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SCHOOL READINESS AND ACADEMIC ACHIEVEMENT IN SECOND GRADE

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Julia E. Moore

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The thesis of Julia E. Moore was reviewed and approved* by the following:

Mark T. Greenberg

Professor of Human Development and Family Studies

Thesis Advisor

Celene Domitrovich

Research Associate at Prevention Research Center,

in the Department of Human Development and Family Studies

Steven H. Zarit

Professor of Human Development and Family Studies

Head of the Department of Human Development and Family Studies

*Signatures are on file in the Graduate School.

ABSTRACT

Children raised in low-income families experience delays in cognitive and academic performance as of school entry. Evaluations of preschool programs serving children from low-income households have found that attending a quality preschool can improve children's academic performance. In normative samples, a positive relation has been found between cognitive aspects of school readiness, and later cognitive and academic components of children's competence in elementary school. The present study examined whether this relation holds true in an at-risk sample of children who attended a combined Head Start and public preschool program. After controlling for primary caregiver education attainment, free/reduced lunch status and gender, both pre-reading and pre-math skills assessed in preschool (age 4) positively predicted children's cognitive and academic abilities in 2nd grade, measured both by standardized assessments and teacher reports. Analyses of groups who experienced different level of growth illustrate that preschool pre-math and pre-reading abilities predicted group membership, yet demographic characteristics did not.

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Chapter 1

INTRODUCTION

Children who live in low-income households are at risk for a host of problematic outcomes, ranging from lower levels of academic success (Brooks-Gunn & Duncan, 1997; Dregger & Miller, 1960; Esposito, 1999; McLoyd, 1998a) to higher rates of adolescent pregnancy, unprotected sexual activity, drug and alcohol use, school dropout and delinquency (Mayer, 1997; McLanahan & Sandefur, 1994). Years of research have repeatedly documented an association between family income and academic achievement, with children from lower-income households more likely to experience lower scores on standardized tests as well as on teacher reports of achievement from kindergarten through high school (Huston et al., 2005; McLoyd, 1998b; McLoyd, Aikens, & Burton, 2006; Patterson, Kupersmidt, & Vaden, 1990).

Understanding the difficulties that children face as of school entry is particularly important, since entering school ill-prepared is predictive of later academic difficulties (Alexander & Entwisle, 1988; Belsky & MacKinnon, 1994; Duncan & Brooks-Gunn, 2000; Duncan, Brooks-Gunn, & Klebanov, 1994; Mayer, 1997). A child's family, childcare and preschool experiences play a significant role in determining their adjustment and performance in kindergarten (Ramey & Ramey, 2004). Specifically, the preschool years are foundational for the development of later math and reading skills (Starkey, Klein, & Wakeley, 2004). By school entry, children from low-income families already experience delays in academic abilities which only worsen with time (Alexander, Entwisle, & Olson, 2001; Downey, von Hippel, & Borh, 2004).

In response to the evidence that children from low-income families experience deficits in academic domains at school entry, extensive work has been devoted to the creation, implementation and evaluation of preschool programs (Ramey & Ramey, 1998). Attending a quality preschool program with a responsive educational environment is associated with improved academic success and cognitive and social-emotional outcomes in elementary school (Barnett, 1995; Haskins, 1989; Ramey & Ramey, 2004; Weissberg & Greenberg, 1998). Furthermore, longitudinal research on children who attend a quality preschool program indicates that those who attended preschool completed more years of education, were more likely to graduate from high school and had a higher attendance rate in college than peers who had not attended preschool (Ou & Reynolds, 2006). The impact of these programs may be moderated by children's background, with children from more at-risk backgrounds benefiting more than those from less at-risk backgrounds (Peisner-Feinberg et al., 2001).

Head Start is the largest federally-funded preschool program in the United States and is geared toward children of poor families at risk of academic difficulties. Evaluations of Head Start and Early Head Start show that children experience immediate gains in cognitive and language abilities after attending the program, but that these initial gains fade with time (Haskins, 1989; Love et al., 2005). In a randomized, control trial of Head Start, researchers have found that children who attended Head Start experienced positive impacts in cognitive and social-emotional domains into the elementary school years (US Department of Health & Human Services, 2005). For the cognitive domain, moderately statistically significant impacts were found for pre-reading, pre-writing, vocabulary and

parent report of literacy skills; these results were found for both children who entered Head Start at ages 3 and 4.

The present study will explore the relation between cognitive measures of school readiness at age 4 and later measures of cognitive and academic achievement in 2nd grade. The sample consists of children from predominantly low-income families who attended a combined Head Start and publicly-funded preschool program prior to entering kindergarten. Cognitive measures of school readiness, such as pre-reading and pre-math skills will be employed to predict both standardized tests and teacher reports of children's reading and math abilities in 2nd grade. While the relation between cognitive aspects of school readiness and later achievement has been documented in normative populations, we examine the continuity of cognitive competence in an at-risk sample that has received an intensive preschool program.

Predictors of Math and Reading Achievement

To understand the preschool predictors of elementary math and reading ability, it is important to consider children's own characteristics as well the quality of both the home and childcare settings, as these environments are likely impact children's academic development. Two categories of control variables and two predictor variables will be considered; control variables include family demographics and gender, predictor variables include preschool pre-reading and pre-math abilities.

Demographics. Family income and socio-economic status (SES) have been consistently associated with measures of school readiness (Janus & Duku, 2007; McLoyd, 1998b; McLoyd et al., 2006; White, 1982), with children from low-income families showing

delays in letter knowledge, phonological processing and other pre-reading skills before school entry (NICHD Early Child Care Research Network, 2005), which increase with time (Chatterji, 2006). In a study exploring the predictors of educational attainment at age 22, Entwisle and colleagues found that SES was the strongest predictor of years of school and the highest level of school attempted (Entwisle, Alexander, & Olson, 2005). Other predictors of academic success and grade completion included neighborhood quality, social background, gender and race.

Multiple aspects of living in low-SES households may account for these delays, including that low-income parents spend less time reading to their children (Whitehurst & Lonigan, 1998), have fewer books in the home (Arnold & Doctoroff, 2003), talk to their children less (Hart & Risley, 1992) and use less complex vocabulary (Hart, 2004); all of these characteristics are associated with reading outcomes (Britto & Brooks-Gunn, 2001; Walker, Greenwood, Hart, & Carta, 1994). The quality of the home environment uniquely contributes to children's reading development (Bradley, Corwyn, McAdoo, & Garcia Coll, 2001; Downer & Pianta, 2006) and there is evidence that the home environment may be a stronger predictor of reading development than home literacy practices, including shared book reading and maternal book reading strategies (Roberts, Jurgens, & Burchinal, 2005).

Socio-economic status has also shown strong and lasting associations with children's elementary math skills (Entwisle & Alexander, 1990; Fuchs & Fuchs, 2001; Fuchs, Fuchs, Yazdian, & Powell, 2002; Jordan, Kaplan, Locuniak, & Ramineni, 2007). Socio-economic status has been found to predict children's math abilities in preschool (Starkey & Klein, 1992), kindergarten (Espy, Molfese, & DiLalla, 2001; Jordan et al., 2007) and first grade (Entwisle & Alexander, 1990), as well as the growth curves in abilities from

kindergarten through the early elementary years (Jordan et al., 2007). In addition, parental education is positively related to math scores (National Center for Education Statistics, 2006).

The quality of the home environment also uniquely contributes to children's math abilities from age 3 through elementary school (Bradley et al., 2001; Espy et al., 2001). There is evidence that the increasing income gap for math abilities includes overall measures of math, as well as specific math domains in which children from low-income families are particularly behind, including story problems and informal addition and subtraction (Ginsburg & Pappas, 2004; Jordan et al., 2007; Jordan, Kaplan, Olah, & Locuniak, 2006).

Gender. While differences are not large, findings consistently show that girls out-perform boys in reading across childhood and adolescence (Chatterji, 2006; Stevenson & Newman, 1986) and these differences are evident by preschool. Girls appear to not only maintain a gender advantage in reading, but also remain more motivated than boys (Reynolds, 1991). There is some evidence of an interaction between gender and SES, where the gender gap is larger for children from low-SES families; this interaction appears as early as 1st grade and increases as children enter middle and high school (Entwisle, Alexander, & Olson, 2007; Wood, Kaplan, & McLoyd, 2007). Entwisle and colleagues hypothesize that teachers and parents not only treat children from each gender differently, but that they also hold different expectations of their behavior, which lead to differing forms of sex-socialization.

In contrast to the consistent gender effects for reading, there is inconsistency in the effects of gender on math abilities. The preponderance of evidence indicates small but

significant gender effects, with boys outperforming girls as early as kindergarten (Arnold & Doctoroff, 2003; Entwisle & Alexander, 1990; Ginsburg & Pappas, 2004; Jordan et al., 2006). Recent studies of young children show that from kindergarten through first grade boys show higher math abilities and that gender effects are not accounted for by income level or reading ability (Jordan et al., 2007). In addition, when children were divided into high and low performance in number sense and nonverbal calculations, the percentage of boys in the high-achieving category was much larger than that of girls (61% compared to 39%) (Jordan et al., 2006). Another study found differential effects of an intervention in Head Start classrooms on children's math scores by gender, where the intervention was more effective for boys than for girls (Arnold, Fisher, Doctoroff, & Dobbs, 2002). There is also some evidence that there may be an interaction between gender and SES for math, with girls from low-SES families underachieving in math and science from elementary school through post-doctoral programs (Arnold & Doctoroff, 2003).

Early reading abilities. Prior to school entry, children are developing the tools and skills necessary to learn how to read. Emergent literacy consists of the skills, knowledge and attitudes acquired in early childhood which are believed to be the building blocks of learning how to read and write (Whitehurst & Lonigan, 1998). Children's early exposure to different environments, as well as their own individual differences lead to significant variability in the development of pre-reading skills (NICHD Early Child Care Research Network, 2005). Research is conclusive that preschoolers with weaker pre-reading skills continue to lag behind their peers in reading ability across childhood (Juel, 1988; Lonigan, 2006; Stevenson & Newman, 1986; Whitehurst & Lonigan, 1998).

An explanation of the stability of reading abilities has been termed the *Matthew effects*, whereby more skilled readers are exposed to more print and get better vocabulary skills, which in turn leads them to be better readers than their counterparts who were less proficient readers at the outset (Stanovich, 1986). Children's interest in reading could also explain why children who have difficulty reading maintain deficits compared to their peers who begin as more proficient readers. Children who are better readers may be more interested in reading and therefore read more, explaining their maintained advantage in reading abilities (Reynolds, 1989).

While there is evidence of substantial stability in measures of pre-reading and reading, other factors influence the development of reading, such as math, attention and social-emotional skills (La Paro & Pianta, 2000). Analyses of later math and reading achievement found that preschool pre-reading skills predicted not only later reading achievement, but also math achievement (Duncan et al., 2007). One explanation for this finding is that as elementary math problems often require reading or verbal abilities, particularly for story problems. In addition, it has been hypothesized that certain elements of math skills may be stored verbally (Geary, 1993). Support for this hypothesis comes from a study which found that reading was a significant predictor of the growth curves in children's math abilities in elementary school (Grimm, 2008).

Early Math Skills. Despite evidence that early math ability is a strong predictor of reading ability, there is less research that explores the relation between preschool pre-math skills and early elementary reading abilities, yet recent studies have found that early math skills may be predictive of later reading abilities (Duncan et al., 2007). In addition, one study evaluating a preschool math curriculum found that children who participated in

a math-focused preschool had better reading comprehension abilities than their peers who had not participated in the intervention (Lange, Sarama, & Clements, 2009).

There is increasing evidence that math achievement is relatively stable: preschool pre-math abilities were highly correlated with 10th grade math achievement (r = .46) (Stevenson & Newman, 1986). More recently, multiple studies have documented a strong association between preschool and kindergarten math abilities to elementary math skills (La Paro & Pianta, 2000). Growth curve analyses from kindergarten through 2nd grade indicate the growth rates for students with lower math abilities were slower than those with higher math abilities in kindergarten (Aunola, Leskinen, & Lerkkanen, 2004). Another series of studies from kindergarten into the elementary years grouped children into three categories of math abilities in kindergarten (low, medium and high) and found that those groupings were significant predictors of children's growth curves in math during elementary school (Jordan et al., 2006). All three studies confirm that math abilities have a high level of stability, and a fanning effect in which children with better early math skills have math skills that improve at a faster rate than lower achieving students.

Teacher Reports of Academic Abilities. Most of the literature cited thus far predominantly uses direct assessments of children's academic skills; however, there are numerous advantages of employing teacher reports of academic competence in addition to direct assessments of children's cognitive abilities. Unlike psychometric tests, which often only assess children on one day, teacher reports are based on repeated observations over the school year. Teacher reports are often moderate to highly correlated with scores on standardized assessments, with correlations ranging from .66 to .84 (DiPerna & Elliott, 1999; Hoge & Coladarci, 1989).

The Present Study

The present study explores how cognitive assessments of school readiness at age 4 predict academic achievement in 2nd grade in at-risk preschoolers who attended a preschool program infused with academic and social-emotional components. To this aim, four research questions will be addressed:

1. After controlling for primary caregiver highest education, free/reduced lunch status and gender, do cognitive measures of school readiness predict 2nd grade math and reading abilities assessed by standardized child measures and teacher reports?
2. Are there differences in the predictors of 2nd grade math and reading abilities?
3. Are there differences in the predictors of standardized child assessments and teacher reports?
4. What are the characteristics of children who make significant growth over time between preschool and 2nd grade?

Two hypotheses emerge:

1. Preschool pre-reading and math skills will significantly positively predict both child measures and teacher reports of 2nd grade math skills, although preschool pre-math skills will be a stronger predictor than preschool pre-reading.
2. Preschool pre-reading and pre-math skills will significantly positively predict both child measures and teacher reports of 2nd grade reading skills, although preschool pre-reading skills will be a stronger predictor than preschool pre-math.

Chapter 2

METHOD

Participants

Participants were drawn from the evaluation of a preschool program in a mid-sized, urban school district in Pennsylvania. Three hundred and three children were assessed at age 4; by second grade, 241 children remained in the study. Table 1 provides details regarding the demographic characteristics of the sample. Of the 303 children, 45.1% were boys. The sample was predominantly African-American (68.7%; 5.7% White (non-Hispanic); 12.0% White (Hispanic); 13.6% Other), with an average age in preschool of 56 months. Seventy two percent of the sample was eligible to receive Free or Reduced Lunch (FRL). The education distribution was such that 30.1% of the caregivers had not completed high school or a GED, 38.5% completed high school or a GED, 21.1% completed some college or vocational school, and 10.4% had at least an associate's degree.

Procedure

Data for this study were collected as part of an evaluation of a comprehensive preschool program. The program was conducted by the Harrisburg School District in partnership with a local Head Start grantee. As a result of this collaborative effort, the program adhered to national Head Start standards, but went beyond educational requirements of that program by staffing each classroom with two teachers, one of which was required to have a Pennsylvania teaching certificate. The program was comprehensive in that it provided half-day preschool (8am to 1pm) five days a week, three home visits a year, two parent-teacher conferences and offered wrap-around childcare before and after

the program. The base curriculum in the classroom was High/Scope (Schweinhart & Weikart, 1989) infused with an evidence-based social-emotional curriculum, Promoting Alternative THinking Strategies (PATHS; (Kusche & Greenberg, 1994) , Everyday Math and Balanced Literacy.

The data in this report includes assessments taken in preschool at approximately age 4 and three years later when children were in 2nd grade. Preschool and 2nd grade assessments were individually conducted by trained interviewers. Preschoolers completed the measures in two sittings; most 2nd graders completed the entire interview in one sitting. Teachers completed questionnaires pertaining to each child both in preschool and 2nd grade.

Measures

Demographic information was collected from caregivers when children enrolled in the preschool program. Questions include both the ethnicity and age of the caregiver and the child, as well as the caregiver's relationship to the child, his or her education level and marital status. Free/reduced lunch status was collected from the school district.

Standardized Assessments In the present study, two subtests of the Woodcock-Johnson Psycho-Educational Battery-Revised (Woodcock & Johnson, 1990) were included as standardized measures of children's academic achievement. The WJ-R consists of multiple individually administered subtests which attempt to assess children's intellectual and academic abilities. These subtests are standardized by age and have been normed in the United States (M=100, SD=15).

Letter-Word Identification. The Letter-Word Identification (WJ-Letter Word) subtest consists of 57 items that measure the child's ability to match a rebus (pictographic representation of a word) with the actual picture of that object and the ability to identify letters and words in large type in the test booklet. The first item administered depends on the child's projected grade, but if the child does not establish basal (six correct items in a row), earlier items will be administered. Ceiling is established when the child incorrectly answers 6 items and finishes a set. The total unstandardized score is calculated by subtracting the number of incorrect items from final item answered. Scores are then age-standardized (M = 100, SD = 15).

Applied Problems. The Applied Problem (WJ-Applied Problems) subtest is a measure of mathematical ability with a total of 60 items. The items are graded in difficulty (empirically determined by the Rasch item analyses). Easier items include content addressing ordinal counting, counting relevant objects in an assortment of objects, and simple addition and subtraction, while more complex items include multiplication, division and problem solving questions. Similar to the Letter-Word Identification subtest, the first item is dependent on the child's grade; basal, ceiling and the unstandardized scores are established using the same rubric. Scores are then converted to age-standardized (M = 100, SD = 15).

The WJ-R has high reliability and good predictive and concurrent validity (Woodcock & Johnson, 1990). For children aged 8-12 reported reliabilities have ranged from .78 to .94, with a median reliability of .94 for Letter-Word Identification and .92 for Applied Problems using standardized samples. Furthermore, using a random, stratified probability sample of 2479 children in Head Start classrooms, the reliability was .84 for

Letter-Word Identification and .90 for Applied Problems. In addition, the predictive and concurrent validity of the measure have been tested using ECLS-K Reading Scale and ECLS-K General Knowledge Scale as outcome variables.

Teacher Reports. Teacher assessments of student achievement were collected with the Teacher Report of Children's Reading and Math (TRC). The TRC measure includes two items that asks teachers to rate the student's academic skills in comparison with grade-level expectations at their school. The two items, drawn from the Academic Competence Evaluation Scales (ACES) (DiPerna & Elliott, 2000) were "Reading/Language Arts (i.e. Vocabulary, Reading Comprehension, Reading Fluency, Oral Communication)" and "Mathematics (i.e. Computation, Patterns Analysis, Using Numbers to Solve Daily Problems)". For each item, teachers rated children on a five point scale with 1=far below, 2=below, 3=grade level, 4=above, and 5=far above. Teachers also had the option of responding "not observed". Test-retest reliability for the full ACES measures (4-week latency) ranged from .88 to .97 (Elliott, DiPerna, Mroch, & Lang, 2004). There is evidence of external validity as moderate to high correlations have been found with large-scale achievement tests and measures of social skills.

Treatment of Missing Data. A common problem encountered when using longitudinal data is attrition. Using SAS, the software program employed for the regression analyses PROC MI and PROC MIANALYZE were employed to impute 40 data sets to account for missing data. All further analyses will refer to the 303 children with data at age 4 in preschool.

Table 1

Descriptive Characteristics of Study Participants (N=303)

Characteristics	Mean (SD) or Percent
Age	56 months (3.6)
Gender (Male)	45.2%
Ethnicity	
African American	68.7%
European American	5.7%
Hispanic	12.0%
Multi-racial or Other	13.6%
Received Free/Reduced Lunch	72.3%
PC Education	
Some High School	30.0%
GED or High School Diploma	38.5%
Some College	21.1%
College Degree or more	10.4%
Resides with	
Single-Parent Family	77.3%
Two-Parent Family	18.6%
Other	4.1%

Chapter 3

RESULTS

Standardized scores were used for the WJ-Applied Problems and WJ-Letter Word. The means for WJ-Letter Word were 94.52 (*SD* = 10.96) in preschool and 102.52 (*SD* = 16.31) in 2nd grade. For the WJ-Applied Problems the mean in preschool was 87.37 (*SD* = 14.53) and by second grade was 99.20 (*SD* = 16.65). The children showed significant growth both in reading and math compared to standardized norms for age 4 and 2nd grade. Raw scores were used for TRC-Reading and TRC-Math, where 1 indicates far below grade-level expectation, 3 indicates at grade level and 5 indicates far above grade-level. The mean for TRC-Reading was 2.72 (*SD* = 1.02) and for TRC-Math was 2.70 (*SD* = .94), both values were slightly below expected grade level. Table 2 provides the descriptive statistics by time point for each of the measures.

Correlations among the predictor and outcome variables can be found in Table 3. In terms of the correlations between predictor and outcome variables, both preschool pre-reading and pre-math are significantly correlated with all the outcome variables. In second grade, there are high correlations between the standardized assessments and the teacher reports of reading ($r = .68$; $p < .001$) and standardized assessments and teacher reports of math ($r = .64$; $p < .001$). In addition, there is a slightly higher correlation across time for the same subscale of the WJ than between subscales measures. Gender is correlated with the WJ-Letter Word and WJ-Applied Problems in preschool, but not with any 2nd grade measures, with females scoring higher than males on both measures. PC Education is positively correlated with the WJ measures both in preschool and 2nd grade; however, it is

not correlated with 2nd grade teacher reports. Similar to PC Education, FRL was correlated with the WJ measures, but not with teacher reports of academics.

In order to examine predictors of 1st grade academic outcomes, each outcome measure was analyzed using hierarchical linear regression. Hierarchical models were chosen so that the added value of additional predictors could be assessed in a conceptual order. Covariates were included in the first block: Primary Caregiver Highest Education (PC Ed), Free/Reduced Lunch Status (FRL; coded 0 = received FRL; 1 = did not receive FRL) and Gender (coded 0 = boys; 1 = girls). In the second block, the predictor variable from preschool that matched the outcome construct was entered; for the reading outcomes, WJ-Letter Word was entered in Block 2 and for the math outcomes WJ-Applied Problems was entered. In the third block, the remaining predictor variable was entered: WJ-Applied Problems for the reading outcomes and WJ-Letter Word for the math outcomes. Finally, in block 4, interaction terms were entered between the demographic and predictor variables.

Predictors of Reading Ability

What are the preschool predictors of child assessments of elementary reading ability? For the WJ-Letter Word, it was hypothesized that after accounting for the covariates, the preschool WJ- Letter Word would be the most significant predictor and that preschool WJ-Applied Problems would provide unique variance in predicting reading. Table 4 illustrates each of the regressions with WJ- Letter Word as the outcome variable. In Block 1 PC Education ($p < .05$) and FRL ($p < .01$) were significantly associated with 2nd grade reading abilities, gender was a trend level ($p < .10$). In Block 2, WJ-Letter Word ($p < .001$) significantly contributed variance with an R^2 change of .18. In Block 3, WJ-Applied

Problems ($p < .01$) provided significant unique variance in predicting WJ-Letter Word (R^2 *Change* = .03). None of the interactions significantly predicted 2nd grade WJ-Letter Word. The magnitude and direction of these regression analyses suggest that preschool pre-reading abilities are strongly predictive of elementary reading abilities and that preschool pre-math skills also contribute unique variance to later reading development, with better abilities in preschool related to higher achievement in 2nd grade.

What are the preschool predictors of teacher reports of elementary reading ability? Similar to the direct child assessment of reading abilities, it was expected that teacher report of reading abilities in 2nd grade would be significantly predicted by preschool pre-reading and pre-math skills after controlling for gender and demographics. Table 5 illustrates the regression models for TRC-Reading. None of the covariates were significant. When WJ-Letter Word was entered in the model, it significantly predicted TRC-Reading ($p < .001$; R^2 *change* = .19). WJ-Applied Problems was also a significant predictor in Block 3 ($p < .01$; R^2 *change* = .04). None of the interactions were significant.

Predictors of Math Ability

What are the preschool predictors of child assessments of math ability? Using WJ-Applied Problems as the outcome variable, it was hypothesized that preschool pre-reading and pre-math would predict 2nd grade math abilities, and that preschool pre-math would be a stronger predictor than pre-reading skills. As can be seen in Table 6, in Block 1 PC Education ($p < .05$) significantly predicted 2nd grade math abilities; receiving FRL ($p < .10$) was a trend-level. In Block 2, WJ-Applied problems ($p < .001$; r^2 *Change* = .26) was a significant predictor, and in Block 3 WJ-Letter Word ($p < .01$; r^2 *Change* = .03) significantly

predicted 2nd grade math abilities. None of the interactions were significant. As expected, preschool pre-math abilities accounted for the largest portion of the variance in 2nd math abilities, with pre-reading abilities contributing unique variance to 2nd grade math abilities.

What are the preschool predictors of teacher reports of math ability? Using the teacher rating of math ability as the outcome variable, and it was expected that preschool pre-math and pre-reading would be significant predictors, with pre-math providing more explained variance. In Block 1, none of the covariates were significant, see Table 7 for details. Both WJ-Applied Problems ($p < .001$; r^2 *Change* = .12) and WJ-Letter Word ($p = .001$; r^2 *Change* = .05) were significant predictors of TRC-Math in Blocks 2 and 3. Gender by WJ-Letter Word was the only significant interaction ($p < .05$), with boys outperforming girls. Therefore both pre-math and pre-reading abilities predicted 2nd grade teacher reports of math.

Groupings Based on Change from Preschool to 2nd Grade

Based on the results from the regression models, a second set of analyses were conducted. First, difference scores from preschool to 2nd grade were created for WJ-Applied Problems and WJ-Letter Word. Based on these difference scores, children were categorized into one of three groups for each variable. Group 1 included those who decreased or experienced no change from preschool to 2nd grade; group 2 increased by less than one standard deviation; group 3 was characterized by individuals who increased by more than one standard deviation. One-way ANOVAs were run to determine whether pre-

test demographic variables or preschool pre-academic abilities differed between children with different rates of change.

Table 8 and 9 provide the characteristics of the children in each of the three groups who experienced different levels of change on the WJ-Letter Word and WJ-Applied Problems respectively. One-way ANOVAs were conducted to compare the composition of each of these groups. Results indicated that there are statistical differences in the characteristics of the children in each group. For the groups defined by changes in WJ-Letter Word, none of the demographic variables were statistically significantly different by group. There were statistically significant differences though for preschool WJ-Letter Word scores and WJ-Applied Problems, whereby children with higher WJ-Letter Word scores were more likely to be in the group that decreased. WJ-Applied Problems scores also varied significantly by group, with the middle group, who increased by up to one standard deviation experiencing the lowest WJ-Applied Problems scores.

For the groups defined by changes in WJ-Applied Problems both gender and preschool WJ-Applied Problems were significantly different by group. For gender, boys were more likely to be in the group that improved by more than one standard deviation. For WJ-Applied Problems, those with the highest scores in preschool were most likely to be in the group that decreased over time and those with the lowest scores were most likely to end up in the group that increased by more than one standard deviation.

Table 2

Descriptive Statistics for Child Variables and Teacher Ratings

Measure	Mean (SD)	Range
Preschool WJ-Letter Word	94.52 (10.97)	75-133
Preschool WJ-Applied Problems	87.37 (14.53)	24-136
2nd grade WJ-Letter Word	102.52 (16.14)	55-142
2nd grade WJ-Applied Problems	99.20 (16.64)	46-142
2nd grade TRC-Reading	2.72 (1.02)	1-5
2nd grade TRC-Math	2.70 (.94)	1-5

Table 3

Correlations between Predictor and Outcome Variables

	1	2	3	4	5	6	7	8	9	10
1. PC Education										
2. FRL	.296**									
3. Gender	.040	.013								
4. Race	-.056	.172**	.048							
5. WJ-Letter Word (Preschool)	.227**	.159**	.164**	.002						
6. WJ-Applied Problems (Preschool)	.207**	.149**	.159**	.003	.394**					
7. WJ-Letter Word (2nd gr.)	.217**	.234**	.120	.084	.506**	.398**				
8. WJ-Applied Problems (2nd gr.)	.203**	.200**	-.054	-.046	.387**	.534**	.608**			
9. TRC-Reading (2nd gr.)	.072	.037	.032	-.083	.441**	.349**	.684**	.486**		
10. TRC-Math (2nd gr.)	.122	.126	-.063	-.064	.343**	.352**	.471**	.642**	.673**	

** $p<.01$

Table 4

Regression Models with Outcome Variable WJ-Letter Word

Coefficient	*B*	Beta	*T*-Value	*p*-value	R^2 *Change*
Block 1					0.084
PC Education	1.05	0.15	2.23	0.026	
FRL	6.14	0.17	2.53	0.012	
Gender	3.57	0.11	1.69	0.093	
Race	-2.60	-0.07	-1.04	0.302	
Block 2					0.178
WJ-Letter Word	0.65	0.44	7.54	<0.001	
Block 3					0.029
WJ-Applied Problems	0.20	0.18	2.82	0.005	
Interactions					
Gender by WJ-Letter Word	-0.15	-0.01	-0.92	0.357	
Gender by WJ-Applied Problems	0.01	0.00	0.11	0.909	
PC Ed by WJ-Letter Word	0.00	0.00	0.03	0.976	
PC Ed by WJ-Applied Problems	0.02	0.00	0.82	0.411	
FRL by WJ-Letter Word	0.15	0.01	0.87	0.384	
FRL by WJ- Applied Problems	-0.00	-0.00	-0.05	0.957	
WJ-Letter Word by WJ-Applied Problems	-0.00	-0.00	0.38	0.703	

Table 5

Regression Models with Outcome Variable Academic Competence Evaluation – Reading Subscale

Coefficient	*B*	Beta	*T*-Value	*p*-value	R^2 *Change*
Block 1					0.009
PC Education	0.00	0.00	0.05	0.962	
FRL	0.11	0.05	0.65	0.515	
Gender	0.02	0.01	0.11	0.916	
Race	-0.24	-0.10	-1.23	0.221	
Block 2					0.188
WJ-Letter Word	0.04	0.45	6.84	<0.001	
Block 3					0.035
WJ-Applied Problems	0.01	0.20	2.70	0.008	
Interactions					
Gender by WJ-Letter Word	-0.02	-0.16	-1.42	0.156	
Gender by WJ-Applied Problems	0.00	0.00	0.43	0.667	
PC Ed by WJ-Letter Word	0.00	0.00	0.12	0.903	
PC Ed by WJ-Applied Problems	0.00	0.00	0.22	0.824	
FRL by WJ-Letter Word	-0.00	-0.00	-0.23	0.819	
FRL by WJ- Applied Problems	-0.00	-0.00	-0.09	0.927	
WJ-Letter Word by WJ-Applied Problems	0.00	0.00	0.04	0.971	

Table 6

Regression Models with Outcome Variable WJ-Applied Problems

Coefficient	*B*	Beta	*T*-Value	*p*-value	R^2 *Change*
Block 1					0.055
PC Education	1.10	0.15	2.29	0.022	
FRL	4.27	0.12	1.75	0.080	
Gender	-2.56	-0.08	-1.16	0.248	
Race	2.85	0.08	1.10	0.271	
Block 2					0.258
WJ-Applied Problems	0.60	0.53	8.97	<0.001	
Block 3					0.026
WJ-Letter Word	0.27	0.18	3.06	0.002	
Interactions					
Gender by WJ-Letter Word	-0.26	-0.02	-1.62	0.105	
Gender by WJ-Applied Problems	-0.05	-0.00	-0.13	0.900	
PC Ed by WJ-Letter Word	0.01	0.00	0.28	0.777	
PC Ed by WJ-Applied Problems	0.03	0.00	0.97	0.330	
FRL by WJ-Letter Word	-0.05	-0.00	-0.30	0.762	
FRL by WJ- Applied Problems	0.06	0.00	0.40	0.692	
WJ-Letter Word by WJ-Applied Problems	-0.00	-0.00	-0.23	0.817	

Table 7

Regression Models with Outcome Variable Academic Competence Evaluation – Math Subscale

Coefficient	*B*	Beta	*T*-Value	*p*-value	R^2 *Change*
Block 1					0.033
PC Education	0.03	0.07	0.88	0.379	
FRL	0.22	0.10	1.41	0.160	
Gender	-0.15	-0.08	-1.03	0.206	
Race	-0.20	-0.09	-1.10=1	0.270	
Block 2					0.116
WJ-Applied Problems	0.02	0.35	4.95	<0.001	
Block 3					0.049
WJ-Letter Word	0.02	0.24	3.32	0.001	
Interactions					
Gender by WJ-Letter Word	-0.02	-0.02	-2.03	0.043	
Gender by WJ-Applied Problems	-0.00	-0.01	-0.60	0.548	
PC Ed by WJ-Letter Word	-0.00	-0.00	-0.61	0.541	
PC Ed by WJ-Applied Problems	-0.00	-0.00	-0.17	0.862	
FRL by WJ-Letter Word	-0.00	-0.00	-0.02	0.985	
FRL by WJ- Applied Problems	-0.00	-0.00	-0.16	0.872	
WJ-Letter Word by WJ-Applied Problems	-0.00	-0.00	-0.18	0.854	

Table 8

Characteristics of the Three Groups Assessing Change for WJ-Letter Word

Characteristics (Mean (SD) or Percent)	Entire Group (n=210)	Group 1 (Decreased) (n=62)	Group 2 (Increased <1SD) (n=92)	Group 3 (Increased > 1SD) (n=56)	ANOVA p-value
Gender (Male)	46%	42%	49%	41%	.566
Ethnicity					
African American	73%	71%	75%	71%	.851
Received Free/Reduced Lunch	73%	79%	72%	70%	.467
PC Education					.673
Some High School	30.0%	31.1%	32.6%	25%	
GED or High School Diploma	38.5%	44.3%	37.0%	39.3%	
Some College	21.1%	14.8%	18.5%	26.8%	
College Degree or more	10.4%	9.8%	11.9%	8.9%	
Preschool WJ-Letter Word	94.47 (11.8)	99.00 (12.0)	91.76 (11.4)	93.89 (10.7)	.001
Preschool WJ-Applied Problems	86.93 (14.7)	87.58 (15.0)	84.33 (15.0)	90.55 (13.1)	.041
2nd grade WJ-Letter Word	102.52 (16.4)	90.92 (13.0)	99.55 (11.7)	120.23 (10.9)	<.001
2nd grade WJ-Applied Problems	99.20 (16.7)	93.71 (17.2)	96.62 (14.6)	109.50 (14.9)	<.001

Table 9

Characteristics of the Three Groups Assessing Change for WJ-Applied Problems

Characteristics (Mean (SD) or Percent)	Entire Group (n=209)	Group 1 (Decreased) (n=48)	Group 2 (Increased <1SD) (n=80)	Group 3 (Increased > 1SD) (n=81)	ANOVA p-value
Gender (Male)	44%	31%	39%	58%	.005
Ethnicity					
African American	73%	73%	77%	69%	.463
Received Free/Reduced Lunch	74%	75%	75%	72%	.865
PC Education					.817
Some High School	30.0%	31.9%	30.0%	29.6%	
GED or High School Diploma	38.5%	44.7%	41.3%	35.8%	
Some College	21.1%	10.6%	20.0%	24.7%	
College Degree or more	10.4%	12.8%	8.7%	9.9%	
Preschool WJ-Applied Problems	86.93 (14.7)	93.25 (13.5)	87.16 (10.8)	72.95 (17.3)	.788
Preschool WJ-Letter Word	94.48 (11.8)	95.29 (13.6)	93.84(10.9)	94.64 (11.6)	<.001
2nd grade WJ-Applied Problems	99.15 (16.7)	86.29 (13.5)	95.04 (11.34)	110.84 (15.4)	<.001
2nd grade WJ-Letter Word	102.46 (16.4)	95.79 (15.8)	101.44 (16.1)	107.43 (15.5)	<.001

Chapter 4

DISCUSSION

The purpose of this study was to explore how cognitive assessments of school readiness at age 4 predicted academic achievement in elementary school assessed by both standardized tests and teacher reports in an at-risk sample of children who attended an enhanced Head Start preschool program. Specifically, the Letter Word Identification and Applied Problems subscales of the Woodcock Johnson assessed prior to entry in kindergarten were used to predict the same measures in 2nd grade as well as teacher-reports of reading and math abilities after controlling for demographic characteristics. There was considerable stability as children with higher scores on the pre-academic cognitive tests in preschool also scored higher in 2nd grade on both the standardized measures and the teacher reports.

Predictors of Reading Ability

Both preschool pre-reading and pre-math abilities predicted both the teacher reports of 2nd grade reading ability and standardized assessment of reading ability. For both outcomes, the preschool WJ-Letter Word explained a substantial variance; 18% for WJ-Letter Word and 19% for TRC-Reading. After accounting for the effects of pre-reading skills, the preschool score on WJ-Applied Problems predicted about 3% of unique variance to both grade 2 reading outcomes. These results support the previous finding indicating substantial continuity of preschool pre-reading skills to 2nd grade reading abilities (Whitehurst & Lonigan, 1998). The consistent predictive power of preschool pre-math to

both measures of 2nd grade reading ability support the findings of Duncan and colleagues (2007) in a particular population, children from low-income families who participated in a preschool program. The fact that pre-math was predictive of both reading assessments provides evidence that this relation is not merely an artifact of standardized assessments.

Predictors of Math Ability

For 2nd grade math outcomes, the predictive ability of each of the preschool measures on standardized assessments and teacher-reports were slightly different. For the WJ-Applied Problems outcome, 26% of the variance was explained by the preschool score on the WJ-Applied Problems. After accounting for the effects of pre-math skills, the preschool score on WJ-Letter-Word predicted about 3% of unique variance to both grade 2 math outcomes. Thus, while math skills showed somewhat higher stability from preschool to 2nd grade, preschool reading abilities provided about the same amount of unique variance in math outcomes as early math showed for later reading outcomes.

For the teacher reports, preschool pre-math abilities explained 11% of the later variance. Again, WJ-Letter Word contributed unique variance (5%). Therefore, preschool pre-math abilities are better predictors of later standardized measures of math than of teacher reports of math. This finding is not surprising considering the fact that the same measure is being used at both times and therefore is likely to be assessing very similar constructs at both times, while teacher might be reporting on different aspects of math ability.

Growth over time

Children from low-income families display consistent delays compared to their more affluent peers from school entry through elementary school (Brooks-Gunn & Duncan, 1997; McLoyd, 1998b). One of the major goals of enriched preschool programs is to provide children from disadvantaged environments with the tools and opportunities to do well at school. From preschool to 2nd grade, the children who attended this preschool program made substantial standardize score achievement gains in math and reading abilities. At preschool, children scored a full standard deviation below the norm on WJ-Applied Problems with a mean score of 87.37 (*sd* = 14.53). By 2nd grade the group mean had reached the national norm, 99.20 (*sd* = 16.64), indicating a gain of .8 standard deviation over three years. The WJ-Letter Word scores in preschool were than those for WJ-Applied Problems, yet children were still almost half a standard deviation behind the norm with a mean of 94.52 (*sd* = 10.97). By 2nd grade, the sample mean was slightly above the national norm at 102.52 (*sd* = 16.14), illustrating a gain of 8 standardized points (or half a SD) over three years.

The design of the current study limits the ability to infer a causal link between attending the preschool program and experiencing substantial gains in standardized assessments of reading and math. Other reports have compared this sample of children to a cohort of children who attended the same schools, but entered kindergarten the year the preschool program began and thus were too old to participate (Morgan, Rhoades, Domitrovich, & Greenberg, 2009). The findings indicated that children who attended the preschool program had significantly higher scores in early math and receptive vocabulary than children who had not attended the preschool program.

Groupings Based on Change from Preschool to 2nd Grade

To further understand factors influencing differential rates of growth in reading and math, groups were formed based on the rate of change on WJ-Letter Word and WJ-Applied Problems from preschool to 2nd grade. It should be noted that the majority of children had scores that increased from preschool to 2nd grade.

A number of factors were related to the rate of growth in academic abilities. First, for both 2nd grade reading and math outcomes, those children with the highest scores at pre-schools showed the lowest rate of growth or declines in standardized scores. In contrast, children who began with the lowest scores at preschool entrance were those that showed the greatest growth both in math and reading, This effect was particularly strong for math with those who increased the most showing very low scores (X= 73) in preschool. The finding that children who most improve are those that begin with the lowest levels of performance is very promising. It suggests that children most in need showed the greatest benefit of enriched early education, as has been found with the FACES study of Head Start classrooms (FACES, 2006). In contrast, children who began with the highest levels of preschool performance showed little or no change in standardized scores and thus showed less benefit of early enrichment. One question this raises is whether the instructional practices were adequate for children at all levels or whether the program provided was only effective for children at the most basic level. If this was the case, the program would be less likely to create substantial growth in children who began with high verbal and math skills. Regression to the mean is another possible explanation for this finding. For example, students who received particularly high scores may be more likely to regress toward the mean in subsequent testing.

The fact that none of demographic characteristics were associated with the relative rate of change in academic ability can be seen as a promising finding as children living in greater poverty or whose parents had lower educational attainment were just as likely to improve as their non-at-risk, although it is possible that other non-measured demographic characteristics were predictive of later achievement. Gender was significantly associated with group membership for WJ-Applied Problems, with boys more likely to be in the group that improved more than one standard deviation. Arnold and colleagues had a similar finding, although they did not divide the children into groups, they found that overall, boys had more improvement as a result of their intervention than girls (Arnold et al., 2002).

Boys of Color

Another noteworthy finding is the lack of significance of both gender and race as predictors of 2nd grade achievement. There is an extensive literature documenting underachievement among people of color (Ogbu, 1997; Osborne, 1999), and in particular there is evidence that African American boys fail to achieve their full potential. Whether these deficits are a result of a "cool pose" (Major & Billson, 1992) or due to social, psychological and cultural hurdles (Osborne, 1997), boys of color, in particular African American boys who live in urban settings fall behind their peers in academic achievement. Due to the age of the children, it is likely that the social, psychological and cultural hurdles are a more plausible explanation of the deficits experienced by African American males.

This sample is composed predominantly of African Americans in an urban setting, yet neither race nor gender were significant predictors of outcomes at 2nd grade. Moreover, there was a higher percentage of boys in the group whose math abilities

increased by more than one standard deviation. This finding indicates that within this sample, boys of color did not fall behind their peers. It is possible that no racial differences emerged because of the high percentage of African Americans in the sample, accompanied by the fact that most of the children who are not African American are either Hispanic or of mixed race. Future analyses should further explore the performance of these racial subgroups.

Demographics and Teacher Reports

The demographic variables, primary caregiver education and free/reduced lunch status predicted reading and math scores on the WJ; all regression weights had p-values of less than .08. Yet, these demographics were not significant predictors of either teacher report of reading or math. This is a surprising finding as we might expect that teachers' awareness of children's demographic characteristics might influence their perceptions of children. It may be that parent involvement is a key factor in this relation, as parent involvement has been found to be a mediator between demographic characteristics including SES and education level, and children's academic abilities both in preschool (Arnold, Zeljo, Doctoroff, & Ortiz, 2008) and in early elementary school (Jimerson, Egeland, & Teo, 1999). Future research should explore differences between children who attended the preschool and those who did not on parent involvement and its relation with academic outcomes.

Limitations

The current study had several limitations. First, it is important to note that this study focused on how predictive pre-academic, cognitive measures of school readiness were of later cognitive and academic abilities in 2nd grade for a predominantly low-income, urban population. These findings are not necessarily generalizable to other socio-economic groups or to low-income children who did not participate in a preschool program. However, these findings support previous work conducted on a more representative sample, specifically the Early Childhood Longitudinal Study – Kindergarten Cohort and the National Longitudinal Survey of Youth (Duncan et al., 2007). Second, this study employed only limited measures of preschool reading and math abilities, therefore based on these results it is not possible to tease out which aspects of pre-reading or pre-math skills are predictive of elementary achievement.

In conclusion, there was a high level of stability in reading and math scores from preschool to 2nd grade in a sample of at-risk children who participated in a combined Head Start and publicly-funded preschool program. In addition there were some crossover effects, whereby pre-reading predicted later math abilities and pre-math predicted 2nd grade reading abilities. Interestingly, demographic characteristics were only significant predictors of standardized assessments of reading and math, not of teacher reports. When children were grouped into three categories, based on their change scores from preschool to 2nd grade, preschool pre-math and pre-reading abilities predicted which group children were categorized into, with lower preschool scores associated with membership to the groups that experienced the most change.

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