Race
Sex
Prekindergarten
Kindergarten
Parent's Ability Estimate
Parent's Expectations
Background Factors
Plus
Parent's Psychological
Resources
Parent's
Education
Meal Subsidy
Parent's
Material
Resources
Solo Mother (baseline)
Mother-Other Adult
Mother-Father
or Stepfather
Verbal CAT Score

Figure 1

Table 1. Means and Standard Deviations of Variables in Models

	Black								White							
	N = 71		N = 83		N = 72		N = 226		N = 66		N = 60		N = 38		N = 164	
	Years of Parent Education								Years of Parent Education							
	Less than 12		12		More than 12		Total		Less than 12		12		More than 12		Total	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Percent females	0.51	0.50	0.53	0.50	0.56	0.50	0.53	0.50	0.53	0.50	0.50	0.50	0.50	0.51	0.51	0.50
Fall '82, Math Reasoning	287	26	296	28	302	29	295	28	285	27	301	28	331	34	302	34
Fall '82, Math Computation	230	24	232	28	241	28	234	27	223	27	236	27	264	31	238	32
Fall '82, Verbal CAT	278	24	280	26	293	28	283	27	272	29	282	30	311	40	285	36
Prekindergarten	1.52	0.50	1.55	0.50	1.61	0.49	1.56	0.50	1.35	0.48	1.55	0.50	1.95	0.23	1.56	0[illegible]
Amount of Kindergarten	3.11	0.46	3.16	0.46	3.44	0.55	3.24	0.51	3.01	0.41	3.00	0.32	3.79	0.41	3.19	0.50
Parent's Ability Estimate	4.01	0.87	3.75	0.82	3.83	0.82	3.86	0.84	3.41	0.70	3.58	0.77	3.92	0.78	3.59	0.27
Parent's Math Expectation	2.69	0.67	2.76	0.60	2.94	0.67	2.79	0.65	2.42	0.66	2.82	0.77	3.29	0 61	2.77	0.76
Percent Not on Meal Subsidy	0.07	0.26	0.16	0.37	0.51	0.50	0.24	0.43	0.26	0.44	0.57	0.50	0.92	0.27	0.52	0.50
Parent's Educational Attainment	9.94	1.36	12.00	0.00	14.65	1.78	12.20	2.26	9.35	1.07	12.00	0.00	16.50	1.91	11.97	2.98
Percent Families with Father Present in Household	0.38	0.49	0.47	0.50	0.57	0 50	0.47	0.50	0.62	0.49	0.77	0.43	0.87	0.34	0.73	0.44
Percent Families with Other Adult Present in Household	0.28	0.45	0.34	0.48	0.24	0.43	0.29	0.45	0.17	0.38	0.13	0.34	0.05	0.23	0.13	0.34

Table 2. Estimates of Model to Explain Children's Level of Attainment in Math Reasoning at the Point of School Entry

Independent Variables	Black				White				Total			
Race									-9.2*	-8.5*	-8.4*	-8.1*
									(-.15)	(-.13)	(-.13)	(-.13)
Sex	-4.9	-6.3	-6.4	-7.1*	0.7	0.8	0.9	-0.4	-2.3	-3.3	-3.3	-4.3
	(-.08)	(-.11)	(-.11)	(-.13)	(.01)	(.01)	(.01)	(-.01)	(-.04)	(-.05)	(-.05)	(-.07)
Prekindergarten	0.7	-0.3	-0.1	-1.4	2.7	-2.0	-2.4	-3.8	2.0	0.0	0.0	-1.5
	(.01)	(-.01)	(-.00)	(-.02)	(.04)	(-.03)	(-.04)	(-.06)	(.03)	(.00)	(.00)	(-.02)
Amount of Kindergarten	8.5*	3.3	3.3	1.2	17.7*	11.2*	10.4*	8.2	12.4*	7.4*	7.4*	5.1
	(.15)	(.06)	(.06)	(.02)	(.26)	(.17)	(.15)	(.12)	(.20)	(.12)	(.12)	(.08)
Parent's Expectation for Math Mark	14.4*	13.1*	12.8*	10.6*	17.0*	14.2*	14.3*	10.0*	16.4*	14.1*	14.1*	13.6*
	(.33)	(.30)	(.29)	(.24)	(.38)	(.32)	(.32)	(.23)	(.37)	(.32)	(.32)	(.31)
Parent's Ability Estimate	3.4	3.9	3.9	1.2	5.9	5.3	5.3	2.7	4.7*	5.0*	5.0*	2.2
	(.10)	(.12)	(.12)	(.04)	(.13)	(.12)	(.12)	(.06)	(.12)	(.13)	(.13)	(.06)
Parent's Education		3.6	3.4	2.0		11.1*	11.5*	9.6*		6.5*	6.5*	4.8*
		(.10)	(.10)	(.06)		(.26)	(.27)	(.22)		(.17)	(.17)	(.12)
Meal Subsidy		10.5*	10.5*	6.2		1.0	1.7	-2.0		5.9	5.8	1.5
		(.16)	(.16)	(.09)		(.01)	(.03)	(-.03)		(.09)	(.09)	(.02)
Other Adult Present in Household			4.1	4.1			-9.5	-8.8			-0.5	-0.2
			(.07)	(.07)			(-.09)	(-.09)			(.01)	(-.00)
Father Present in Household			3.1	1.6			-6.5	-8.4			-0.1	-1.7
			(.06)	(.03)			(-.09)	(-.11)			(-.00)	(-.03)
Verbal CAT Score				0.41*				0.39*				0.40*
				(.39)				(.41)				(.40)
R^2 (adj.)	.155	.187	.182	.306	.352	.364	.382	.501	.260	.292	.288	.410

* Significant at .05 level or better

Table 3. Estimates of Model to Explain Math Reasoning by Parent Education Groups (standardized coefficients in parentheses)

	Black						White					
	High School vs. Drop-out			Post-Secondary vs. High School			High School vs. Drop-out			Post-Secondary vs. High School		
Sex	-3.3 (-.06)	-4.4 (-.08)	-4.2 (-.08)	-6.8 (-.12)	-7.6 (-.13)	-8.1 (-.14)	3.0 (.05)	3.1 (.05)	2.9 (.05)	-2.7 (-.04)	-2.5 (-.04)	-2.9 (-.04)
Prekindergarten	-4.0 (-.07)	-3.7 (-.07)	-3.4 (-.06)	1.3 (.02)	0.2 (.00)	0.5 (.01)	-3.8 (-.07)	-3.8 (-.07)	-4.1 (-.07)	0.8 (.01)	1.2 (.02)	1.4 (.02)
Amount of Kindergarten	2.9 (.05)	0.1 (.00)	0.0 (.00)	6.3 (.12)	2.9 (.05)	3.2 (.06)	2.2 (.03)	2.5 (.03)	1.7 (.02)	23.0* (.36)	23.5* (.37)	22.2* (.35)
Parent's Expectations	13.0* (.30)	12.6* (.29)	12.2* (.28)	18.2* (.41)	18.0* (.40)	17.8* (.40)	16.1* (.42)	16.4* (.43)	16.9* (.44)	14.8* (.33)	15.1* (.33)	15.0* (.33)
Parent's Ability Estimate	3.5 (.11)	3.8 (.12)	3.7 (.12)	2.1 (.06)	1.8 (.05)	1.7 (.05)	3.0 (.08)	2.8 (.07)	2.5 (.06)	5.3 (.12)	5.0 (.12)	5.2 (.12)
Parent's Education	8.9* (.16)	8.1 (.15)	[illegible].7 (.14)	1.3 (.02)	-1.1 (-.02)	-1.2 (-.02)	9.6* (.17)	10.0* (.18)	9.9* (.17)	2.9 (.04)	3.2 (.05)	4.0 (.06)
Meal Subsidy		12.0 (.14)	11.4 (.13)		9.9 (.16)	12.0* (.20)		-1.4 (-.02)	-1.9 (-.03)		-2.7 (-.04)	-0.6 (-.01)
Other Adult Present in Household			3.2 (.05)			11.4 (.18)			-6.9 (-.09)			-6.3 (-.06)
Father Present in Household			3.7 (.07)			3.6 (.06)			0.7 (-.01)			-11.4 (-.13)
R^2 (adj.)	.108	.120	.111	.199	.213	.224	.230	.224	.218	.388	.382	.379

* Significant at .05 level or better

Table 4. Estimates of Model to Explain Children's Level of Attainment in Math Computational Skills at Point of School Entry

Independent Variables	Black				White				Total			
Race									-5.4 (-.09)	-5.0 (-.09)	-4.2 (-.07)	-.40 (-.07)
Sex	2.0 (.04)	1.2 (.02)	1.3 (.02)	0.6 (.01)	0.4 (.00)	0.4 (.01)	0.4 (.01)	-0.8 (-.01)	1.7 (.03)	1.0 (.02)	1.0 (.02)	0.1 (.00)
Prekindergarten	0.9 (.02)	0.4 (.01)	0.8 (.01)	-0.4 (-.01)	8.8 (.14)	4.9 (.08)	4.9 (.08)	3.7 (.06)	4.7 (.08)	3.1 (.05)	3.4 (.06)	1.9 (.03)
Amount of Kindergarten	6.4 (.12)	3.6 (.07)	3.3 (.06)	1.3 (.02)	13.0* (.20)	7.4 (.12)	7.6 (.12)	5.5 (.09)	9.6* (.17)	5.8 (.10)	5.6 (.10)	3.4 (.06)
Parent's Expectation for Math Mark	8.6* (.20)	7.7* (.18)	7.7* (.18)	5.6* (.13)	14.8* (.35)	12.4* (.30)	12.6* (.30)	8.5* (.20)	12.1* (.29)	10.3* (.25)	10.4* (.25)	[illegible]
Parent's Ability Estimate	3.9 (.12)	4.2* (.13)	4.4* (.14)	1.9 (.06)	3.7 (.09)	3.3 (.08)	3.2 (.08)	0.7 (.02)	4.3* (.12)	4.5* (.13)	4.6* (.13)	1.9 (.05)
Parent's Education		2.9 (.08)	2.9 (.08)	1.5 (.04)		8.9* (.22)	8.7* (.21)	7.0* (.17)		5.4* (.15)	5.3* (.14)	3.7* (.10)
Meal Subsidy		5.1 (.08)	2.7 (.04)	-1.5 (-.02)		1.8 (.03)	1.2 (.02)	-2.2 (-.04)		4.0 (.07)	2.6 (.04)	-1.5 (-.02)
Mother-Other Adult[a]			-0.3 (-.00)	-0.2 (-.00)			0.4 (.00)	1.0 (.01)			-0.6 (-.01)	-0.3 (-.00)
Mother or Father			5.8 (.11)	4.2 (.08)			2.7 (.04)	0.9 (.01)			4.1 (.07)	2.6 (.04)
Verbal CAT Score				0.39* (.38)				0.36* (.40)				0.38* (.40)
R_2 (adj.)	.060	.067	.069	.191	.301	.323	.316	.431	.174	.194	.195	.316

* Significant at .05 level or better

[a] Mother alone is baseline category.

Table 5. Estimates of Model to Explain Math Computational Skills by Parent Education Groups (standardized coefficients in parentheses)

	Black						White					
	High School vs. Drop-out			Post-Secondary vs. High School			High School vs. Drop-out			Post-Secondary vs. High School		
Sex	5.6 (.11)	4.9 (.10)	5.6 (.11)	3.4 (.06)	3.0 (.05)	2.7 (.05)	2.0 (.04)	2.0 (.04)	1.9 (.03)	-1.0 (-.02)	-1.5 (-.02)	-1.5 (-.02)
Prekindergarten	-0.5 (-.01)	-0.3 (-.01)	0.6 (.01)	-0.3 (-.01)	-0.8 (-.01)	-0.8 (-.01)	2.5 (.05)	2.5 (.05)	2.4 (.04)	7.3 (.11)	6.3 (.09)	6.7 (.10)
Amount of Kindergarten	5.3 (.09)	3.7 (.07)	3.2 (.06)	3.5 (.06)	1.9 (.03)	1.9 (.03)	-3.5 (-.05)	-3.4 (-.05)	-3.6 (-.05)	16.6* (.28)	15.3 (.26)	14.8 (.25)
Parent's Expectations	6.5 (.16)	6.2 (.15)	5.5 (.13)	11.1* (.25)	11.0* (.25)	10.8* (.24)	11.6* (.31)	11.7* (.31)	12.2* (.32)	11.1* (.26)	10.2* (.24)	10.1* (.24)
Parent's Ability Estimate	4.5 (.15)	4.7 (.15)	4.4 (.14)	2.8 (.08)	2.7 (.08)	3.0 (.09)	1.1 (.03)	1.1 (.03)	0.7 (.02)	3.5 (.09)	4.2 (.11)	4.3 (.11)
Parent's Education	1.7 (.03)	1.3 (.02)	0.2 (.00)	5.8 (.10)	4.7 (.08)	4.8 (.08)	7.9 (.14)	8.0 (.14)	7.6 (.14)	5.3 (.08)	4.6 (.07)	5.1 (.08)
Meal Subsidy		7.0 (.09)	4.4 (.05)		4.6 (.08)	3.7 (.06)		-0.5 (-.01)	-1.7 (-.03)		6.4 (.09)	7.1 (.10)
Other Adult Present in Household			5.6 (.10)			2.3 (.04)			0.2 (.00)			4.2 (.04)
Father Present in Household			10.4 (.20)			4.4 (.08)			4.5 (.08)			-1.5 (-.02)
R^2 (adj.)	.026	.026	.037	.070	.068	.059	.113	.106	.096	.311	.311	.298

* Significant at .05 level or better