In the Running for Successful Outcomes:

Exploring the evidence for thresholds of school readiness

Technical Report

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In the Running for Successful Outcomes: Exploring the evidence for thresholds of school readiness

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The findings described in this report are the product of the ASPE-funded project entitled *In the Running for Successful Outcomes: Early Education, Care, and Comprehensive Services* (Contract # HHSP23320095631WC).The *In the Running* project examined the evidence for thresholds of school readiness within and across domains (including language, reading, math, attention, socioemotional, and health) which, when attained, predict skill acquisition in later schooling. Research questions included: Are there particular school readiness skills or a level of development that children need to attain in early childhood in order to meet later measures of success? Do outcomes in elementary or later schooling depend on the school readiness skills and competencies in various domains at entry to school? Through secondary data analysis, the project tested the extent to which associations between trajectories of school-age skills can be predicted from school readiness skills (both within and across domains) and whether those associations are linear or nonlinear. It also examined whether identified thresholds replicate across datasets.

The project team, led by Tamara Halle at Child Trends, also included Beth Hair (NORC; co-Principal Investigator), Peg Burchinal (UNC-Chapel Hill; Expert Advisor) and Marty Zaslow (SRCD and Child Trends; Expert Advisor). The Technical Expert Panel was comprised of Linda Espinosa (University of Missouri-Columbia, Retired), Sue Hegland (Iowa State University), Stephanie Jones (Harvard Graduate School of Education), and Katherine Magnuson (University of Wisconsin-Madison). Amy Madigan and Laura Radel were the Project Officers at ASPE for this project. The contents of this report are solely the responsibility of the authors and do not necessarily represent the official views of the Office of the Assistant Secretary for Planning and Evaluation, or the U.S. Department of Health and Human Services.

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Contents

Executive Summary

Background

Children's school readiness has long been of interest to policymakers, educators and early childhood practitioners. Children enter school with a range of academic and social skills, with children from disadvantaged backgrounds (e.g., low-income and/or single parent households) lagging behind their more affluent peers on a range of outcomes(Brooks-Gunn & Duncan, 1997; Lee & Burkham, 2002; Reardon, 2011). This gap in school readiness emerges early, is evident even before kindergarten (Fryer & Levitt, 2004; Halle et al., 2009), and is predictive of academic trajectories through later schooling (Entwisle & Alexander, 1999). Concerns about these disparities in skills have focused state and federal efforts on initiatives to improve young children's school readiness, such as through early care and education programs including Head Start, child care and public pre-kindergarten. These initiatives have also led to a proliferation of state early learning guidelines and kindergarten readiness assessments aimed at articulating and evaluating the set of skills and competencies young children need to prepare them for the increased challenges and demands of kindergarten and to succeed in later schooling (Scott-Little, Lesko, Martella, & Milburn, 2007; Stedron & Berger, 2010). Yet, the evidence base available to identify what these guidelines and standards should look like is quite thin. Despite theoretical reasons to believe that early skills are the foundation for later success, few studies have offered more than a piecemeal view of the relationship between specific school readiness skills and later academic, social and emotional outcomes. Research has not clearly articulated what children should know and be able to do by the time they reach kindergarten in order to participate in and benefit from learning in kindergarten and subsequent grades.

Research Questions and Methods

In 2009, the Office of the Assistant Secretary for Planning and Evaluation (ASPE) of the U.S. Department of Health and Human Services funded Child Trends to conduct a review of the literature as well as plan and execute secondary data analyses to examine whether there is evidence of thresholds of school readiness which, when attained, predict skill acquisition in later schooling. This project, entitled *In the Running for Successful Outcomes: Early Education, Care and Comprehensive Services* , focused on understanding what children need to know and be able to do at the start of school in order to be "in the running" for long-term success. The overarching research questions of interest that motivated this project included:

- Are there particular school readiness skills or a level of development that children need to attain in early childhood in order to meet later measures of success?
- Do outcomes in elementary or later schooling depend on the school readiness skills and competencies in various domains at entry to school?

In order to address these questions the study team analyzed two national datasets and employed various methods. The data sets utilized for the analysis were the National Institute of Child Health and Human Development's Study of Early Child Care and Youth Development (NICHD SECCYD) and the Early Childhood Longitudinal Study – Kindergarten Class of 1998-99 (ECLS-K). These data sets were chosen

because of their nationally representative longitudinal data and the available measures in the domains of interest. While these were the best data sources available for these analyses, the extant measures were not ideal and several subpopulations including children who could not be assessed in English were omitted. Therefore, the results, while informative, should not be interpreted as definitive. Two different approaches were used to characterize school readiness and two different approaches were used to characterize success in school. These are represented in Table 1, and described in more detail below.

Table 1. Analytic approaches for characterizing school readiness skills and school outcomes in the *In the Running* project

Analytic Approach: School Readiness Skills	Representation of "thresholds" of School Readiness Skills in Analyses	Analytic Approach: School-age Outcomes
Person-centered	Latent Profiles	**Longitudinal: Growth curve analysis of academic and behavioral skills**
Variable-centered	Nonlinear (linear and quadratic) of individual school readiness skills Piecewise spline of individual school readiness skills	**Retrospective: Fifth grade status in terms of being "in the running"**

School readiness was examined through two approaches: person-centered and variable-centered. The school readiness skills included in all analyses included measures of language or general knowledge, reading, math, attention, social skills, behavior problems, and health scores at kindergarten entry. These were chosen because each is believed to play an important role in school success (Kagan, Moore, & Bradekamp, 1995; Scott-Little, et al., 2007; Stedron & Berger, 2010).

Latent profile analyses were used for the person-centered approach. Latent profile analysis seeks to identify individual children with similar combinations of skills; individuals with similar combinations of school readiness skills are members of the same "profile." The latent profile analyses began with a determination of the groups or profiles of school readiness in the ECLS-K and NICHD SECCYD datasets. In this step, a statistical analysis allowed the individual children to be sorted into groups that were similar in terms of their combination of school readiness skills. The complex regressions conducted as part of the latent profile analysis for the *In the Running* project found four profiles of children in both the ECLS-K and NICHD SECCYD datasets. In other words, analyses identified four groups of children, with each group representing a different profile of strengths and weaknesses in school readiness skills. This approach tested for thresholds by asking whether the profiles showed different patterns of school-age outcomes. Specifically, latent growth curve analyses were used to look at the longitudinal predictions from the latent profiles to the school-age outcomes. The models included demographic and sampling characteristics and child gender and age as covariates.

For the variable-centered approach, the school readiness variables were entered into the analytic models separately first and together second. The models included demographic and sampling characteristics and child gender and age as covariates. The school readiness skills were examined both individually and simultaneously because they were moderately to highly correlated. Accordingly, analyses that included a single school readiness skill asked whether that entry skill predicted subsequent academic and behavioral skills during the school years, while the analyses that included all school readiness skills allowed for the identification of the strongest predictor of school success across the set of school readiness skills. The threshold question was examined by testing whether there were nonlinear associations using a quadratic model to identify a threshold and by setting a threshold and then asking if associations between school entry skills and subsequent school outcomes was different depending on whether the child was above or below the conceptually-determined threshold.

The school-age outcomes were also analyzed in two different ways. Most analyses involved fitting growth curves to the selected outcomes: reading, math, social skills, and behavior problems. Models allowed for nonlinear change during elementary school through middle school in the ECLS-B and high school in the SECCYD. Specifically, quadratic group growth curves and linear individual curves were estimated for each outcome. The quadratic group model allowed for changes in the magnitude in the rate of change over time. Both latent growth curve and hierarchical linear model analyses were conducted, but the individual growth curves would be estimated in the same manner using the two approaches (Burchinal, Nelson, & Poe, 2006).

In addition, as a follow-up analysis, we examined outcomes in fifth grade to determine whether children seemed to be "in the running" at that point. The process used to determine whether children seemed to be in the running at fifth grade is described below.

Four research questions were developed to look for evidence of developmental thresholds in different ways. Table 2 below introduces the four research questions and the analytic method with which it was paired.

Table 2. Research questions and corresponding analytic approaches for the *In the Running* project

Research Question	Analytic Approach
1. Do children who show qualitatively different patterns of school readiness skills have qualitatively different trajectories of performance on academic and social outcomes during elementary school?	Latent profiles of school readiness variables-Longitudinal latent growth curve analysis of school-age outcomes
2. Are there non-linear associations between school readiness skills and subsequent developmental trajectories for academic and social outcomes	Quadratic analyses of school readiness variables -Longitudinal hierarchical linear modeling of

	during elementary school?	school-age outcomes
3.	Do children who are in the low and normal range in school readiness skills differ in terms of their developmental trajectories for academic and social outcomes during elementary school?	Piecewise analyses of school readiness variables –Longitudinal hierarchical linear modeling of school-age outcomes
4.	Do children who have qualitatively different patterns of school readiness skills differ in their likelihood of success based on our categorization of their fifth grade academic and social skills?	Latent profiles of school readiness variables –Related to fifth grade *status*

Below is a more detailed explanation of the four types of analyses used to address the respective research questions. Following the methodological explanations are a descriptions of the results of each analysis.

Latent Profile Analyses - Longitudinal Analysis of School Outcomes

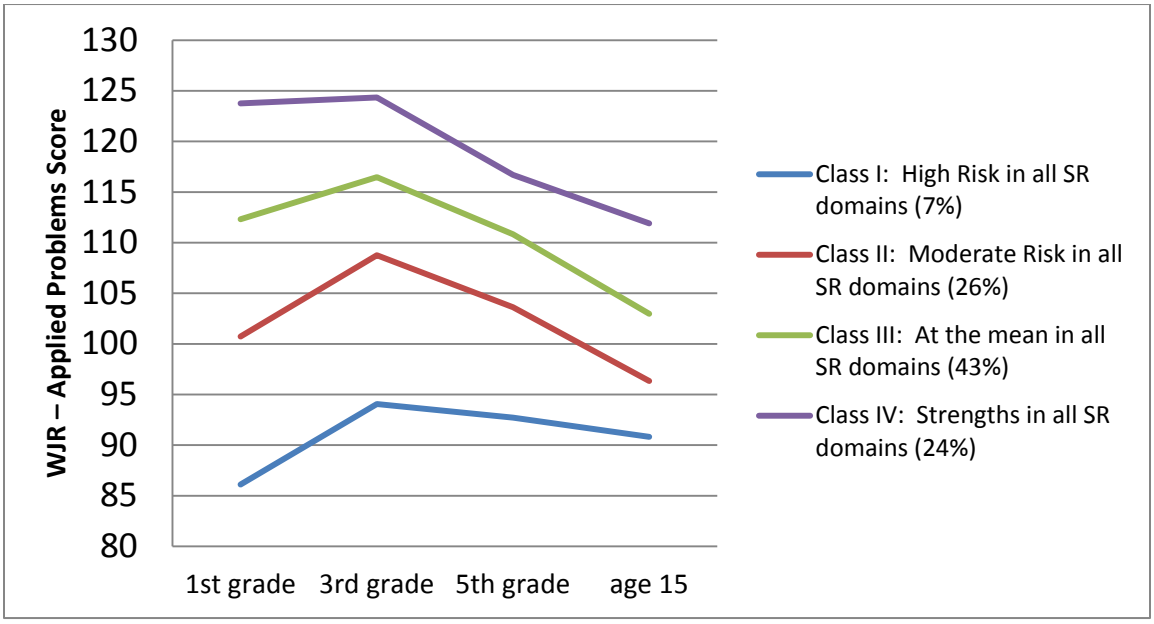
Latent profile analysis and latent growth modeling were used to investigate the first research question – whether children with qualitatively different patterns of school readiness skills have qualitatively different academic and social trajectories in later elementary school. The latent profiles identified four distinct groups of children on their school readiness skills. Subsequent growth curve analyses helped to determine whether individuals with different profiles of readiness at kindergarten entry were similar or different on measures of academic achievement and behavior at spring of kindergarten or in terms of patterns of growth over time (i.e., first grade through middle school).

Using the distinct profile groups of children determined by the latent profile analyses, growth curve analyses were completed to see whether qualitatively different patterns of school readiness predicted to qualitatively different patterns or trajectories of child development over time. Growth curve analysis allowed researchers to look for change (in this case change in child cognitive, social-emotional, and behavioral skills) over time that may not be steadily changing (linear) in pattern. For example, children with a certain profile of skills may have shown very rapid growth in behavioral skills at kindergarten entry and then shown a slowing of their acquisition of these skills in later elementary school; growth curve analysis could show these temporal changes. These analyses allowed for nonlinear change over time in school-age outcomes. We were interested in whether children with different profiles on their school readiness skills would differ in terms of their skills at 15 years of age or in the rates of change over time in their skills.

Overall, results of these analyses indicated that the rank ordering of the profiles from the profile representing the highest levels of skills to the profile representing the lowest level of skills

tended to be maintained over time in children's acquisition of reading and math skills and in teacher ratings of social skills. The rank ordering of the profiles with regard to rate of problem behaviors was in the reverse order, with the profile representing the highest level of skill at kindergarten entry having the lowest ratings of problem behaviors over time. The rates of change over time were slightly higher in the lower profiles. Figure 1 shows the estimated math growth curves in the SECCYD sample for the four latent profiles, illustrating these findings of preservation of relative rank order over time of the latent profiles while showing slightly faster acquisition of math skills in the profile representing the lowest level of skills at kindergarten entry (i.e., Class I).

Figure 1. Developmental trajectories for math from the first grade to age 15 by school readiness profile in NICHD SECCYD



Source: NICHD SECCYD dataset

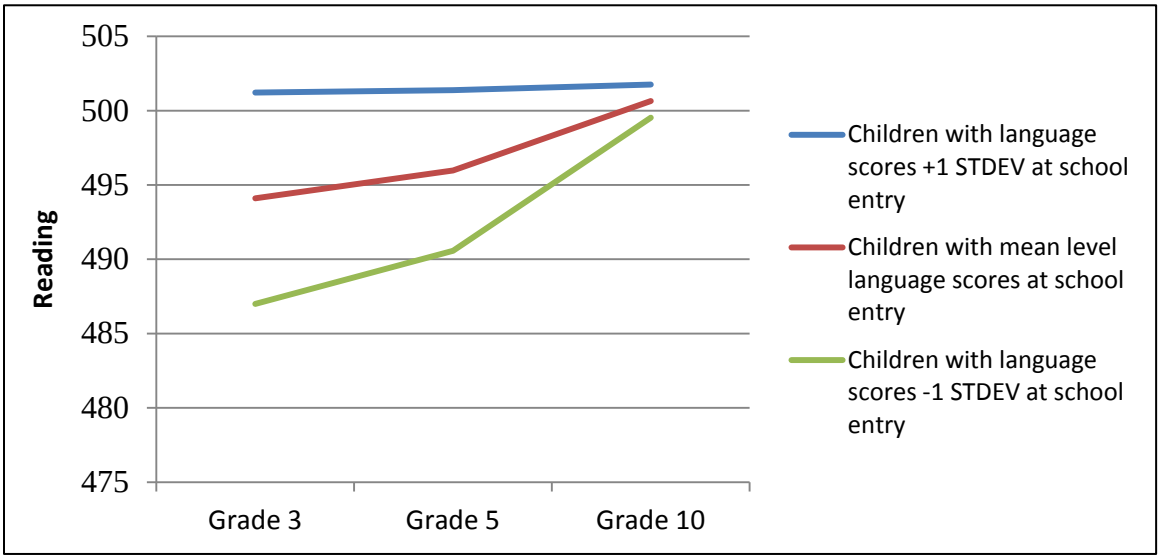
Quadratic Analyses – Longitudinal Analysis of School Outcomes

While the previous set of analyses looked at how school readiness skills grouped together within individuals (a person-centered approach) to predict differential outcomes over time, this set of analyses looked at how school readiness measures, considered singly and together (from a variable-centered approach), predicted later outcomes. In order to examine thresholds, operationalized as any potential non-linear associations between school readiness skills and later social and academic developmental trajectories, school readiness skills – either individually or together – were used as predictors in HLM growth curve analyses of school-aged achievement and behavior. Instead of looking for a linear relationship between school readiness skills and later outcomes (that is, instead of assuming that an incremental increase in a particular skill resulted in the same incremental increase in skills later on), this analysis tested for non-linear relationships between early and later skill development. Using both the school

readiness variable as a linear and quadratic predictor allowed for an estimation of a threshold if the quadratic term was significant.

Overall, these analyses supported the conclusions from the analyses involving the latent profiles. Children who entered school with higher skill levels on language, academic, attention and social skills tended to maintain that advantage over time, but children who entered school with lower skill levels tended to show slightly larger gains over time. Analyses that included all school readiness variables together suggested within-domain prediction was the strongest (e.g., entry skill levels in math were the strongest predictors of later math skills – especially when the same measure was used over time). Aside from within-domain prediction, language and general knowledge tended to provide the best prediction of school-age academic skills while attention tended to provide the best prediction of school-age behavior. No evidence of thresholds emerged that indicated that children who entered with a certain skill level showed more rapid gains during the school years. These findings are illustrated below, showing the predicted regression line for children who entered school with language skills one standard deviation below the mean, at the mean, and one standard deviation above the mean (please note that preschool language skill was entered as a continuous variable so as to plot only three of the possible estimated curves, with the number of curves determined by the number of different language scores in the sample).

Language skills' association with reading skill growth over time



Source: NICHD SECCYD dataset

Piecewise Analyses - Longitudinal Analysis of School Outcomes

The analyses designed to address the third research question involved fitting a piecewise regression model to examine whether and how children's performance at the beginning of kindergarten predicted later outcomes in elementary school in both the NICHD SECCYD and the

ECLS-K data sets. Piecewise analysis allowed school readiness skills to predict school-age trajectories differently for children above and below a specific skill level at entry to school.

Thus, for the piecewise analysis, two groups were created for each school readiness variable:

- Children in the "low range" on a school readiness skill (i.e., those who scored more than one standard deviation below the mean on the school readiness variable), and
- Children in the "normal range" on a school readiness skill (i.e., those who scored at or above one standard deviation below the mean on the school readiness variable).[1]

Performing one standard deviation below the mean was chosen as the cut point differentiating the "normal" and "low" groups as it is a widely accepted marker of being in an at-risk range of performance on a measure (for example, the Achenbach Child Behavior Checklist). The piecewise analyses allowed each school readiness variable to predict the level and rate of change over time in school-age outcomes differently for children in the low group and the normal group. One example of a threshold would involve stronger prediction from readiness skills to either the level or rate of change over time in school-age skills for children in the normal than the low range.

Overall, findings suggested that the prediction from school readiness skills to the overall level of school-age skills was stronger among children in the "normal range" of performance at kindergarten entry, but that prediction from school readiness skills to rates of change overall time in school-age outcomes was stronger among children in the "low range" of performance at kindergarten entry. The same findings regarding which school readiness skills provided the best prediction of each of the school-age outcomes obtained was the same as in these analyses reported above.

Latent Profile Analyses - Regression Analysis of the Fifth Grade Definition of In the Running

In a separate but related set of analyses, "In the Running" was defined as the children's status during fifth grade instead of the children's status at school entry. The rationale here was to see if indicators at this later stage of elementary school performance that are linked to academic and life success (e.g., graduating from high school) had correlates at kindergarten entry. A review of the literature indicated that school-level factors (such as peer interactions, extracurricular activities, small class size, relationships with teachers, parent involvement) and individual-level factors (such as good school attendance, early academic success, and low rates of internalizing and externalizing behaviors) were key predictors of high school completion (Cairns & Cairns, 1994; Dotterer, McHale, & Crouter, 2007; Duchesne, Vitaro, Larose, & Tremblay, 2008; Finn, Gerber, & Boyd-Zaharis, 2005; Jimerson, Egeland, Sroufe, & Carlson, 2000; Kokko, Tremblay, Lacourse, Nagin, & Vitaro, 2006; North Carolina Family Impact Seminar, 2008;

[1] One standard deviation above the mean was used for behavior problems.

Reynolds, Temple, Robertson, & Mann, 2001; Rumberger & Lim, 2008; Temple, Reynolds, & Miedel, 2000; Vitaro, Brendgen, Larose, & Tremblay, 2005).[2]

Regression analysis was employed to examine the prediction of children's performance in fifth grade from their school entry skills. Two methods were used to create the "In the Running" (ITR) indices using data from the fifth grade data wave of the ECLS-K—an "empirical" and a "conceptual" method. As noted above, individual indicators were chosen based on a review of the literature on factors contributing to either staying in school or dropping out of school over time. For each method of creating the ITR index, the research team created continuous and binary versions of the variable. Three sub-domains of being "in the running" (cognitive, social, and engagement) were created by each method. The cognitive indicators of being "in the running" in fifth grade included direct child assessments of reading, math, and science skills, while the social indicators were child self-reports of peer relations and externalizing behavior problem, and the school engagement indicators were child self-reports of interest in school, school reports of total absences for the year, and whether the child was performing below, on or above grade level.

For the "empirical" method, a composite was constructed with principal component factor analysis, which weighted the contributions of individual indicators within the continuous factor. Then, logistic regression analyses used the kindergarten School Readiness profiles and covariates to predict the binary versions of the empirically-derived ITR indices for the full sample. For the "conceptual" method, an *a priori* cutpoint was determined for each individual indicator of being "in the running." Cutpoints were based on the research literature or were placed at 40% of the distribution, similar to what is considered "basic" performance on the National Assessment of Educational Progress (NAEP) exams.

Analyses asked whether the four latent profiles based on school readiness skills differed in terms of being in the running at fifth grade. Again, results suggested that the likelihood of being in the running at fifth grade according to these criteria reflected the average level of skills in each school readiness profile. As in previous analyses, the profile representing the highest levels of skills at kindergarten entry was more likely to be "in the running" at fifth grade than the profiles representing lower levels of skill at kindergarten entry, with the profile representing the lowest level of skills tending to be the least likely to be "in the running" at fifth grade.

Key Findings

This study represents a multi-method approach to examining the evidence for thresholds in the association between children's school readiness and subsequent academic, social and emotional outcomes, both within and across domains. Results across analyses suggested some, albeit limited,

[2] Some of the literature predicts high school dropout rather than high school completion. When this is the case, the reverse statement was used to indicate predictors of high school completion. For example, high levels of aggression and anxiety are positively correlated with high school dropout (Duchesne et al., 2008; Kokko et al., 2006; Vitaro et al., 2005).

support for thresholds of school readiness, but strong associations between school entry skills and later school outcomes.

There was no evidence of thresholds in school readiness skills above which children showed more rapid acquisition of skills during the school years. However, analyses provided some evidence of thresholds related to subsequent acquisition of skills among children who entered school with lower skill levels on the school readiness skills.

- None of the analyses showed any evidence of a "springboard effect" whereby above a threshold of school readiness children showed accelerated growth over time. This conclusion held whether looking at skill levels within individual school readiness domains or when looking at the patterns of skills at school entry across multiple domains.
- All of the longitudinal analyses indicated that children who perform at the lowest levels at kindergarten entry tended to show slightly larger gains over time than other children. These gains reduced the gap in school-age outcomes slightly, but did not result in "catch up" to their peers in absolute levels of performance. The accelerated growth among initially lower-performing children could be considered a threshold effect, albeit a very modest one.

There was evidence that entry skill levels predicted the level of skills during the school years.

- All of the longitudinal analyses indicated that children who entered with stronger school readiness skills tended to maintain their advantage over time, while children who entered with lower school readiness skills tended to maintain their relative disadvantage over time.
- The piecewise analyses suggested that school entry skills were stronger predictors of levels of school-age academic skills and behavior among children who entered school with skills in the "normal" range of performance than among children who entered school with skills in the "low" range of performance.

School readiness variables provided differential prediction of developmental outcomes.

- No single school readiness variable provided the best prediction of all school-age outcomes in any of the analyses.
- All analyses suggested within-domain prediction. For example, entry-level math skills provided the best prediction of subsequent math skills and entry-level social skills provided the best prediction of subsequent social skills.
- Aside from within-domain prediction, content-based skills (e.g., language and general knowledge) were the best predictors of academic skills later in elementary school, whereas social skills and process skills (e.g., approaches to learning and attention) were the best predictors of later behavioral skills.
- There was no compensatory nature between the school readiness domains and their associations with outcomes over time. The HLM and the latent profile analyses did not find evidence that stronger social-emotional skills compensated for weaker cognitive skills or that stronger cognitive skills compensated for weaker social skills.

Summary

Overall, the school readiness skills with which a child enters school do seem to matter in terms of level and rate of acquisition of academic and social skills during elementary school. The analyses presented in this study corroborated findings shown elsewhere: strong school readiness skills were associated with higher performance in later schooling, both for academic and behavioral outcomes, although there was no evidence that they showed faster acquisition of skills during the school years. But, the effects of early skills on later achievement were probabilistic, not deterministic; children with lower school entry skills were likely to show lower achievement later in school, but children with lower levels of entry skills showed slightly larger improvement over time than their peers with higher skills at school entry. Basically, these findings suggest that improving children's school readiness skills will benefit them no matter where they may be on the continuum. **Children do not need to reach the national average for achievement in order to be "in the running" for later school success, but the better a child's skills are when he or she enters school, the better his or her skills are likely to be in elementary school and beyond.**

This study shed new light on the concept of school readiness and its relationship with later outcomes. No one school readiness skill emerged as the strongest predictor of subsequent academic skills and behavior. Instead, not surprisingly, the skill levels within that domain provided good prediction of subsequent skills. Further, the findings indicated that it appears that children who enter school with both strong process skills such as attention and approaches to learning and strong content skills such as language and general knowledge skills are more likely to experience success in terms of both behavior and academic skills during their school years. **The fact that there was differential prediction from entry skills to later skills but no single school readiness skill emerged as the strongest predictor of both academic and behavioral outcomes emphasizes that children need to develop a constellation of school readiness skills in order to have a better chance of being successful in elementary school and beyond**. **Further, the findings may provide additional focus as practitioners, policy makers, and parents make decisions about early education.** The results suggest that a focus on improving content skills is more likely to translate into improved academic skills during the school years and a focus on improving social and process skills is more likely to translate into improved social skills during the school years.

Although there was no evidence that children with lower school-entry skills fully "catch up" to their higher-performing peers during the school years, the data did show some evidence of a reduction in the gap between children who start school with higher and lower skills. This suggests that school itself is likely a critically important intervention for the most at-risk children.

Limitations and Implications for Future Research

The findings of the *In the Running* project present important implications for early childhood research, policy, and practice. In particular, the results suggest that school entry skills are strongly connected to later achievement. However, while there was evidence of differential prediction among school readiness skills, there was no evidence of a specific skill level that young children need to reach in order to succeed

later in school. This importance of school readiness skills but lack of strong evidence for specific school readiness thresholds have significant implications for the goals early care and education programs set for children's growth and development, how State and Federal early childhood initiatives define what it means for children to be "school ready," and how early childhood progress and school readiness are measured. States can use these findings to support continuing efforts to improve children's skills in all domains before school entry and to reassess the appropriateness of their school readiness benchmarks and kindergarten entry assessments.

The *In the Running* project was exploratory and only a first step in looking at this important topic from a systematic, empirical standpoint. All analyses were conducted to describe association, not to estimate causal linkages. More research is needed that explores school readiness levels systematically so that policy and practice decisions can be made on sound research findings. This future research can collect data on more specialized measures of school entry skills, later development, and the measures and benchmarks used by states in their benchmarks or kindergarten entry assessments.

While the *In the Running* project represents a more complex and thorough investigation of school readiness thresholds and trajectories than had previously existed in the literature, the analysis was challenged by measurement issues. Most large-scale national surveys do not use criterion-based measures (i.e., those that measure a child's performance against a fixed or objective scale or benchmark as opposed to measuring their performance in the context of other children) which lend themselves better to cutpoint analyses and which are more similar to the types of measures states and school systems are using currently to assess children's skill levels in kindergarten. Finally, the measurements of the datasets relied heavily on subjective parent and teacher reports of the child's approach to learning and social skills as opposed to direct assessments. These reports tend to be less precise than the achievement, language, and attention assessments, in part because they are subject to respondent bias.

Although the secondary data analysis uncovered only limited evidence of school readiness thresholds needed to achieve later school success, the differential prediction to outcomes over time based on skill level at school entry still suggests important policy and practice implications.

- There was some evidence of a reduction in the gap between children who started school with higher and lower skills, but not strong evidence of "catch up" in terms of absolute level of performance. Schools can and do benefit children who enter kindergarten with low skill levels.
- The evidence suggested that children's later outcomes can be improved by increasing their school readiness skills, regardless of where they are in relation to the national average.
- There are long-term developmental benefits to helping children reach and exceed the "normal range" (i.e., at or above one standard deviation below the mean) at school entry. All children can grow and benefit from early care and education programs. The goal of these programs should be maximizing child growth before school entry rather than achieving specific skill thresholds.

Conclusion

The multiple analytic strategies employed as part of the *In the Running* project were primarily exploratory in nature and involved person-centered and variable-centered approaches to describing school readiness skills and longitudinal and retrospective analyses of school-age outcomes. Regardless of the analytic strategy, a single story emerged with a relatively similar pattern of results across two different datasets. Findings indicated that the level of skill with which children entered school did indeed seem to matter for later outcomes. Children's school readiness skills predicted levels of academic skills and behavioral skills during the school years, with stronger prediction of subsequent *level* among children in the "normal" range of performance at school entry and stronger prediction of *rates* of change among children in the "low" range of performance at school entry. For those who were lower in skill level at the beginning of school, entry skill levels were stronger predictors of growth compared to their higher-performing peers. Collectively, these findings indicate that efforts to support children's school readiness skills prior to school entry are critically important, and that school itself may be an important intervention for those children most at risk of poor outcomes.

The lack of strong evidence for a clear "threshold" for school readiness either within or across domains of development at kindergarten entry or that a single school readiness variable is especially important for subsequent academic achievement and behavior may have been due to limitations of the data sources used in this study. But researchers, practitioners and policymakers should be open to the possibility that there is no specific measure or score on an assessment that will identify which children at kindergarten entry are or are not "in the running" for future success. More studies, perhaps using well-designed criterion-based measures and causal analytic methods, can further explore this timely and policy-relevant question. However, it should be kept in mind that while criterion-based skill measures are critically important to identifying and tracking a child's development, they should not be used to create artificial thresholds of achievement.

I. Introduction

A. Background and Purpose

Children's school readiness has long been of interest to policymakers, educators and early childhood practitioners (Meisels, 1999). Children enter school with a range of academic and social skills, with children from disadvantaged backgrounds (e.g., low-income and/or single parent households) lagging behind their more affluent peers on a range of outcomes (Brooks-Gunn & Duncan, 1997; Lee & Burkham, 2002). This gap in school readiness emerges early, is evident even before kindergarten (Fryer & Levitt, 2004; Halle et al., 2009), and is predictive of academic trajectories through later schooling (Entwisle & Alexander, 1999). Concerns about these disparities in skills have focused state and federal efforts on initiatives to improve young children's school readiness, such as through early care and education programs including Head Start, child care and public pre-kindergarten. These initiatives have also led to a proliferation of state early learning guidelines and kindergarten readiness assessments aimed at articulating and evaluating the set of skills and competencies young children need to prepare them for the increased challenges and demands of kindergarten and to succeed in later schooling (Scott-Little et al., 2007; Stedron & Berger, 2010). Yet the evidence base available to identify what these guidelines and standards should look like is quite thin. Despite theoretical reasons to believe that early skills are the foundation for later success, few studies have offered more than a piecemeal view of the relationship between specific school readiness skills and later academic, social and emotional outcomes. Research has not clearly articulated what children should know and be able to do by the time they reach kindergarten in order to participate in and benefit from learning in kindergarten and subsequent grades. And, despite state early learning guidelines and state school readiness assessments, there is a relative lack of empirical data to support the criteria for school readiness used within state systems, which affects schools' ability to assess children's skills and growth in a meaningful way. Although this report is not intended as a validation exercise for the state early learning guidelines, these policy issues highlight the value of this research.

The *In the Running for Successful Outcomes: Early Education, Care and Comprehensive Services* project aimed to determine if there are certain levels of competency on specific school readiness skills that children need to attain by the start of kindergarten that enable them to fully benefit from subsequent learning opportunities in elementary school and beyond. The project included a look at the relationship between young children's school readiness outcomes and later success (including children's developmental trajectories in later schooling), especially for disadvantaged children. A particular focus was on exploring whether there are thresholds of school readiness within and across school readiness domains that children need to attain in early childhood in order to meet later measures of success.

The overarching questions of interest that motivated and guided the *In the Running* project included:

- Are there particular school readiness skills or a level of development that children need to attain in early childhood in order to meet later measures of success?

- Do outcomes in elementary or later schooling depend on the school readiness skills and competencies in various domains at entry to school?

To address these questions, literature was reviewed for evidence that studies have identified a particular level of performance for determining competency in specific school readiness skills or combinations of skills, or have looked at how children have performed later in schooling and then identified retrospectively what characteristics distinguished these children early on in schooling. Subsequent analyses operationalized later school outcomes by looking at both levels of specific skills or domains later in schooling and at rate of change or acquisition of skills during the elementary school years.

In order to examine these policy-relevant questions around evidence for thresholds of school readiness and trends in children's development, the *In the Running* project used several alternative analytic methods. To form a comprehensive conceptualization of achievement, level of skill was defined in two ways: as individual skills (a variable-centered approach using means/standard deviation) or as clusters or profiles of skills within individuals (a person-centered approach). Both individual skills and clusters of skills can predict to level of skill later in development within or across domains, or the rate of change in skills within or across domains over time. Furthermore, this variety of methods allowed for the identification of potential thresholds on school readiness tasks that predicted later skill acquisition differently depending on whether children entered school above or below that threshold.

Children At-risk for Academic Challenges

While not a central focus of the *In the Running* project, interest in school readiness for policymakers and practitioners has been spurred by the fact that children with certain socioeconomic and demographic characteristics tend to be less "ready" for school upon kindergarten entry, and these gaps in school readiness compared with their peers may negatively affect children's academic trajectories through later schooling (Entwisle & Alexander, 1999). For example, children's socioeconomic status has been linked to a variety of long-term educational, social and socioeconomic outcomes (Natriello, McDill, & Pallas, 1990). Poor children are more likely than their more affluent peers to start school with lower scores on language and math assessments, score lower on achievement tests, to fail courses, and to be held back in school (McLoyd, 1998). Low birth weight status of children (Hill, Brooks-Gunn, & Waldfogel, 2003), family immigration history (Han, 2006), low parental educational attainment (Reynolds & Temple, 1998), poor neighborhood quality (Borman & Overman, 2004; Rathbun, West, & Hausken, 2003), dysfunctional parenting practices, single-parenting, and low quality home environments (Barbarin et al., 2006) have all been associated with risk for poor school readiness and/or long-term outcomes and play an important role in the relationship between socioeconomic status and children's development. Even among children from the same low-socioeconomic backgrounds or with similar socio-demographic risks (e.g., children in single parent families), research indicates that African American and Latino students are at risk for academic and social challenges at the start of and throughout later schooling compared to their white peers (Borman & Overman, 2004). And, despite the potential benefits of being bilingual, including earlier development of executive function abilities and attention control, (Bialystok, 2001; L.

M. Espinosa, 2006; Oller & Jarmulowicz, 2007), children who are learning English as a second language often lag behind their native English-speaking peers in measures of cognitive and language proficiency and are at greater risk for reading difficulties in elementary school, high school dropout, and low college attendance (Committee on the Prevention of Reading Difficulties in Young Children, 1998; Espinosa, 2006; Fitzgerald, 1993; Snow, Burns, & Griffin, 1998). Finally, research indicates that having multiple risk factors across the various socioeconomic and demographic variables discussed above is associated with a greater number of, and more serious, negative outcomes than having any one alone (Gutman, Sameroff, & Cole, 2003; Halle et al., 2009).

However, there is a robust literature to suggest that high-quality and comprehensive interventions starting in infancy and continuing to school entry can produce positive gains for disadvantaged children through school entry. The quality of care as well as the type and extent of early care and education have often been cited as important factors contributing to academic and social-emotional school readiness for low-income children (Belsky et al., 2007; Committee on Family and Work Policies, 2003; Lamb, 1998; McCartney, Dearing, Taylor, & Bub, 2007; National Institute of Child Health and Human Development Early Child Care Research Network, 2000, 2003; Peisner-Feinberg & Burchinal, 1997; Votruba-Drzal, Coley, & Chase-Lansdale, 2004). An in-depth exploration of the particular features of quality associated with child outcomes, and whether children begin to benefit only or more strongly when quality is above certain levels or when it is experienced over particular periods of time was conducted in a complementary project called the *Quality, Dosage, Thresholds, and Features* (Q-DOT) project, sponsored by the Office of Planning, Research, and Evaluation within HHS's Administration for Children and Families, providing a valuable start for future research.[3] The *In the Running* project aimed to contribute to this work on early care and education by examining evidence for thresholds of school readiness that may be able to inform the goals that programs set for children's growth and development.

B. Defining "School Readiness" and Being "In the Running"

A review of the existing research literature, summarized below, allowed for synthesis of the field's definitions of school readiness as well as to recap the evidence of associations around reaching certain levels of school readiness (i.e., thresholds) as they relate to later developmental outcomes within and across school readiness domains over time. In addition, this literature guided the research team's understanding of where unique patterns of association among school readiness dimensions emerge for specific subgroups of the population and how thresholds of readiness are operationalized and measured in the recent school readiness literature. The literature review was used to develop a conceptualization of what it means to be "in the running" for later school success and to inform what variables should be considered for the *In the Running* project analyses.

[3] For more information on the Q-DOT project, please see Zaslow, M., Anderson, R., Redd, Z., Wessel, J. Tarullo, L., & Burchinal, M. (2010). *Quality dosage, thresholds, and features in early childhood settings: A review of the literature*. Washington, DC: Office of Planning, Research, and Evaluation.

One way of thinking about school readiness is from a maturational perspective: children are ready for school in the United States when they reach age five. Indeed, many school districts have birthday cut-offs for kindergarten entry that can be taken as a type of "threshold" for school readiness. However, from a different perspective, readiness for school implies the mastery of certain basic skills or abilities that, in turn, permit a child to function successfully in a school setting, both academically and socially. The National Education Goals Panel succinctly articulated the five developmental dimensions associated with early development and learning: physical well-being and motor development, social-emotional development, approaches to learning, language development, and cognitive and general knowledge (Kagan, Moore, & Bradekamp, 1995). Consensus in the field has supported the argument that school readiness is multidimensional and is represented by these five dimensions. Research since the National Education Goals Panel has extended the understanding of each dimension and of the foundations for school readiness.

Dimensions of Being "In the Running"

Although research posits that school readiness is multidimensional, experts additionally assert that school readiness is not only dependent upon the skills and characteristics that children bring to the learning experience, but also dependent upon the contexts in which learning occurs – contexts which include the home and school environments as well as the larger community. Literature was reviewed to examine each of the five dimensions identified by the National Education Goals Panel as essential to children's early learning and development, including an identification of constructs within each school readiness dimension that may be important to operationalize in terms of thresholds. Also examined was executive function as a component of the approaches to learning school readiness dimension; executive function has been conceptualized as both a foundation for school readiness and also a component of it.

Domains of School Readiness

Physical Well-being and Motor Development

The first dimension is *physical well-being and motor development* which encompass such characteristics as rate of growth, physical fitness, chronic conditions such as diabetes, disabilities, nutrition, motor skills, and self-care abilities. The achievement of early milestones in motor development (e.g., crawling, sitting, walking) permit children to fully explore and function in their environments, and fine motor skills are necessary to perform tasks particularly relevant to a school environment (e.g., holding a crayon or pencil, using scissors, etc.). Physical well-being and motor development encompass such characteristics as overall physical health and fitness, nutrition, fine and gross motor skills, self-care abilities and management of health conditions. Gross motor development (e.g., large muscle control for a range of physical activities including movement and coordination) permits children to fully explore and function in their environments, thereby supporting the cognitive and social development of young children. In addition, fine motor skills (i.e., small muscle control) are necessary to perform tasks particularly relevant to a school environment such as manipulating objects or tools for writing, drawing and reading (Kagan et al., 1995; Piek et al., 2004).

Adequate nutrition and adequate sleep are essential to optimal functioning in school. For example, a child who arrives at school hungry or overtired may not be able to concentrate and therefore may not benefit fully from learning opportunities. In response to recent public health concerns about the growing rate of childhood obesity (Estabrooks, Fisher, & Hayman, 2008; Hedley et al., 2004), a renewed emphasis has been placed on children eating a reasonable diet and getting regular opportunities for physical activity in order to maintain a healthy body weight. Physical fitness can help boost children's self-esteem as well (Schmalz, Deane, Birch, & Davison, 2007). Furthermore, dental health is important, as pain from dental caries can also severely distract a child's attention from learning or result in more restricted activity (Centers for Disease Control, 2004).

Children with physical disabilities and genetic health conditions can be fully school ready with the proper supports. Chronic conditions, such as ear infections or asthma, can lead to impairments in both cognitive and social development, particularly if left untreated (Gortmaker, Walker, Weitzman, & Sobol, 1990). Additionally, other characteristics like being low birth weight could be a moderator or mediator of school readiness. Therefore an important component of the Physical Wellbeing domain of school readiness is prevention of communicable or preventable disease and management of chronic health conditions.

Language Development

The second dimension, *language development*, is defined by the National Education Goals Panel as understanding spoken language, using spoken language to accomplish tasks, developing a broad vocabulary, developing an interest in books and stories, understanding the purpose of print, understanding that stories follow a standard sequence, recognizing the letters and sounds of a language, and beginning writing skills (Kagan et al., 1995). This definition incorporates components of both language development and early literacy development. The acquisition of language is distinct from early literacy development (i.e., behaviors that lead to conventional reading and writing), but both share a common purpose of communicating meaning and are highly inter-related (Snow, 2006).

The use of language requires multiple capabilities: the ability to distinguish among the sounds of a language, the ability to combine those sounds into meaningful units or words, the ability to understand the meaning of those words, and the ability to combine words into meaningful sentences. Collectively, the ability to use the language system to communicate is called communicative competence (Hoff, 2006). Even before children are able to use words and phrases they are still able to communicate with others through vocalizations such as crying, cooing, and laughing. They also use non-verbal communication, such as smiling. Intentional communication emerges around 10 months of age and can be demonstrated by the child intentionally seeking to engage another person in joint attention to an activity, for example by gazing at the other person while pointing to an object (Carpenter, Nagell, & Tomasello, 1998).

Children's ability to understand language (i.e., receptive vocabulary) precedes their ability to use it themselves (i.e., expressive vocabulary). Children may be able to understand their first word by five months of age, and to use their first word between 10 and 15 months of age (Fenson et al., 1994). The rate of vocabulary growth varies considerably among children (Hoff, 2006). Language development is critical to children's school readiness and their ability to learn and participate in school (Pungello, Iruka, Dotterer, Mills-Koonce, & Reznick, 2009). Language is foundational to early literacy and provides opportunities and capabilities for learning through interactions with teachers and peers (National Association for the Education of Young Children, 2009).

Just as language development involves multiple skills and capabilities, so too does early literacy development. "There is general consensus that early emerging literacy-relevant skills include the capacity to recite the alphabet, to name and print letters, to spell simple words including one's own name, to recognize letters and signs in the environment, to identify books by their titles, and to handle books and other literacy artifacts appropriately" (Snow, 2006, p. 279). Another feature associated with the development of conventional reading and writing includes phonemic awareness. Phonemic awareness is the ability to distinguish the different sounds that make up words; it is considered one of the critical early literacy skills that supports later literacy outcomes (National Research Council, 1998). Because reading and writing are the foundation for virtually all academic endeavors in formal schooling, literacy skills are considered one of the most important school readiness skills.

Cognition and General Knowledge

The third dimension identified by the National Education Goals Panel is *cognition and general knowledge*, which encompasses knowledge of the properties of objects (such as color and weight); an understanding of the relationships between objects, events, or people (such as being able to determine how two objects are different); and the acquisition of the conventions of society or school-learned knowledge (such as knowing one's address, or being able to count by rote) (Kagan et al., 1995). Children's understanding of the properties of objects and the relations among them is part of concept development (Gelman, 2006; Hirschfeld & Gelman, 1994). Concept development is influenced by children's experiences in the world, and also by linguistic input (e.g., naming of objects or actions). When children encounter a novel experience or object, they will likely try to make sense of it by applying previous knowledge to the current situation. Creative problem solving and the use of reasoning skills (both inductive and deductive) are important cognitive competencies (Goswami, 2010). Knowledge of social conventions and "scripts" can help children understand and navigate new experiences (Schank & Abelson, 1977).

A particular aspect of early cognitive development that has a strong relationship with later academic achievement is children's mathematical knowledge. Everyday mathematical knowledge encompasses knowledge about number, shape, pattern, measurement, and space

(Ginsburg, Cannon, Eisenband, & Pappas, 2006). As with other developmental domains reviewed thus far, the development of mathematical knowledge is evident quite early in infancy (Wynn, 1992), which leads some researchers to conclude that there are in-born mental structures that support the development of these abilities (Gelman, 2000). Still, ordinary observation and exploration of the environment is necessary in order to fully understand a concept such as space, which requires specifying a spatial location as well as a spatial representation of one or more objects. As with other developmental areas, there are individual differences in the extent and speed with which children acquire early mathematics concepts. In addition, some mathematics concepts are easier for young children to learn than others, and some are more closely related to later achievement than others. For example, children understand the concept of "more" (which is related to the concept of number) at an early age, but have much more difficulty with the concepts of distance and perspective (which are related to the concept of space) (Ginsburg et al., 2006). Together, cognitive and math skills support children's school readiness and later school success by helping them to problem solve, integrate new information, and make use of their school experiences for intellectual development (Fuchs et al., 2010; Romano, Babchishin, Pagani, & Kohen, 2010).

Social-Emotional Development

The fourth dimension, *social-emotional development,* is considered by the National Education Goals Panel as a single dimension within their conceptualization of early learning and development. Social competence includes the ability to interact effectively with family, friends, teachers and peers and to develop positive relationships with these social partners (Rubin, Bukowski, & Parker, 1998). Emotional competence includes the ability to identify emotions in oneself and others, to express feelings appropriately (including adjusting or controlling one's emotional expression in certain cases), and to be sensitive to others' feelings (Saarni, 1990). The development of social competence is distinct from the development of emotional competence, yet these two aspects of development are closely intertwined (Damon & Eisenberg, 1998; Fabes, Gaertner, & Popp, 2006; Thompson & Lagattuta, 2006). For example, understanding of emotions can facilitate the development of social competence (Denham, 1986; Denham, McKinley, Couchoud, & Holt, 1990; Eisenberg & Fabes, 1998) and positive, supportive interactions with parents and caregivers can facilitate the development of emotion regulation and general emotional well-being in young children (Cassidy, 1994). Conversely, heightened emotional arousal may interfere with the ability to process social cues (Fabes et al., 2006). This interaction led the National Education Goals Panel to consider social-emotional development as a single dimension within their conceptualization of early learning and development.

The early childhood years are the time during which children are first exposed to a broader social context outside of the family, and play with peers is a key context for the development and refinement of social-emotional competencies. It is thought that children possess certain social dispositions which influence the types of interactions they have with others. However, the relationship is reciprocal, such that the social interactions that children experience influence the

social-emotional characteristics that get strengthened, refined, and retained over time (Fabes et al., 2006). Social-emotional competency is important for success in classroom settings. Behavioral regulation, while actually a component of executive function (see later section on executive function for further detail), has also been posited as an important moderator of social competence (Eisenberg & Fabes, 1998).Specifically, the ability to regulate one's emotions and behavior supports a child's ability to pay attention, follow directions, and cooperate and collaborate with peers and teachers on joint activities (Thompson & Lagattuta, 2006). In fact, parents and teachers often agree that the most important school readiness skills children can have as they enter kindergarten are social interaction skills such as listening, following directions, communicating verbally about needs/thoughts, taking turns and sharing, complying with teacher authority, not being disruptive, and being sensitive to others (Kim, Murdock, & Choi, 2005; Knudsen-Lindauer & Harris, 1989; Lin, Lawrence, & Gorrell, 2003; O'Donnell, 2008; Piotrkowski, Botsko, & Matthews, 2000; Wesley & Buysse, 2003). If children are lacking in the social skills to support these executive function tasks, they are often viewed as being "immature" and are more likely to be held back from kindergarten entry by parents even if they are age eligible (Diamond, Reagan, & Bandyk, 2000).

Approaches to Learning

The fifth dimension, a*pproaches to learning*, which encompasses executive function, is described by The National Education Goals Panel as "the least understood, the least researched, and perhaps the most important dimension" of school readiness (Kagan et al., 1995, p. 22) but includes many elements of behavior and attention that are critical to a child's ability to learn. Now, 15 years later, approaches to learning has been the focus of much more research. Approaches to learning refers to the "behaviors, tendencies, or typical patterns that children use in learning situations" (Hyson, 2008, p. 10). Approaches to learning includes many elements; among them are: intrinsic motivation to learn, interest and joy in learning, engagement, persistence, planning, ability to focus and control attention, flexible problem solving, inventiveness, and tolerance for frustration (Hyson, 2008).

Research indicates that children begin to demonstrate distinct approaches to learning at early ages, and that these patterns of behavior reflect individual differences (for instance, children show different levels of tolerance for frustration at early ages). Because these dispositions and learning-related skills and behaviors emerge so early, some researchers have proposed that approaches to learning are innate; some call them "cognitive styles" (Rider, 1997). A study by McClelland and Morrison (2003) suggested that a clear construct of learning-related skills comprised of mastery behaviors, assertion, self-control, and cooperation could be identified in children as young as three or four years of age and that these skill levels remained stable over the following year. However, other research indicates that positive approaches to learning can be taught or changed over time. In fact, some researchers have identified specific strategies within early care and education environments that can either support positive approaches toward learning or inhibit such behaviors (Bodrova & Leong, 2007).

Approaches to learning has both emotional and behavioral aspects; some components of approaches to learning include cognitive functioning and specifically executive functioning (see section below). Hyson (2008) divided the multiple elements of approaches to learning into an emotion/motivation component ("enthusiasm for learning") and an action/behavior component ("engagement in learning"). Included in the motivational component are elements such as interest, pleasure, and motivation to learn. Interest and pleasure are basic emotional states that serve as strong motivators to stay engaged in activities. Curiosity and a drive for mastery of new and challenging tasks are evident even in infancy, and serve as the basis for the motivation to learn. Included in the action component are attention, persistence, flexibility, and self-regulation (Hyson, 2008). Attention is a critical component of approaches to learning as well as to the separate but related domains of cognitive development and executive function (see below). In order to be engaged in learning, children need to focus on and pay attention to the learning experience. Task orientation is a related concept (Ames, 1992). In addition, the ability to persist in a task that is challenging is an important element of school readiness. A child's ability to withstand frustration with a new or challenging task is central to the ability to be persistent in such tasks (Fantuzzo, Perry, & McDermott, 2004). When problems are encountered with a task, the ability to be flexible in one's problem solving is critical to avoiding getting "stuck" or giving up. Finally, the ability to regulate one's own emotions and behaviors is known as self-regulation. Infants have a rudimentary ability to self-regulate, and this skill develops over time. However, children often need support from adults (e.g., parents, caregivers, and teachers) in order to master self-regulation. As such, positive approaches to learning can be supported by strategies put in place in the home and in early care and education environments.

Executive Function

Finally, while not one of The National Education Goals Panel's domains of schools readiness, executive function is examined in the context of its contributions to the development of school readiness skills in the approaches to learning dimension. Due to its complex nature and importance in school readiness, executive function is further explained here. Executive functions involves reasoning skills and the development of adaptive approaches to learning and social-emotional skills (Bierman, Torres, Domitrovich, Welsh, & Gest, 2008). These skills transfer directly to the development of attention, working memory, and inhibitory control (Barkley, 1994), which are vital to a child's filtering of information in the classroom.

Executive function is an important type of cognitive functioning seen as foundational for early school success. While it is not a standalone domain of school readiness identified by the National Education Goals Panel, executive function skills manifest themselves across several domains and have important implications for children's school readiness and later outcomes. Here, we briefly review research on executive function and its connection to school readiness.

Executive function is defined as the "processes required for the conscious control of thought and action" (Happaney, Zelazo, & Stuss, 2004, p. 1). It involves fluid cognitive reasoning skills and plays an important role in supporting the adaptive approaches to learning and social-emotional competencies acquired by preschoolers skills (Bierman et al., 2008).

Three components of executive function that research shows to be connected to school success are attention, working memory, and inhibitory control. Attention involves focusing on important aspects of a situation, ignoring distractions, filtering information that is irrelevant, and switching focus from one thing to another (Barkley, 1994). In a busy classroom, attention helps determine what children notice and learn. Children who have trouble identifying important information or ignoring distractions have difficulties in complex classroom settings (McClelland, Cameron, Wanless, & Murray, 2007). For example, in one study, children were required to ignore an entertaining game while focusing their attention on a computer task. Low-income kindergartners showed poorer attention compared to their more affluent peers, and lower attention predicted lower achievement skills in the socioeconomically disadvantaged group (Howse, Lange, Farran, & Boyles, 2003).

Young children need working memory to select and hold significant information as they participate in work or activities in the classroom. This cognitive skill is crucial for children to understand, process, and act upon the multitude of information they receive from their surroundings (McClelland et al., 2007). Working memory may help children acquire academic knowledge by enabling them to hold more information for a longer period of time, engage in mental rehearsal, and consolidate information into long-term memory (Bull & Scerif, 2001). Indeed, Bull and Scerif (2001) found that good working memory was associated with high mathematical ability in children who are 6 to 8 years old and Adams, Bourke, and Willis (1999) found that working memory predicted language comprehension skills in 4- and 5-year-olds.

Inhibitory control involves the capacity to interrupt a dominant or habitual response and perform an alternative, more adaptive learned response associated with goal attainment. Miyake, Friedman, Emerson, Witzki, and Howerter (2000) suggest that inhibitory control plays a central role in self-regulation by creating a delay in responding that enables flexibility and allows for strategic selection of alternative behaviors. In the classroom, inhibitory control helps children remember to clean up materials before starting another project, raise their hand before talking, and wait their turn before participating during group activities. Blair and Razza (2007) found that inhibitory control was positively associated with mathematics ability and with the letter knowledge aspect of emerging literacy. Similarly, in a study by Espy, McDiarmid, Cwik, Stalets, Hamby and Senn (2004), both inhibitory control and, to a lesser extent, working memory contributed to mathematic performance in preschool children. Several researchers have argued that inhibitory control is the central feature of the development of executive function in early childhood (Diamond, 2002; Kirkham, Cruess, & Diamond, 2003).

The *In the Running* project employed measures of these dimensions of school readiness to predict later successful outcomes. High school completion was determined to be one outcome of interest through a review of the literature, and one that is influenced by a wide variety of individual, family, and school-level variables throughout childhood and adolescence. The literature review assessed the research on early childhood, middle school, and institutional predictors of high school completion at the individual, family, and school-level.

Early Childhood Predictors of High School Completion

Dropping out of high school is an especially important outcome for the *In the Running* study as it appears to be a gradual process that begins throughout elementary school, even before adolescents reach high school (Peters et al., 2010, p. 53). There is an ample amount of literature that supports the relationship between early childhood, elementary school, and middle school success and high school completion. In the early childhood and elementary school literature, the predictors of high school completion are evident at the individual, family, and school level, whereas in the middle school literature, the three levels (individual, family, and school) are grouped into two categories: individual predictors and broader or institutional influences (e.g., family, school, and community-level).

Individual-level predictors

At the individual level, the literature seems to suggest that some behaviors predict to high school dropout. Jimerson, Egeland, Sroufe, and Carlson (2000) utilized data from a 19-year longitudinal study of at-risk children. The researchers' findings suggested that problem behaviors at first grade were predictors of high school dropout (Jimerson et al., 2000). Participants from the Montreal Longitudinal and Experimental Study consisted of males ages six to twelve (n=1,025), and the study found that physical aggression was positively correlated with high school dropout (Kokko, Tremblay, Lacourse, Nagin, & Vitaro, 2006). In another international study, Brazilian males from third and fourth grades (n=44) who had been diagnosed with conduct disorders were more likely to drop out of high school when compared to their peers without conduct disorders (Tramontina et al., 2001). Vitaro, Brendgen, Larose, and Tremblay (2005) studied kindergarteners (n=4,330) with hyperactivity-inattention and aggressiveness-opposition. The researchers found that hyperactivity-inattention was a stronger predictor of high school dropout than aggressiveness-opposition (Vitaro et al., 2005). In another study with kindergartners, Duchesne, Vitaro, Larose, and Tremblay (2008) suggested that high levels of anxiety during kindergarten through sixth grade were positively correlated with high school dropout.

Early academic success has also been correlated with high school completion. Jimerson et al. (2000) found that academic achievement in the elementary grades and through adolescence were predictors of high school completion. One study that examined children in the Project STAR program in Tennessee (n=4,948) found that math and reading achievement in kindergarten through third grade were positively correlated with high school completion (Finn, Gerber, & Boyd-Zaharis, 2005).

Family-level predictors

Researchers have also examined how parental involvement early in the child's education can influence high school completion. In addition to academic behavioral indicators at the child-level, Jimerson et al. (2000) found that the quality of early maternal care giving at 12 and 40 months were predictors of high school dropout. In another study that used data from the Chicago Longitudinal Study, the researchers looked at parental involvement in elementary school and found that teacher ratings of parental involvement in first through sixth grade were positively correlated with a higher grade completed (Barnard, 2004).

School-level predictors

Various school-based interventional programs focusing on the provision of preschool, kindergarten, and family services have been linked to high school completion. Low-income, urban children who participated in a federal center-based pre-school and school-based intervention program in Chicago (the Title 1 Chicago Child-Parent Center and Expansion Program) that provided half-day preschool and half- or full-day kindergarten along with family and health services had higher rates of high school completion (Reynolds, Temple, Robertson, & Mann, 2001). The program, which provided preschool and kindergarten featuring low child-to-teacher ratios, language-based instructional activities focusing on reading readiness, and a multifaceted parent program with family support from preschool through third grade, reduced a child's rate of dropping out by twenty-four percent (Temple, Reynolds, & Miedel, 2000). Participation in the program for five to six years reduced the rate of dropping out by twenty-seven percent (Temple et al., 2000). Project STAR, a Tennessee based study that looked at class size, found that participation in small class sizes in kindergarten through third grade was positively correlated with high school graduation (Finn et al., 2005).

Middle School Predictors of High School Completion

High school completion was identified in the literature reviewed as an important marker of school success, and one which could be predicted from outcomes in elementary and middle school. Middle school predictors of high school completion can be broken down into the two categories: individual and societal/institutional (family, school, and community). Even though the literature seemed to suggest a relationship between early childhood and middle school academic and social success and high school completion, Gleason and Dynarski (2002) argued that past studies have not examined the predictive validity of factors whose correlations with dropping out have been established. In addition, the authors also suggested that risk factors that may be associated with dropping out were actually weak predictors (Gleason & Dynarksi, 2002).

Individual-level predictors

Much of the literature that has looked at children in the middle school has focused on the individual level characteristics of the early adolescent. Rumberger and Lim (2008) argued that dropout factors are grouped into two categories: individual factors such as educational

performance (retention and test scores), behaviors (engagement in extra-curricular activities and attendance), attitudes (educational expectations), and background (demographics).

Several studies looked at academic performance and behaviors in middle school and their relationships to high school completion. North Carolina students in sixth grade who had poor attendance, behavior problems, and low academic achievement were less likely to graduate (North Carolina Family Impact Seminar, 2008). Balfanz, Herzog, and MacIver (2007) used longitudinal analyses of 12,972 students from Philadelphia and identified predictive factors (poor attendance, misbehavior, failing classes) that were associated with not graduating from high school. Other studies have looked at school retention and found being retained at first grade (Randolph, Rose, Fraser, & Orthner, 2004) or during middle school to be negatively correlated with school completion (although a causal link was not established; ongoing problems may have contributed to retention/failure to complete school at both time points) (Bushnik, Barr-Telford, & Bussiere, 2004; Randolph et al., 2004).

Other studies looked specifically at individual behaviors and attitudes, both positive and negative, and how they were related to high school dropout. African-American teens who participated in extra-curricular activities had higher reports of self-esteem and feelings of connectedness to the school (Dotterer, McHale, & Crouter, 2007). However, problem behaviors during middle school were predictors of dropping out (Cairns & Cairns, 1994; Jimerson et al., 2000). Cairns and Cairns (1994) argued that drop out is linked to both problem behaviors and poor academic performance, as well as belonging to a peer group where others drop out of school. In one study that used the National Education Longitudinal Study of 1988 cohort of eighth graders, Ream and Rumberger (2008) examined the students' engagement and peer social capital. The authors' analyses found weak evidence (.09 to .12 SD) that high student engagement (participating in school-related activities) positively influenced school completion or dropout and social capital (peer friendships) acts as a mediator (Ream & Rumberger, 2008). When evaluating the Check and Connection program which promotes school attendance and engagement, youth who participated in the program demonstrated a decrease in absences, a predictor of dropping out of high school (Lehr, Sinclair, & Christenson, 2004).

Family-level predictors

Family characteristics and behavior were also found to be meaningful. Among African-American middle school youth, parental monitoring and family cohesion positively affected school engagement (Annuziata, Hogue, Faw, & Liddle, 2006). Additionally, two studies specifically looked at parental engagement and its effects on youth. Jimerson et al. (2000) found parental involvement at sixth grade to be a predictor of high school dropout. Englund, Egeland, and Collins (2008) found that parent involvement during middle childhood reduced the rate of dropout in high school. In addition, youth who graduated had more positive relationships with adults than their counterparts who didn't graduate (Englund et al., 2008).

Research also points to school and community level predictors of high school success and completion. Two studies looked at attitudes and engagement of students when they were surrounded by adults varying in supportiveness. Woolley and Bowen (2007) found that when youth were surrounded by caring and supportive adults in school, in the community, and at home, youth were more engaged in school, both psychologically and behaviorally.

School-level and community-level predictors

At the school and community level, teacher support has a positive effect on school engagement of Latino middle and high school youth (Brewster & Bowen, 2004). However in a study using data from the 1988 NELS to examine the eighth grade cohort, the findings indicated that schools that promoted student learning and growth did not significantly reduce the dropout rate (Rumberger & Palardy, 2005). Another study looked at a community-school partnership program that focused on positive interactions between African-American and Latino youth and adults (Rodriguez & Conchas, 2009). This qualitative study indicated that when programs offer safe places, incentives, and advocacy within the family and in the school setting, and foster social networks by giving youth opportunities to interact with older students and mentors, students change their dispositions towards school and their future education (Rodriguez & Conchas, 2009).

C. Evidence of thresholds of school readiness in the literature

Another key issue for this review of the literature was whether previous research has identified thresholds of school readiness. After identifying studies that used the above indicators of school readiness, literature was examined for evidence of thresholds of school readiness using one of several indicators of skills or skill levels:

- Starting school with a certain range or profile of skills;
- Non-linear associations over time in one or more domain of developmental competency, suggesting a rapid increase in development correlating to school entry skills at or above a certain level;
- Starting school with a certain level or above a cut point of capability on individual skills; and
- Retrospective analyses that looked at performance later in schooling and then tried to determine characteristics of children that distinguish these children early on in schooling.

Studies Identifying Profiles of School Readiness

Two studies looked at profiles of school readiness. Hair et al. (2006) examined patterns of school readiness in children at school entry and how these patterns predict first-grade outcomes in a nationally representative sample of first-time kindergartners from the Early Childhood Longitudinal Study – Kindergarten Class of 1998-99 (ECLS-K). Cluster analyses revealed four profiles based on composite indicators of health, social-emotional development, language and cognition. The first profile was marked by comprehensive positive development (above average performance on composite indicators of health and social-emotional skills and especially high scores in language and cognition) and the second profile was marked by social-emotional and health strengths (above average performance on health and social-

emotional composite indicators, but below average performance on language and cognition). The third profile consisted of children showing social-emotional risk (below average on all four school readiness domains but being two standard deviations below the mean on social-emotional indicators). The final profile was health risk (below average on language and cognition as well as more than one standard deviation below the mean in health). The third and fourth profiles were deemed to demonstrate particular risk (social-emotional and health respectively). Analysis results revealed that children with one of the two "risk" profiles were more likely to be from families with multiple socioeconomic disadvantages (e.g., parents with the least education, families with the lowest incomes, teen or unmarried mothers). In addition, Hair et al. (2006) found that all four profiles differentially predicted academic and social adjustment in early elementary school with children with a risk profile performing the worst on all outcomes and children with a comprehensive positive development profile performing the best. These results suggest that assessments of children's readiness for school should encompass not only children's cognitive and literacy abilities, but also their health and their social and emotional well-being.

Studying kindergarten and first graders in the Early Childhood Care Research Network (ECCRN) data, Konold and Pianta (2005) examined three domains related to school readiness – cognitive, social-emotional, and approaches to learning/executive function and identified six profiles that represented the natural variation of children's skills before entering school. Children who were comparable on cognitive ability (about average) but differed in their level of social skills (high vs. average) differed at both 54 months and first grade on applied problems and vocabulary tests, with those with higher social skills outperforming those with average social skills.

Taken together, these two studies suggested that children arrive at school with different patterns of school readiness competencies, and that their subsequent school performance can be predicted by the profiles of readiness evident at this early stage. However, these studies only suggest that early skills predict to later skills and cannot determine whether these different profiles are evidence of specific skill thresholds needed for later school success.

Evidence of Non-linear Associations

As background to the analysis of developmental trajectories, studies were sought that examined non-linear growth patterns, specifically those looking for evidence of children with certain initial scores that then grew over time in a nonlinear way. This conceptualization and review of non-linear growth also briefly considered the impact of early education participation in determining the early scores that may contribute to later patterns of development.

Three reviewed studies reported growth trajectories of children's competencies over time, starting either at school entry or in early elementary school, to see whether this general pattern of non-linear growth existed in children's development. Using a sample of first grade children (ECCRN data from 10 U.S. sites), Pianta and colleagues (2008) found that the emotional quality of the classroom predicted literacy and math outcomes, especially in later grades. The authors also found that students showing

certain types of learning patterns in reading were affected differently by classroom emotional quality: "fast readers" whose rapidly increasing early growth is followed by deceleration, were not affected by classroom variables, while "typical readers," who show slower growth over a longer period of time, were affected by teacher interaction quality. Findings also varied by gender and poverty status for some reading pattern groups.

Abbott-Shim, Lambert and McCarty (2003) compared four-year-olds in Head Start with children who remained on the waitlist for Head Start and assessed health, social skills, cognitive skills, and language skills over one year. Growth curve modeling was used to look at growth over the three time points during the four-year-old year for some of these skills. For some outcomes, including language skills, both groups improved their scores over time, but the children who were in Head Start grew at a significantly faster rate, showing potential non-linear associations between the higher school entry skills developed by high quality early education experiences and later academic trajectories.

McClelland, Acock, and Morrison (2006) examined the contribution of children's learning-related skills to academic achievement between kindergarten and sixth grade and used growth curve analyses to analyze reading and math achievement between kindergarten and second grade, and between third and sixth grade. Learning-related skills at kindergarten (defined in this study to include independence, responsibility, self-regulation, and cooperation as measured by teacher ratings of children's social skills and mastery behaviors) predicted reading and math levels between kindergarten and second grade and between third and sixth grade. Kindergarten learning-related skills predicted growth in children's reading and math scores between kindergarten and second grade but not between third and sixth grade. Children with low learning-related skills fell behind in reading and math between kindergarten and second grade and continued to perform below grade level between third and sixth grade. No statistically significant effects from social skills or positive approach to learning were found.

There were also some non-linear findings in the Head Start Impact Study (Administration for Children and Families, 2005, 2010). The majority of the findings in the final report suggested non-linear relationships between Head Start access in preschool and child outcomes across domains at age four, in kindergarten, and in first grade. Non-linear impacts emerged around oral comprehension, child behavior, health insurance, parenting style, and other academic outcomes. For example, Head Start was not associated with any change in oral comprehension at the end of the Head Start year, at age four, or at the end of kindergarten, but at the end of first grade, an increase in oral comprehension scores appeared. Non-linear impacts also emerged around health insurance, parenting style, and other academic outcomes, suggesting that the benefits of early intervention programs cannot be fully understood at the time of school entry alone and that there may be some "sleeper effects" whereby early exposure or experiences create changes that emerge at a later time point.

Studies Using Cut-points for School Readiness Skills

Five identified studies considered a certain capability or skill level when examining school readiness and later outcomes. Drawing on a U.K. 1970 birth cohort re-interviewed at ages 5, 10, 16, 26, and 30,

Feinstein and Bynner (2004) examined cognitive performance between ages 5 and 10, specifically looking for continuity of growth during that period, as predictors of adult outcomes. Based on children's cognitive test scores at age five and 10, children were classified into four groups: those that performed highly (in the top quartile) at both time points, those that performed poorly (in the bottom quartile) at both time points, those that performed highly at age five and poorly at age 10, and those that performed poorly at age five and well at age 10. The analyses demonstrated considerable predicative power for age five cognitive scores and indicated the importance of development up to age five.

Justice and colleagues (2009) examined two dimensions of language ability as predictors of school readiness, drawing from NICHD ECCRN data. Children were categorized according to whether they have language deficiencies (scoring below the 10th percentile on an age-normed measure) in expressive and receptive language skills at 15, 24, 36, and 54 months. Both language receptiveness and language expressiveness exhibited varying associations with kindergarten performance measures. Children with language difficulties at 15 months did not perform differently in kindergarten than children with typical language abilities at 15 months, but children with difficulties at later times exhibit poorer performance on kindergarten measures across domains. This finding may indicate the presence of temporal cut points since low performance at 15 months did not predict to lower kindergarten achievement, but low performance in later early childhood did.

Retrospective Studies

This review of the literature did not identify any studies that looked retrospectively at children's performance in later schooling to see if it was predicted by children's development in early schooling. The research team searched for studies that identified academic or other outcomes in later schooling and then used these outcomes to predict back to the child's school entry skills or characteristics, but none were found that fit the review's scope and criteria.

Literature Review Summary

Collectively, the reviewed studies highlighted several important things about thresholds of school readiness and the methods that have been used thus far to examine them. First, the three studies that used some form of cut-point or threshold to determine school readiness did so only within one domain, not multiple domains. It may be easier to examine one domain at a time when examining thresholds of readiness. However, it may still be important to look at associations among domains of readiness and how thresholds across domains affect later development. One of the studies that experimented with cut-points used quartile breaks among the distribution of scores of their sample to set thresholds (Feinstein & Bynner, 2004), whereas another study (Justice et al., 2009) used a cut-off based on performance on a particular set of skills on a normed instrument (at or below the 10th percentile on a measurement normed on child age). Given that the Feinstein and Bynner (2004) study was based on a nationally representative sample, basing the cut-points on sample distribution may be reasonable. But depending on how representative another study's sample is or whether the measure of interest has standardized scores, using such methodology to create cut-points may or may not apply to other groups of children within future studies.

While a threshold for school readiness may be thought of as being assessed at one point in time (e.g., at the end of the four-year-old year or in the fall of kindergarten), one of the studies reviewed employed cut-points during two points in early childhood and early schooling (ages 5 and 10) to designate children into different patterns of development (Feinstein & Bynner, 2004). Some children started school in a strong position but then their performance deteriorated ("fallers"), while others started off poorly but caught up over time ("escapers"). Still others stayed "high" at both time points, and yet others scored "low" at both time points. This study supported the idea that researchers may need to examine development across the early years of school in order to determine who is "in the running" for successful outcomes later in development. Indeed, studies that used growth curve analyses to look at patterns of development over the elementary school years suggested a need to better understand additional characteristics of children (and aspects of their environments) that may help them maintain their "in the running" status, or achieve it belatedly (Administration for Children and Families, 2010).

In addition, there is emerging evidence that it is possible to consider combinations of school readiness skills simultaneously in analyses. Two studies took the approach of looking at school readiness "profiles" and identified different patterns of readiness in two separate samples of children. Besides the samples of children differing, the domains included in the profiles also differed (e.g., one study was unique in including health; the other study unique in considering executive function). Since only two studies have taken this approach, it was difficult to identify consistent patterns of development using the cluster or profile analysis techniques. More systematic research using this methodology may be useful. Although no retrospective studies were identified, this is an additional analysis technique which may be useful for identifying what helps children stay "in the running" for later success.

The data analyses designed for the *In the Running* project grew out of the findings of this literature review. The data analyses were conducted to address gaps and limitations in the existing literature and contribute substantively to the field's understanding of school readiness, the existence and definition of thresholds, and patterns and trajectories of children's development. These goals and the findings from the literature review shaped the analytic approaches employed by the *In the Running* project. For each of the operationalizations of thresholds identified in the literature, each research question was paired with one analytic technique. The next section introduces each of the four research questions and the analytic technique chosen to explore it.

D. Research Questions

The *In the Running* project began with the following questions about the relationship between children's school readiness skills and later school outcomes:

- Are there particular school readiness skills or a level of development that children need to attain in early childhood in order to meet later measures of success?
- Do outcomes in elementary or later schooling depend on the school readiness skills and competencies in various domains at entry to school?

Stemming from the literature focused on the above two questions, the study team chose to look at school readiness in four ways: 1) profiles or combinations of skills or characteristics; 2) non-linear associations between school entry skills and academic and social outcomes later in school; 3) specific academic growth trajectories or pathways predicted by a particular level of skill at school entry; and 4) cutpoints or skill levels. In order to best understand school readiness and its relationships to later school outcomes, the study team conceptualized and translated the study's original three questions into four more specific research questions with corresponding analytic methodologies to address the goals of the *In the Running* project. The four specific research questions were:

1. Do children who show qualitatively different patterns of school readiness skills have different trajectories of performance on academic and social outcomes during elementary school?
2. Are there non-linear associations between school readiness skills and subsequent trajectories of academic and social outcomes during elementary school?
3. Do children who are in the low and normal range in school readiness skills differ in terms of their trajectories of academic and social outcomes during elementary school?
4. Do children who have qualitatively different patterns of school readiness skills differ in their likelihood of success based on our categorization of their fifth grade academic and social skills (as defined by the variables indentified by the literature review)?

To answer these questions, the research team used multiple analytic methods within a secondary data analysis of two large, national datasets. The methodology of the secondary data analysis plan is described in more detail below.

II. Methodology

A. Data Sources

To address the four research questions above, the project selected the Study of Early Child Care and Youth Development (NICHD SECCYD) and Early Childhood Longitudinal Study- Kindergarten Class 1998-1999 (ECLS-K) as the primary datasets for this study, although initial variable exploration was also conducted with the Family and Child Experiences Survey (FACES) 2003 and National Center for Early Development and Learning (NCEDL) datasets. NICHD SECCYD and ECLS-K contain data from school entry through middle school, which serves the purpose of mapping out learning trajectories over time. The majority of the other datasets that were examined for possible inclusion in the study primarily included data from preschool to school entry but lacked information to examine performance in subsequent grades.

NICHD Study of Early Child Care and Youth Development (NICHD SECCYD)

Non-experimental longitudinal data from the NICHD SECCYD were drawn from a multisite study of births in 1991. Participants were recruited from hospitals located at 10 sites across the United States. During 24-hr sampling periods, 5,265 new mothers met the selection criteria and agreed to be contacted after

returning home from the hospital. Slightly over 50% of those contacted agreed to participate in the study. At 1 month of age, 1,364 healthy newborns were enrolled in the study, and over 1,200 children were still enrolled when children entered kindergarten. Although it was not nationally representative (the sample under represented low income families and excludes certain groups, like families expecting to move), the study sample closely matches national and census tract records with respect to some demographic variables such as ethnicity. The majority of children in the sample were White, while 12% were African American, and 11% were Hispanic or of another ethnicity. About 30% of mothers had a high school education or less, and 14% were single parents (NICHD Early Child Care Research Network, 1997). It is important to note that children who could not be assessed in English were not included in the "in the running" analyses.

Family, child care, and child outcome variables were measured in home- and lab-based assessments when the children were 6, 15, 24, 36, and 54 months and in grades 1, 3, and 5. Assessments included repeated measures of demographic and parental characteristics, quality of parenting, type, amount and quality of child care, and children's social, language, cognitive, and academic skills. Child care settings were rated using The Observational Report of the Caregiving Environment (NICHD Study of Early Child Care and Youth Development Phase I Instrument Document, 2004). The ORCE was designed specifically for the NICHD SECCYD to assess the quality of caregiver-child interaction experienced by individual children in all types of child care settings. The ORCE global quality measures the positive caregiving rating composite, with scores range from 1 (unresponsive or harsh caregiving) to 4 (frequent responsive and stimulating caregiving).

Early Childhood Longitudinal Study—Kindergarten Class 1998-1999 (ECLS-K)

This study focused on children's early school experiences beginning with kindergarten and following children through middle school. The ECLS-K data provided descriptive information on children's status at entry to school, their transition into school, and their progression through eighth grade. It can be used to describe and to understand better children's development and experiences in the elementary and middle school grades, as well as how their early experiences relate to their later development, learning, and experiences in school.

The sample consisted of 20,000 kindergarten children in the first year. Children were from both public and private schools and attended both full-day and part-day kindergarten programs. They came from diverse socioeconomic and racial/ethnic backgrounds. Also participating in the study were the children's parents, teachers, and schools. Children and families who could not be assessed in English were not included in the "in the running" analyses. Data were collected in the fall and the spring of kindergarten (1998-99), the fall and spring of first grade (1999-2000), the spring of third grade (2002), the spring of fifth grade (2004), and the spring of eighth grade (2007).

The ECLS-K assessed children's cognitive, social-emotional, and physical development through direct and indirect methods. Direct child assessment scores refer to children's performance on the ECLS-K cognitive and social-emotional batteries. Physical development was also measured directly. Indirect child

assessments refer to parent and teacher ratings of children's cognitive and social-emotional development.

B. Variables Used in Analyses

School Readiness Variables

Once the two datasets were selected, corresponding variables were selected from both to approximate each school readiness construct. Similar variables were chosen across the two datasets to ensure analytic comparability. When necessary, variables were reverse-coded to maintain the positive directionality of all rankings and categorizations.

Initial school readiness constructs were social-emotional skills, task persistence (closely related to approaches to learning), attention (inhibitory control), health, reading, math, language, and general knowledge. In both datasets, social-emotional skills were measured with composites of teacher ratings on the Social Skills Rating System (SSRS) with additional teacher ratings including a measure of externalizing behavior problems. Task persistence was measured with teacher ratings and health was measured with maternal ratings. In both datasets, reading and math were directly assessed. Language skills were measured directly by in the NICHD SECCYD and not measured at all by ECLS-K; the reverse was true of general knowledge measurement. Only the NICHD SECCYD study included a direct assessment of attention.

Table 2. School readiness constructs and their operationalization in the two datasets

School Readiness Constructs	NICHD SECCYD	ECLS-K
Social-emotional	Composite ratings of SSRS & TRF externalizing (reversed) at Fall K (teacher ratings)	Composite ratings of SSRS, externalizing (reversed), self-control at Fall K (teacher ratings)
Task persistence	CBQ Task Persistence at Fall K (teacher rating)	Approaches to Learning at Fall K (teacher rating)
Attention	CPT Continuous performance task at 54 months	N/A
Health	Rating at 54 months (maternal rating)	Rating at Fall K (maternal rating)
Math	WJR-Applied Problems Standard Score at 54 months	ECLS-K Math – IRT score at Fall K
Language	Language composite of PLS Auditory Comprehension, PLS Expressive, WJ-R Picture Vocabulary	N/A
General Knowledge	N/A	ECLS-K General Knowledge – IRT score at Fall K

School Readiness Constructs	NICHD SECCYD	ECLS-K
Reading	WJR-Letter Word Standard Score at 54 months	ECLS-K Reading – IRT score at Fall K

Outcome variables were also selected from both of the datasets. These variables were used to approximate social and academic success in later elementary school. Where applicable, outcome measures were frequently the same or similar to the school readiness variables, but measured at a later time point. Additionally, the outcome measures focused on the academic and social skills critical in later school performance as opposed to the approaches to learning and health variables thought to be more pertinent to school readiness. The ECLS-K had no appropriate language measure, but all other domains (reading, math, language, externalizing behavior problems, and social skills) were operationalized in both datasets. In the analyses, the outcome variables were predicted with the school readiness variables or were used to predict back to school entry performance to uncover developmental patterns or thresholds.

Table 3. Outcome measures selected in the two datasets

Outcome Measures	NICHD SECCYD	ECLS-K
Reading	WJ-R Passage Comp St Scores (at grades 3 and 5 and age 15)	ECLS-K Reading IRT scores (at Spring of kindergarten and grades 1, 3, 5, and 8)
Math	WJ-R Applied Problems St Scores (at grades 1, 3, and 5 and age 15)	ECLS-K Math IRT scores (at Spring of kindergarten and grades 1, 3, 5, and 8)
Externalizing	TRF Externalizing t scores (at kindergarten and grades 1, 2, 3, 4, and 5)	Externalizing (at Spring of kindergarten and grades 1, 3, and 5)
Social Skills	Teacher rating SSRS St Scores (at kindergarten and grades 1, 2, 3, 4, and 5)	Teacher rating SSRS St Scores in externalizing behaviors and self-control (at Spring of kindergarten and grades 1, 3, and 5)

Additionally, corresponding covariates were selected from both of the datasets. These covariates were thought to affect the predictor variables and outcomes of interest. Again, the same or similar covariates were selected in each dataset to maintain comparability. Covariates included controls for dataset

sample weights, race/ethnicity, gender, maternal education, low-income status, marital status, child age, child disability status, and home language.

Table 4. Covariates included in analyses in the two datasets

Covariates	NICHD- SECCYD	ECLS-K
Sampling	Include Site	Use kindergarten weights
Race/ethnicity	Race/Ethnicity	Race/Ethnicity
Gender (female=1)	Female (0/1 variable)	Female (0/1 variable)
Maternal Education	Maternal Education	Maternal Education
Low-income status	Mean of Income/needs 6m-54m < 2	Income/needs Fall of kindergarten < 2
Marital Status	Proportion time mother married 1-54 months	Whether mother is married at Fall of kindergarten
Child age	Age on Sept 1 of kindergarten	Age on Sept 1 of kindergarten
Disability status	Mother report of disability	Mother report or doctor diagnosis of disability
Home Language	N/A	Whether home language is English

C. Analysis

Two different approaches were used to characterize school readiness and two different approaches were used to characterize success in school. These are represented in Table 5, and described in more detail below.

Table 5. Analytic approaches for characterizing school readiness skills and school outcomes in the *In the Running* project

Analytic Approach: School Readiness Skills	Representation of "thresholds" of School Readiness Skills in Analyses	Analytic Approach: School-age Outcomes
Person-centered	Latent Profiles	**Longitudinal: Growth curve analysis of academic and behavioral skills**
Variable-centered	Nonlinear (linear and quadratic) of individual school readiness skills	**Retrospective: Fifth grade status in terms of being "in the running"**

Analytic Approach: School Readiness Skills	Representation of "thresholds" of School Readiness Skills in Analyses	Analytic Approach: School-age Outcomes
	Piecewise spline of individual school readiness skills	

School readiness was examined through two approaches: person-centered and variable-centered. The school readiness skills included in all analyses included measures of language or general knowledge, reading, math, attention, social skills, behavior problems, and health scores at kindergarten entry. These were chosen because each is believed to play an important role in school success (Kagan, Moore, & Bradekamp, 1995; Scott-Little, et al., 2007; Stedron & Berger, 2010).

Latent profile analyses were used for the person-centered approach. Latent profile analysis seeks to identify individual children with similar combinations of skills; individuals with similar combinations of school readiness skills are members of the same "profile." The latent profile analyses began with a determination of the groups or profiles of school readiness in the ECLS-K and NICHD SECCYD datasets. In this step, a statistical analysis allowed the individual children to be sorted into groups that were similar in terms of their combination of school readiness skills. The complex regressions conducted as part of the latent profile analysis for the *In the Running* project found four profiles of children in both the ECLS-K and NICHD SECCYD datasets. In other words, analyses identified four groups of children, with each group representing a different profile of strengths and weaknesses in school readiness skills. This approach tested for thresholds by asking whether the profiles showed different patterns of school-age outcomes. Specifically, latent growth curve analyses were used to look at the longitudinal predictions from the latent profiles to the school-age outcomes. The models included demographic and sampling characteristics and child gender and age as covariates.

For the variable-centered approach, the school readiness variables were entered into the analytic models separately first and together second. The models included demographic and sampling characteristics and child gender and age as covariates. The school readiness skills were examined both individually and simultaneously because they were moderately to highly correlated. Accordingly, analyses that included a single school readiness skill asked whether that entry skill predicted subsequent academic and behavioral skills during the school years, while the analyses that included all school readiness skills allowed for the identification of the strongest predictor of school success across the set of school readiness skills. The threshold question was examined by testing whether there were nonlinear associations using a quadratic model to identify a threshold and by setting a threshold and then asking if associations between school entry skills and subsequent school outcomes was different depending on whether the child was above or below the conceptually-determined threshold.

The school-age outcomes were also analyzed in two different ways. Most analyses involved fitting growth curves to the selected outcomes: reading, math, social skills, and behavior problems. Models allowed for nonlinear change during elementary school through middle school in the ECLS-B and high

school in the SECCYD. Specifically, quadratic group growth curves and linear individual curves were estimated for each outcome. The quadratic group model allowed for changes in the magnitude in the rate of change over time. Both latent growth curve and hierarchical linear model analyses were conducted, but the individual growth curves would be estimated in the same manner using the two approaches (Burchinal, Nelson, & Poe, 2006).

In addition, as a follow-up analysis, we examined outcomes in fifth grade to determine whether children seemed to be "in the running" at that point. The process used to determine whether children seemed to be in the running at fifth grade is described below.

Four research questions were developed to look for evidence of developmental thresholds in different ways. Table 6 below introduces the four research questions and the analytic method with which it was paired.

Table 6. Research questions and corresponding analytic approaches for the *In the Running* project

Research Question	Analytic Approach
1. Do children who show qualitatively different patterns of school readiness skills have qualitatively different trajectories of performance on academic and social outcomes during elementary school?	Latent profiles of school readiness variables-Longitudinal latent growth curve analysis of school-age outcomes
2. Are there non-linear associations between school readiness skills and subsequent developmental trajectories for academic and social outcomes during elementary school?	Quadratic analyses of school readiness variables -Longitudinal hierarchical linear modeling of school-age outcomes
3. Do children who are in the low and normal range in school readiness skills differ in terms of their developmental trajectories for academic and social outcomes during elementary school?	Piecewise analyses of school readiness variables –Longitudinal hierarchical linear modeling of school-age outcomes
4. Do children who have qualitatively different patterns of school readiness skills differ in their likelihood of success based on our categorization of their fifth grade academic and social skills?	Latent profiles of school readiness variables –Related to fifth grade *status*

Below is a more detailed explanation of the four types of analyses used to address the respective research questions. Following the methodological explanations are a descriptions of the results of each analysis.

Question 1: Do children who show qualitatively different patterns of school readiness skills have qualitatively different trajectories of performance on academic and social outcomes during elementary school?

Latent Profile Analyses - Longitudinal Analysis of School Outcomes

Latent profile analysis was used to investigate the first research question of whether children with qualitatively different patterns of school readiness skills have qualitatively different academic and social trajectories in later elementary school.

This approach seeks to identify distinct profiles of individuals who differed in terms of their patterns of scores across the identified variables (e.g., Pre-K language, reading, math, attention, social skills, behavior problems, attention, and health scores) and then determine whether those groups were different at subsequent ages on measures of academic achievement and behavior either at a given school grade (i.e., kindergarten) or in terms of patterns of change over time (i.e., first grade through middle school).

The latent profile analyses began with a determination of the groups or profiles of school readiness in the ECLS-K and NICHD SECCYD datasets. In this step, a statistical analysis allowed the individual children to be sorted into groups that were similar in terms of their combination of school readiness skills. Next, multinomial regressions were run to predict the different profiles. Finally, analyses were run with the school readiness profiles as predictors of school-age outcomes to see whether the children in each of the profiles at school entry showed differences in the trajectories of their outcomes from kindergarten through eighth grade for the ECLS-K and age 15 for the NICHD SECCYD This type of analysis allowed researchers to see whether having a certain combination of skills, as opposed to a specific skill, predicted later school outcomes. Below are tables describing the skill levels and relative risk of each of the four profiles.

Table 7a. Profiles from latent profile analysis in NICHD SECCYD

Profile	Features
Class I	High risk in all school readiness domains; 7% of the sample
Class II	Moderate risk in all school readiness domains; 26% of the sample
Class III	At the mean in all school readiness domains; 43% of the sample
Class IV	Strengths in all school readiness domains; 24% of the sample

Source: NICHD SECCYD dataset

Table 7b. Profiles from latent profile analysis in ECLS-K

Profile	Features
Class I	Risk in all school readiness domains; 37% of the sample
Class II	At the mean in all school readiness domains; 48% of the sample
Class III	On track ; 14% of the sample
Class IV	On track reading and math strengths; 1% of the sample

Source: ECLS-K dataset

In analyses for both the NICHD SECCYD and ECLS-K datasets, Class I represented children with the highest overall level of risk and Class IV represented children with the least overall risk. In the ECLS-K profiles, "on track" denoted being slightly above the mean but without strengths in any particular domain.

To understand the latent profiles, they were compared on background characteristics. For the NICHD SECCYD dataset, compared to children in Class I (risk in all school readiness domains), children in the other groups were more likely to be female, less likely to be a minority compared to white, more likely to be have a mother with a higher education, more likely to be from a family with higher quality parenting, and more likely to come from a family with a higher income to poverty threshold. Similarly, for the ECLS-K dataset, compared to children in Class I (risk in all school readiness domains), children in the other groups are more likely to be female, more likely to be older, less likely to be a minority, more likely to come from a family with a higher income to poverty threshold, more likely to be from a two parent family, more likely to have both parents employed, and less likely to have a disability.

Using these distinct profiles, regressions were run with children's scores in each domain over time to see whether certain qualitatively different patterns of school readiness (as defined by the risk-level profiles at school entry) predicted to qualitatively different patterns in terms of trajectories of development over time. Nonlinear change over time in school age outcomes was estimated with the latent growth curve models and then the analysis tested whether the children in the four latent school readiness profiles differed in terms of overall level or rate of change over time in academic skills and behavior during their school years.

Question 2: Are there non-linear associations between school readiness skills and subsequent trajectories of academic and social outcomes during elementary school?

Quadratic Analyses – Longitudinal Analysis of School Outcomes

In order to examine any potential non-linear associations between school readiness skills and either the level or rate of change in school-age social and academic trajectories (the topic of the second research question), an analysis was designed to use school readiness as a predictor of school-age trajectories in achievement and behavior.

For the HLM analyses, school readiness skills were used to predict to later school outcomes. In one HLM analysis, the school readiness skills were considered separately to predict to each later outcome, while another set of HLM analyses looked at the unique predictive power of each school readiness variable to each later school outcome when all of the school readiness variables were considered together. Both approaches were used because the school readiness skills tended to be moderately to highly correlated. This second method allowed researchers to see if certain types of skills predicted later achievement in that same domain as well as in other domains. For example, researchers could see if math skills at school entry predicted math skills in later elementary school as well as whether math skills at school entry predicted school engagement in later school.

Overall, both the latent growth curve and the HLM analyses were also valuable as they allowed researchers to detect non-linear growth. Non-linear growth is developmental patterns of growth in skills or development over time that do not change at the same rate over time. The quadratic analyses asked whether children's school readiness skills predicted subsequent skills differently for children who entered school with higher or lower skills. For example, children who entered with a certain type or level of skill may have developed more or less quickly than children with another type of level of skill, or children with a certain type or level of skill may have developed more quickly at some ages than at others.

A longitudinal mixed model analysis was designed to use school readiness as a nonlinear predictor of school-aged achievement and behavior. In these models, each school readiness variable was allowed to have a linear and quadratic association with level and change over time in the school-age trajectories. Significant quadratic associations could provide evidence for thresholds – with special interest in determining whether evidence of quadratic associations was detected that indicated a threshold above which children either show substantially higher levels of skills or faster rates of acquisition of skills.

Two sets of analyses were completed to examine each school readiness variable as a predictor of each outcome in separate analyses and to examine all school readiness variables as predictors of each outcome.

Question: 3 Do children who are in the low and normal range in school readiness skills differ in terms of their trajectories of academic and social outcomes during elementary school?

Piecewise Analyses - Longitudinal Analysis of School Outcomes

The analyses designed to address the third research question involved fitting a piecewise regression model to examine whether and how children's performance at the beginning of kindergarten predicted later outcomes in elementary school in both the NICHD SECCYD and the ECLS-K datasets. Piecewise analysis allowed school readiness skills to predict the level and rates of change in school-age academic skills and behaviors differently for children above and below a specific skill level.

Thus, for the piecewise analysis, two groups were created for each school readiness variable:

- Children in the "low range" on a school readiness skill (i.e., those who scored more than one standard deviation below the mean on the school readiness variable), and
- Children in the "normal range" on a school readiness skill (i.e., those who scored at or above one standard deviation below the mean on the school readiness variable).[4]

Performing one standard deviation below the mean was chosen as the cut point differentiating the "normal" and "low" groups as it is a widely accepted marker of being in an at-risk range of performance on a measure (for example, the Achenbach Child Behavior Checklist).

The piecewise analyses allowed school readiness skills to predict the level and rates of change in school-age academic skills and behaviors differently for children above and below a specific skill level. All analyses included the following covariates: gender, race, site (for NICHD SECCYD), maternal education, whether the mother was married (ECLS-K) or proportion of time married 6-54 months (NICHD SECCYD), low-income status, and disability status.

The piecewise analyses estimated the association between school readiness skills and the level and rate of change in school-age skills separately for children in the low group and the normal group and compared the magnitude of these associations were significantly different. Such differences could provide evidence of thresholds by showing that children who started school with different skills levels had different overall levels of skills or rates of growth throughout elementary school.

In order to understand differences between children in the low and normal ranges in terms of school readiness skills, a small set of background characteristics were examined in relation to being in the low versus normal groups according to the piecewise analyses. As expected, children from more advantaged backgrounds at kindergarten entry were more likely to fall within the normal range on school readiness skills at kindergarten entry. Specifically, children in the normal range were more likely than children in the low range to be in two-parent/married families, to live above the 200% poverty threshold for household income, and to have a mother with a bachelor's degree or higher. On the other hand,

[4] One standard deviation above the mean was used for behavior problems.

children in the low range on school readiness skills were more likely than their peers in the normal range to have a mother with a high school degree or less; they also tended to be in households where English was not the primary language (although this varied by the specific school readiness skill).

Participation in center-based versus home-based child care prior to kindergarten was not consistently associated with being in the low or normal ranges on school readiness skills; it varied according to specific outcomes. For example, within the NICHD SECCYD dataset, children in the normal range on Applied Problems were more likely than those in the low range on this skill to have spent more time in center-based care over the early childhood years. But children in the low range on social-emotional outcomes were more likely than those in the normal range on this school readiness skill to have spent more time in center-based care during the early childhood years. Children in the normal range on language outcomes in kindergarten were more likely than those in the low range to have spent more time in home-based care during the early childhood years.

Participating in center-based or home-based care in the year prior to kindergarten was related to being in the "low" vs. "normal" range for the cognitive outcomes only within the NICHD SECCYD dataset. Specifically, children were more likely to be in the normal range on Woodcock-Johnson Letter-Word and Applied Problems outcomes if they were in center-based care only the year prior to kindergarten; they were more likely to be in the low range on both outcomes if they were in home-based care only in the year prior to kindergarten. There was no effect of child care participation in the year prior to kindergarten on language, social-emotional, executive function, or health outcomes.

Similarly, findings from the ECLS-K data indicated that for reading, math, and general knowledge skills at kindergarten entry, children in the normal range on these skills were more likely than those in the low range to have been in center-based care in the year prior to kindergarten. Conversely, children in the low range on these skills, compared to those in the normal range, were generally more likely to have spent time in home-based care or in parental care the year prior to kindergarten. The opposite pattern existed with regard to those in the normal versus low ranges on social skills at kindergarten entry: those children in the normal range for social-emotional outcomes in kindergarten were *less* likely than those in the low range to have spent time in center-based care in the year prior to kindergarten. Conversely, those in the normal range on social-emotional outcomes were more likely than their peers in the low range to have spent time in home-based care or in the care of their parents in the year prior to kindergarten. There was no relation of child care participation in the year prior to kindergarten to low versus normal group categorizations for health or approaches to learning skills in kindergarten within the ECLS-K dataset.

Question 4: Do children who have qualitatively different patterns of school readiness skills differ in their likelihood of success based on our categorization of their fifth grade academic and social skills?

Latent Profile Analyses - Regression Analysis of the Fifth Grade Definition of In the Running

In order to explore whether there were early predictors of being "in the running" for later school success (the topic of the fourth research question), the research team used a review of the literature to identify fifth-grade indicators of later school success and created indices of being "in the running" at fifth grade, which were then predicted by kindergarten characteristics of the child, including the child's school readiness profile membership (derived from earlier LCA analyses).

Two methods were employed to create the "In the Running" (ITR) indices using data from the fifth grade data wave of the ECLS-K—an "empirical" and a "conceptual" method. For each method, continuous and dichotomous versions of "In the Running" indices were created based on the individual indicators (that is one version looked at a continuous range of higher and lower scores without a clear cut point separating scoring groups (continuous) and the other used a specific cut point to identify "high" vs. "low" scores (dichotomous).

Three sub-domains of being "in the running" were created for each method. Index sub-domains of being "in the running" were school engagement, social-emotional adjustment, and cognitive/academic skills. Engagement indicators were child self-report of interest in school; school report of total absences for the year, and whether the child was performing below, on or above grade level. Engagement was measured with children's self-reported ranking as to whether a number of statements such as "I enjoy work in all school subjects" were "not at all true," "a little bit true," "mostly true," or "very true." Social-emotional indicators were self-report of peer relations and externalizing behavior problems where children self-reported the extent to which statements such as "I get along with kids easily" (for peer relations) and "it's hard for me to finish my school work" and "I get in trouble for talking and disturbing others" (for externalizing behaviors) were "not at all true," "a little bit true," "mostly true," or "very true." Cognitive/academic indicators were direct child assessments of reading, math, and science. Logistic regression was used to determine demographic and school readiness predictors of the ITR domain-specific indices.

Below is a table that shows the constructs included in each of the "In the Running" indices.

Table 8. Variables included in the "In the Running" indices

Construct	Cognitive	Social	Engagement
Grade Level			**x**
Interest in School			**x**

Construct	Cognitive	Social	Engagement
Total Absences (excused and unexcused)			x
Peer Relations		x	
Externalizing Problem Behaviors (reverse coded)		x	
Reading IRT Score	x		
Math IRT Score	x		
Science IRT Score	x		

Source: ECLS-K fifth grade wave

Empirical Method

For the "empirical" method, a composite was constructed with principal component factor analysis that weighted the contributions of individual indicators within the continuous factor. Three different indices were created: cognitive, social, and engagement. The cutpoints for the binary "In the Running" (ITR) variables using this method were set at 40% of the distribution on the continuous measures for each index. This cutpoint was based on the idea that, on a normally distributed variable with a mean of 50 and standard deviation of 10, performance at 1 standard deviation below the mean is generally recognized as poor performance. Table 9 shows the mean scores for each domain cut point.

Table 9. Mean scores for each of the empirically-based indices by key percentile distribution points

Percentile	Cognitive	Social	Engagement
Lowest	-5.60	-4.83	-14.91
25%	-0.96	-0.67	-0.48
40%	-0.20	-0.23	-0.05
50%	0.23	0.12	0.18
75%	1.19	0.88	0.71
Highest (100%)	3.19	2.05	1.95

Source: ECLS-K fifth grade wave

A higher score on the continuous factor indicated that a child was more "in the running" at fifth grade than children with lower scores. As noted above, the cut-point for being "in the running" was set at the 40th percentile for the binary version of these indices. For the total score, the cut-point was set at -0.17. Thus, children above -0.17 on the composite, continuous factor were considered "in the running," whereas children below were not. For the Cognitive sub-domain,

the cut-point was set at -0.20. For the Social sub-domain, the cut-point was set at -0.23. And for the Engagement sub-domain, the cut-point was set at -0.05.

Logistic regression analyses used the kindergarten school readiness profiles and covariates to predict the binary versions of the empirically-derived "In the Running" indices for the full sample (this is explained further in Appendix A). As expected for each of the empirically-based indices, children from more advantaged backgrounds at kindergarten entry were more likely to be categorized as "in the running" in fifth grade. In addition, children who were categorized as "in the running" in fifth grade were performing significantly better in each of the school readiness domains at kindergarten entry than children who were not categorized as "in the running" in fifth grade. The pattern held true for both the full sample as well as the sample of children who lived in families with incomes less than 200% of the poverty threshold**.**

Conceptual Method

For the "conceptual" method, an *a priori* cutpoint was determined for each individual indicator of being "in the running." Cutpoints were based on the research literature. For example, research indicated that total absences of 18 days or more per year in early schooling was significantly associated with the likelihood of dropping out of school (Chang & Romero, September 2008). Therefore, the cutpoint on the indicator of Total Absences was set at 18 or more days vs. 17 days or less. Similarly, the cutpoint for Grade Level was put between being "below" grade level and "on or above grade level." For indicators that had four categorical response options from "not at all true" (1) to "very true" (4) (as described above), the cutpoint was placed between "a little bit true" (2) and "mostly true" (3). The cutpoints for the continuous reading, math and science scores were placed at 40% of the distribution. This decision was based, in part, on the trends seen in the latest NAEP results, but also based on the notion that performance at 1 standard deviation below the mean (assuming a normal distribution) was indication of poor performance.

Specifically, the 2009 NAEP data indicate that 67% of fourth graders were performing at or above "basic" in reading in 2009 (National Assessment of Educational Progress, 2009c); 82% of fourth graders were at or above basic in math in 2009 (National Assessment of Educational Progress, 2009b), and 72% of fourth graders were at or above basic in science in 2009 (National Assessment of Educational Progress, 2009a). (See the Table 10 below for a full listing of the conceptual cutpoints for each indicator and the distribution of the sample associated with these cutpoints). The cutpoints for the binary ITR variables were made at approximately 40% of the distribution on continuous measures, based on the idea that performance at one standard deviation below the mean (assuming a normal distribution) was an indication of poor performance. Table 10 shows the scores associated with the conceptual method analysis.

Table 10. Conceptual method score cut points

Percentile	Total Score	Cognitive	Social	Engagement
Lowest	0	0	0	0
25%	4	1	1	2
50%	5	2	1	2
75%	7	3	2	3
Highest	8	3	2	3

Range: 0-8
Minimum: 0
Maximum: 8
Source: ECLS-K fifth grade wave

For the Cognitive sub-domain, the cut-point was set at a score of 2, indicating that approximately 62% of children were "in the running" in the cognitive domain in fifth grade. For the Social sub-domain, the cut-point was set at 1, indicating that 80% of fifth graders were "in the running." For the Engagement sub-domain, the cut-point was set at 2, indicating that 91% of fifth graders were "in the running" for engagement. Table 11 shows the cut points for each domain used in the conceptual analysis.

Table 11. Cutpoints used for the conceptually-based "In the Running" index

Construct	Cutpoint for "Conceptual" version of In the Running Index (noted by *)
Grade Level	**At or above grade level*:** 9712 (89.93%) **Below grade level:** 1075 (9.97%)
Interest in School (1= not true at all, 2= a little bit true, 3 = mostly true, 4 = very true)	**Score of 3 or 4*:** 4762 (42.21%) **Score of 1 or 2:** 6520 (57.79%)
Total Absences **(excused and unexcused)**	**0-17.99*:** 9306 (94.08%) **18+:** 586 (5.92%)
Peer Relations (1= not true at all, 2= a little bit true, 3 = mostly true, 4 = very true)	**Score of 3 or 4*:** 6505 (57.66%) **Score of 1 or 2:** 4777 (42.34%)
Externalizing Problem Behaviors (1= not true at all, 2= a little bit true, 3 = mostly true, 4 = very true)	**Score of 1 or 2*:** 7005 (62.09%) **Score of 3 or 4:** 4277 (37.91%)
Reading IRT Score	**Score greater than 135.52**
Math IRT Score	**Score greater than 111.96**

Construct	Cutpoint for "Conceptual" version of In the Running Index (noted by *)
Science IRT Score	**Score greater than 55.66**

Source: ECLS-K fifth grade wave

As with the empirical method of creating the "In the Running" variable, logistic regression analyses used the kindergarten school readiness latent profiles and covariates to predict the binary versions of the conceptually-created "In the Running" variables.

III. Findings

This study represented a multi-method approach to examining the evidence for thresholds in the association between children's school readiness and subsequent academic, social and emotional outcomes, both within and across domains. Results across analyses suggested some, albeit limited, support for thresholds of school readiness as well as the overall importance and predictive powers of kindergarten entry skills.

This section of the report describes the findings, conclusions, and implications of the analyses with regards to the *In the Running* project's original questions:

- Are there particular school readiness skills or a level of development that children need to attain in early childhood in order to meet later measures of success?
- Do outcomes in elementary or later schooling depend on the school readiness skills and competencies in various domains at entry to school?

As summarized previously, these two questions were examined through four specific research questions:

1. Do children who show qualitatively different patterns of school readiness skills have qualitatively different trajectories of performance on academic and social outcomes during elementary school?
2. Are there non-linear associations between school readiness skills and subsequent trajectories of academic and social outcomes during elementary school?
3. Do children who are in the low and normal range in school readiness skills differ in terms of their trajectories of academic and social outcomes during elementary school?
4. Do children who have qualitatively different patterns of school readiness skills differ in their likelihood of success based on our categorization of their fifth grade academic and social skills?

These four research questions examined the evidence of thresholds, how school entry skills relate to later outcomes both within and across domains, and an emerging picture of children who are ready to succeed in school. Table 12 below shows the analytic method used to examine each of the four research questions.

Table 12. Research questions and analytic approaches

Research Question	Analytic Approach
1. Do children who show qualitatively different patterns of school readiness skills have qualitatively different trajectories of performance on academic and social outcomes during elementary school?	Latent profiles of school readiness variables-Longitudinal latent growth curve analysis of school-age outcomes
2. Are there non-linear associations between school readiness skills and subsequent developmental trajectories for academic and social outcomes during elementary school?	Quadratic analyses of school readiness variables -Longitudinal hierarchical linear modeling of school-age outcomes
3. Do children who are in the low and normal range in school readiness skills differ in terms of their developmental trajectories for academic and social outcomes during elementary school?	Piecewise analyses of school readiness variables –Longitudinal hierarchical linear modeling of school-age outcomes
4. Do children who have qualitatively different patterns of school readiness skills differ in their likelihood of success based on our categorization of their fifth grade academic and social skills?	Latent profiles of school readiness variables –Related to fifth grade *status*

Each research question was paired with an analytic approach to best answer that question. Latent profile analysis was especially suited to questions about patterns of school readiness skills because its analyses grouped children into different categories marked by a particular skill profile. HLM quadratic analysis was best used to address questions about non-linear associations between school readiness skills and later skills because it allowed for an examination of growth and rate of change in skill development over time. Similarly, piecewise HLM analysis could answer questions about the developmental trajectories of children with school readiness skills above and below a certain threshold because it clarified the different growth patterns of children who had been categorized according to an *a priori* cut point. Finally, regression analysis was best suited to answer questions about how well patterns of behaviors and skills at fifth grade map back to patterns of school entry skills. These four analyses yielded numerous results regarding evidence of thresholds, growth patterns and trajectories from school entry through later elementary school across and within domains of development, and whether children's combinations of skills at school entry predicted their later achievement. The findings from these four analyses are presented below.

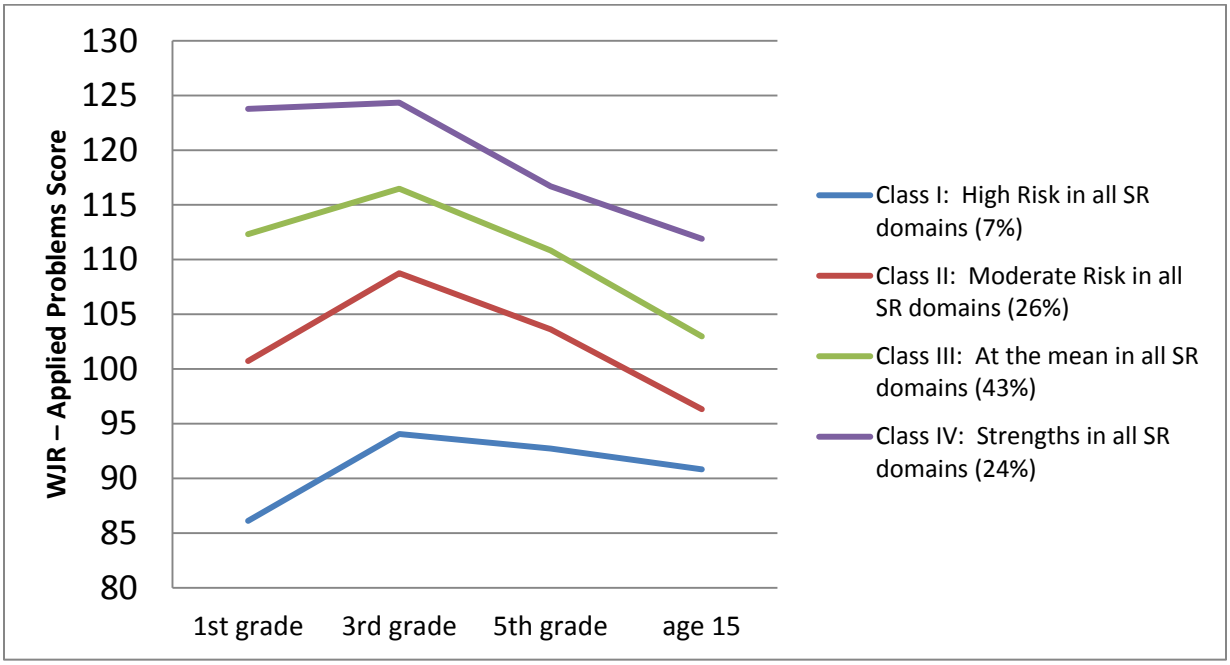
Do children who show qualitatively different patterns of school readiness skills have qualitatively different trajectories of performance on academic and social outcomes during elementary school?

Latent Profile Analysis – Longitudinal Analysis of School Outcomes

Latent profile analysis found four distinct school readiness profiles in both datasets, but none of the profiles included children who were high on some school readiness domains and low on others. Latent profile analyses indicated that children in profiles with higher school readiness skills tended to show higher academic and behavior skills levels during the school years.

Figure 1 shows math trajectories from first grade through age 15 in the NICHD SECCYD dataset. Compared to the children in Class I (risk in all school readiness domains), children in all other groups scored higher on their math assessments in the first grade. A hierarchical progression was apparent with each group performing better than the previous group. And, compared to children in Class I, children in all other groups grew at a faster rate between first grade and age 15 on their math skills.

Figure 1. Developmental trajectories for math from the first grade to age 15 by school readiness profile in NICHD SECCYD

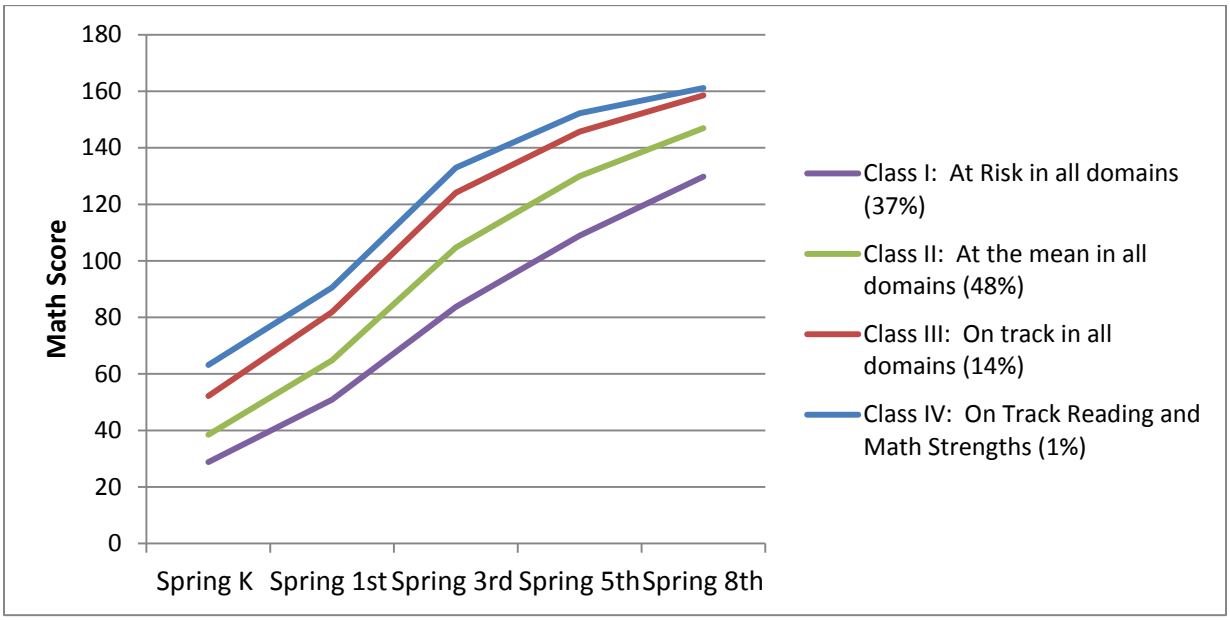


Source: NICHD SECCYD dataset

Figure 2 shows math trajectories from kindergarten entry through eighth grade in the ECLS-K dataset. In ECLS-K, compared to the children in Class I (high risk in all school readiness domains), children in all other groups scored higher on their math assessments at the Spring of Kindergarten. A hierarchical progression was apparent with each group performing better than the previous group. And, compared to children in Class I, children in all other groups grew at a faster rate between the spring of

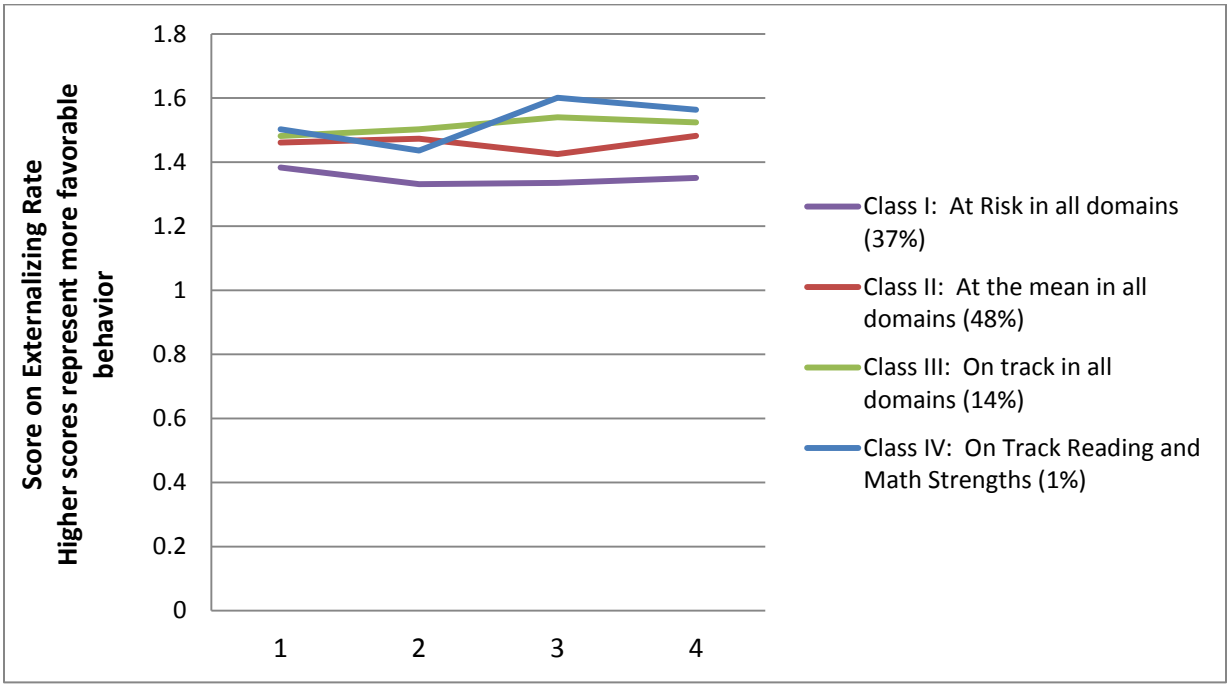
Kindergarten and the spring of eighth grade on their math skills. However, these children in all other groups also grew more slowly in terms of social skills and had a faster rate of growth on externalizing behavior problems, as shown in Figure 3 where higher externalizing behavior scores represent more favorable behavior.

Figure 2. Developmental trajectories for math from the spring of kindergarten to eighth grade by school readiness profile in ECLS-K



Source: ECLS-K dataset

Figure 3. Development trajectories for externalizing behaviors by school readiness class in ECLS-K



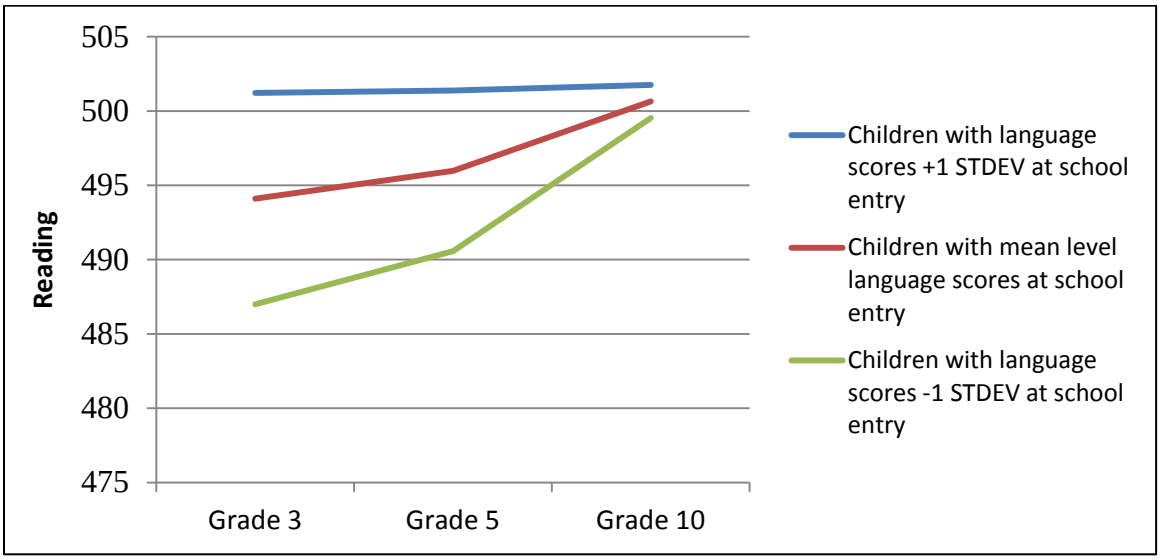
Source: ECLS-K dataset

Are there non-linear associations between school readiness skills and subsequent trajectories of academic and social outcomes during elementary school?

HLM models revealed some evidence of thresholds, but mostly for children at the low end of the developmental spectrum at kindergarten entry. These analyses indicated that children who performed at the lowest levels at kindergarten entry tended to show larger gains than would be expected otherwise over time, even if they did not "catch up" to their peers in absolute levels of performance. There was stronger prediction of *rate of acquisition of skills* from school entry variables for children in the low range than for the children in the normal range on the school readiness variables.

Figure 4 below, from an analysis of how language scores at school entry relate to later reading skills, shows non-linear growth in reading skills. Between grades 3 and 5, reading scores when examined in relation to language skills, showed a particular rate of growth. However, between grade 5 and age 15, growth was accelerated, as denoted by the steeper slope of the reading score line.

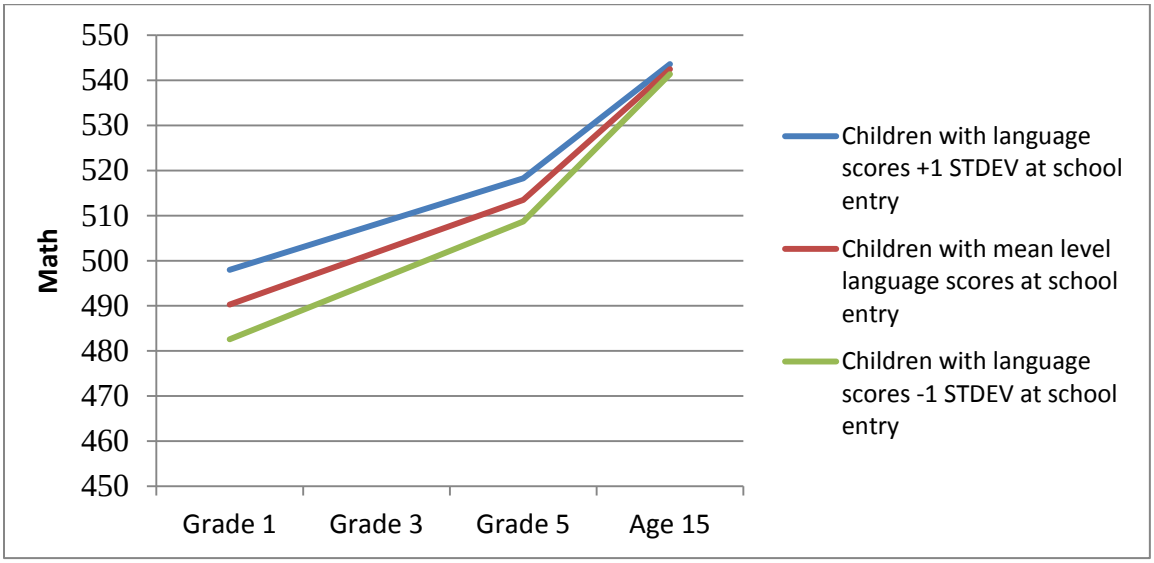
Figure 4. Language skills' association with reading skill growth over time in NICHD SECCYD



Source: NICHD SECCYD dataset

When examined independently, higher school-entry skills related to later higher reading skills (d=.50) with a very slight quadratic curvature. When examined with other school readiness skills, higher school-entry skills were also related to higher reading skills (d=.26), again with a very small quadratic curvature, suggesting slightly smaller reading (d=-.06) gains over time.

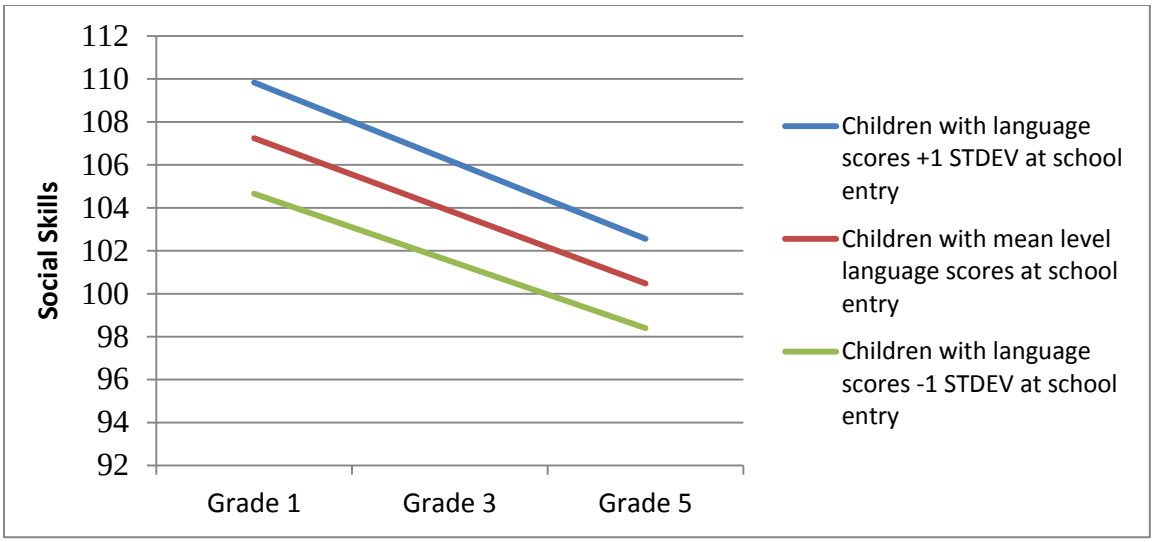
Figure 5. Language skills' association with math skill growth over time in NICHD SECCYD



Source: NICHD SECCYD dataset

Figure 5 above similarly shows the change in math scores from first grade through age 15 among children with various levels of language skills at school entry. Here, students showed a higher rate of development in math skills earlier in elementary school. The rate of growth tapered off in later elementary school and through age 15, meaning that when examined alone, higher school-entry skills related to later math skills (d=.47) with a very slight quadratic curvature for math outcomes. When examined with other school readiness skills, higher school-entry skills again related to higher math skills (d=.19) with slightly smaller math gains (d=-.05) over time.

Figure 6. Language skills' association with social skills growth over time in NICHD SECCYD



Source: NICHD SECCYD dataset

Figure 6 above shows the change in social skills from first grade through fifth grade among children with varying language scores at school entry. When examined alone, higher school-entry skills related to later social skills (d=.19) and fewer behavior problems (d = -.10) with a very slight quadratic curvature for social skills outcomes. When examined with other school readiness skills, higher school-entry skills again related to higher social skills (d=.14).

These and other non-linear associations between school readiness skills with both level and linear rate of change in school-age outcomes indicated a very small tendency for children who entered school with lower skill levels to have slightly higher levels than would be expected from a simple linear prediction model from their entry skills level. These non-linear patterns did not show evidence of "catch up" but did appear to reflect school's positive influence on promoting skill development.

No other analyses uncovered a "springboard effect" or any other evidence of thresholds. None of the four analyses showed any evidence of a "springboard effect" whereby above a threshold of school readiness children showed accelerated growth over time. This conclusion held whether looking at skill levels within individual school readiness domains or when looking at the patterns of skills at school entry across multiple domains. However, the datasets employed in these analyses were not designed for this type of analysis which prevented a definitive look at this topic. Even when looking at "in the running" cutpoints at fifth grade with a regression analysis, no evidence existed for a threshold of school readiness skills that promoted later success for children with characteristics that denoted risk of negative outcomes.

Do children who are in the low and normal range in school readiness skills differ in terms of their trajectories of academic and social outcomes during elementary school?

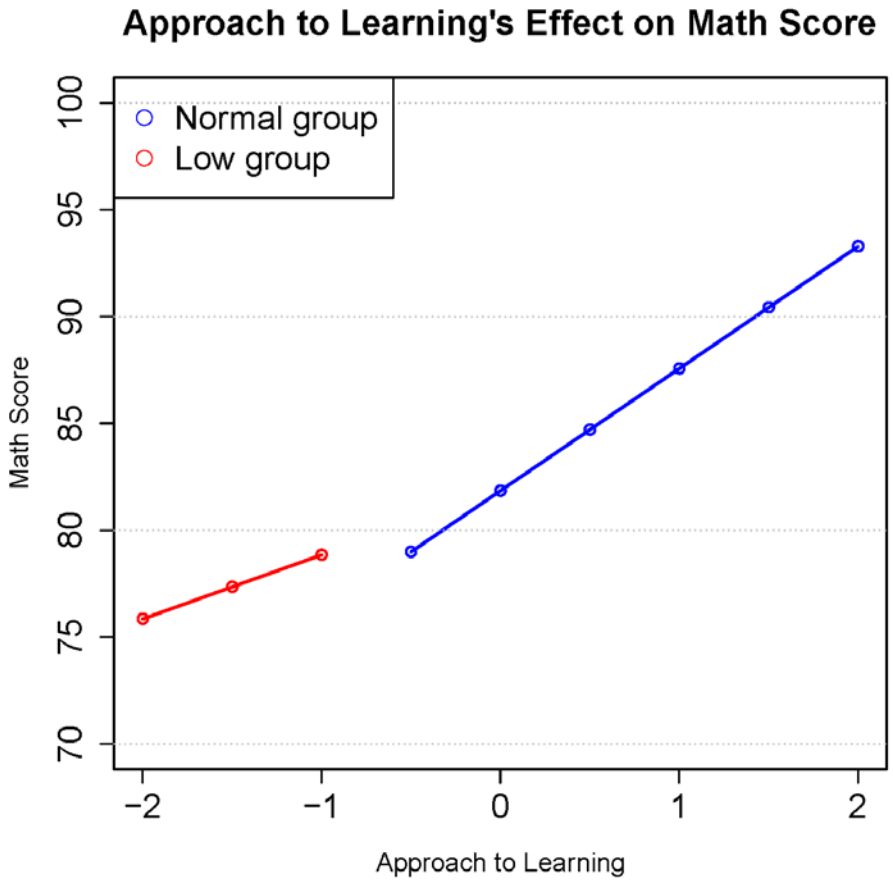
Children who entered school with lower skill levels continued to perform less well throughout schooling. Children who entered school with skills one standard deviation or more below the average tended to remain in the lower range on these skills over time. For children who entered kindergarten with skills in a normal range, school readiness skills were a moderately strong predictor of the *level of skills* in later schooling, particularly within domains of development. For instance cognitive school readiness skills were the best predictors of later cognitive skills while social-emotional skills at school entry were the best predictors of later social-emotional and behavioral skills. There were also modestly strong predictors across domains (e.g., for children in the low range of school readiness skills, these relations between school readiness and levels of later skills were reliably weaker). That is, children who started off well were likely to continue to do well and those who started out with lower skill levels grew at a faster rate than their peers but never caught up to their overall skill level.

Piecewise analysis did find some limited evidence of thresholds. The analyses of the NICHD SECCYD data that examined each school readiness variable individually found reliably stronger prediction in the normal range than low range of overall levels of language reading, math, and social skills for all school readiness variables except health. In contrast, this analysis indicated stronger prediction of beneficial changes over time in externalizing and social skills in the low range than the normal range in school-

entry of social skills. These findings are highlighted in more detail when evidence of thresholds within and across domains is discussed.

Figures 7 and 8 show the interactive effects of school readiness variables on math and social-emotional attainment at grade 3 for low and normal groups. Figure 7 shows how children's initial scores on approaches to learning influence their later math scores. The analysis found stronger prediction for children in the normal range than for those in the low range, as evidenced by the steeper slope of the blue line representing the normal group as compared to the red line representing the low group; the steeper slope of the normal group shows a stronger predictive power between the approaches to learning and math skills.

Figure 7. Piecewise analysis showing approaches to learning's effect on math scores in third grade in ECLS-K

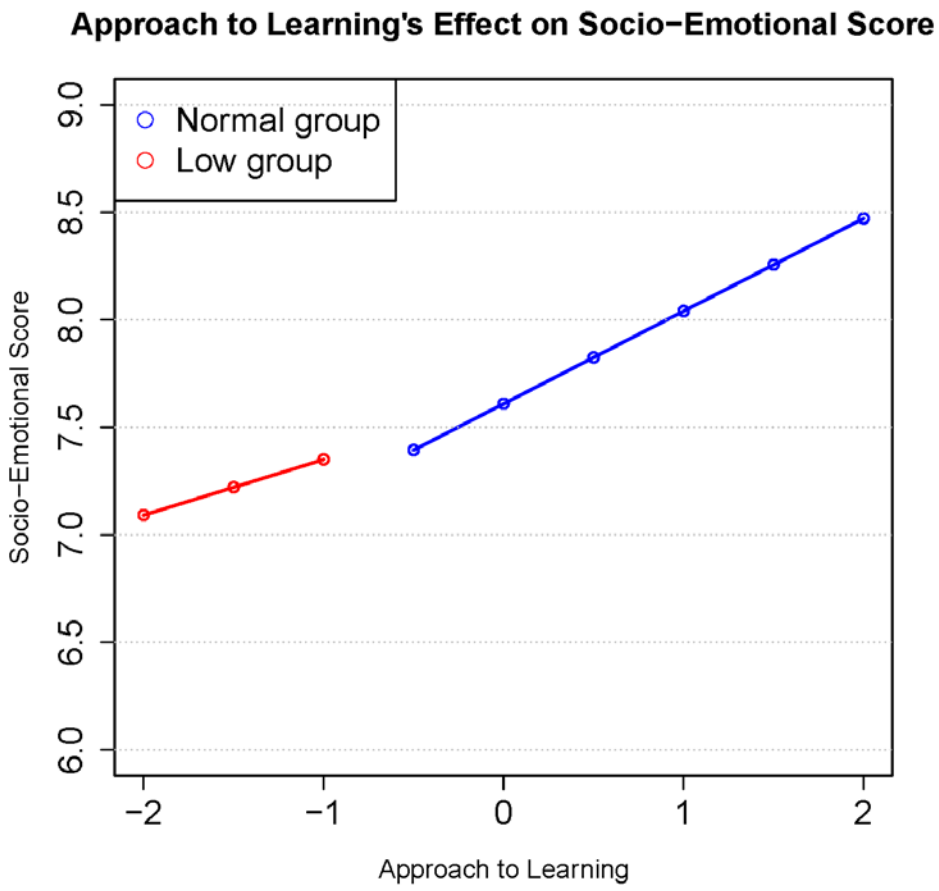


Source: ECLS-K dataset

Figure 8 shows how children's initial scores for approaches to learning influence their later scores in the social-emotional domain; the plot shows the same pattern as the analysis regarding math scores. The fact that the low and normal groups had differing slopes in figures 7 and 8 suggested that where

children entered school (in this case above or below a skill cutpoint) did indeed impact their later rate of growth and that children who entered school with different skill levels had different outcomes. This finding showed evidence of thresholds.

Figure 8. Piecewise analysis showing approaches to learning's effect on social-emotional scores in third grade in ECLS-K



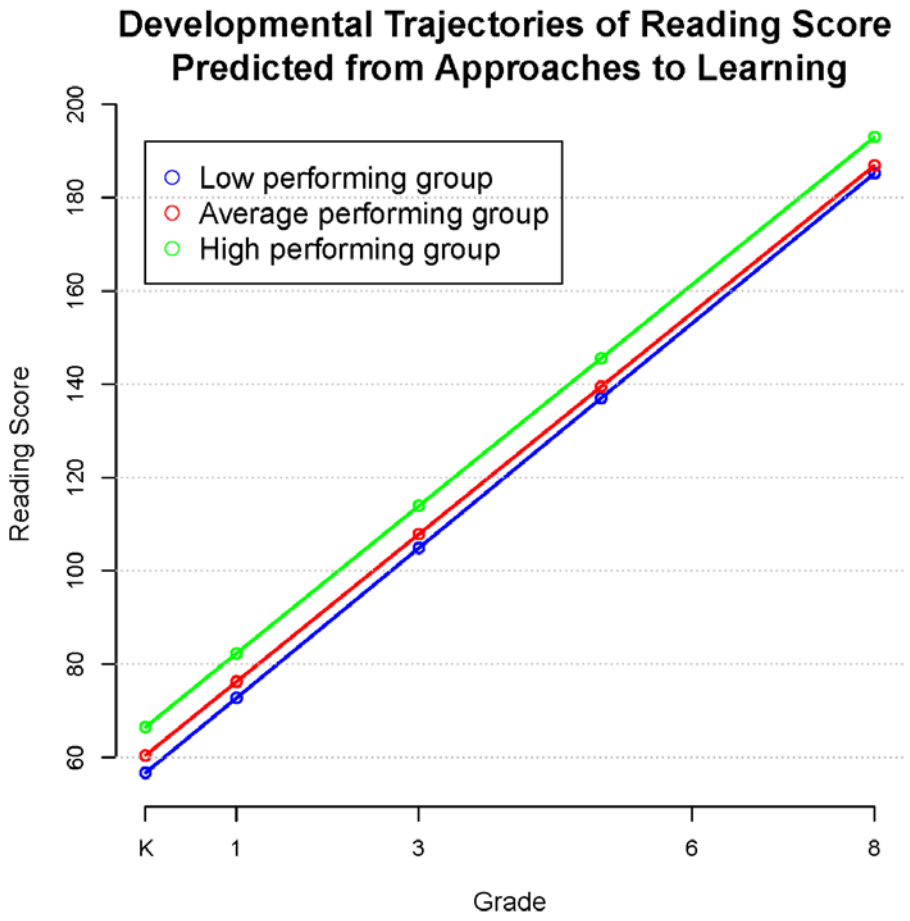
Source: ECLS-K dataset

When all school readiness variables were considered together in the NICHD SECCYD data set, there was stronger prediction of overall level in reading and math during the school years for children who entered school in the normal range on language, reading, and math skills and stronger prediction of overall level in social skills and externalizing problems during the school years for children in the normal range than those the low range for social skills and approaches to learning at entry to school. There were similar findings in ECLS-K, with significantly stronger prediction of overall level for all school-age outcomes from school entry skills among children in the normal range than in the low range. In other words, the skills of children who started out in the normal range at school entry were more predictive of their later growth and outcomes than were the skills of the children who started school in the low range.

Analysis showed less evidence of thresholds in predicting rate of change over time in the school-age trajectories, but analyses with ECLS-K found that children in the lower range on general knowledge, math, reading, and approaches to learning tended to show faster gains over time on at least one school-age outcome (i.e., general knowledge and reading at school age and reading during school years; math and reading at school entry and math during school years; approaches to learning at school entry and social skills during school years). Finally, health at entry to school showed no associations with the selected school-age academic and behavior outcomes.

Figure 9 below shows the outcome that suggested very modest catch up in the group with low performance in approaches to learning (defined as 1 standard deviation below the sample mean). The figure shows the faster gains made over time by the low group for approaches to learning on reading. The gap between the low performing group and those at the average and high performing group (defined respectively as being at and 1 standard deviation above the sample mean in approaches to learning) is larger at kindergarten than it is as grade 8, demonstrating a faster rate of growth in the low group and modest catch-up despite their inability to reach the overall achievement level of the normal group.

Figure 9. Reading score trajectories from approaches to learning in ECLS-K



Source: ECLS-K dataset

School readiness variables provided differential prediction of developmental outcomes. Both the piecewise analyses and the ITR domain-specific index analyses found that within domain prediction was always strongest. For example, entry-level math skills provided the best prediction of subsequent math skills and entry-level social skills provided the best prediction of subsequent social skills. There was also evidence that, after the school readiness skill in the same domain, content-based skills (e.g., language and general knowledge) were the second best predictors of academic skills later in elementary school, whereas social skills and process skills (e.g., executive function and approaches to learning) were the second best predictors of later behavioral skills.

There was a general tendency toward stronger prediction of academic trajectories (level and change – albeit less often) from school readiness skills for children in the normal range than for children in the low range. All instances indicating thresholds in the SECCYD met this pattern whereas about 2/3 of the cases in the ECLS-K did.

There was no compensatory nature between the school readiness domains and their associations with outcomes over time. The HLM and the latent profile analyses found neither a group of children with strong social-emotional skills but weak cognitive skills at kindergarten entry who showed stronger academic gains, nor or a group of children with weak social and strong academic skills at school entry who showed stronger social gains. When all school readiness variables were considered jointly, school readiness skills were always the strongest predictors of alter outcomes in that same domain. When school readiness variables were examined individually, there were many more findings. There was some evidence suggesting thresholds for math, social skills, approaches to learning, and executive function in predicting the intercepts in all school-age trajectories and for language and reading in predicting all trajectories except externalizing in NICHD SECCYD. There were similar but slightly weaker findings in ECLS-K, with significant prediction of all outcomes for general knowledge, social skills, approaches to learning, and math. There was less evidence of thresholds in predicting rate of change over time in the school-age trajectories. Health at entry to school showed few associations.

Entry status relationship to later outcomes (within and across domains)

When school readiness variables were examined separately, several domain-specific findings emerged. For example, when examined alone in the NICHD SECCYD data set, higher levels of language, reading, attention, social, and approaches to learning skills were related to higher levels of all school-age outcomes. Modest negative quadratic associations for school-entry language, reading, and math suggested that there was some decrement in this positive association at the higher school readiness skills. That is, the relationship between these entry skills and later skills may not have been as strong for those students with the highest school entry skills. Few associations with rates of change over time emerged, but there was some suggestion of faster rates of acquisitions of reading and math skills being related to lower school entry skills in language and attention.

When all school readiness skills were examined together, higher school-entry skills in language, reading, math, attention and approaches to learning were related to higher levels of school-age outcomes (i.e., school entry skills in language, reading and math with school-age language, reading and math, school entry skills in attention and approaches to learning with school-age externalizing and social skills). Again, there was evidence that this association was not at strong at the higher levels of school-entry skills in language. Similar trends emerged in analyses of the ECLS-K with school-entry skills in general knowledge, math, reading, social skills, and approaches to learning predicting the level of school-age outcomes. Again, there were nonlinear associations for general knowledge, math, reading, social skills, and approaches to learning that tended to suggest weaker associations at the highest levels.

Piecewise models of school readiness skills uncovered findings that were quite similar to those from the quadratic school readiness models. As with the quadratic models, the piecewise models found that school readiness skills tended to provide the stronger prediction of within-domain outcomes than of outcomes from other domains. For example, math skills at entry to school provided the best prediction of math skills during the school years. General knowledge in the ECLS-K and language/literacy in the NICHD SECCYD tended to be the next strongest predictor of academic skills (reading, math). Executive functioning and approaches to learning tended to be the next strongest predictor of behavioral skills. Table 13 below shows the piecewise analysis findings for evidence of thresholds and trajectories of growth in each domain of school readiness for each of the two datasets.

Table 13. Summary of findings from piecewise analyses predicting outcomes across both datasets

School Readiness Variable	NICHD SECCYD	ECLS-K
Language/ General Knowledge	1. Evidence of stronger positive prediction of the subsequent level of reading, math, and language skills in normal range than low range. 2. Evidence of positive prediction of externalizing for both low and normal groups.	1. Evidence of stronger positive prediction of subsequent levels of reading and math in low range than in normal range—only when entry skills in reading and math were also considered. 2. Evidence of positive prediction of externalizing for both low and normal groups.
Reading	1. Evidence of stronger positive prediction of the subsequent level of reading, math, and language skills in children in the normal range than in the low range.	1. Not related when considered with all other school readiness skills, but evidence of stronger positive prediction of the level of subsequent levels of reading, math, and social skills for children in normal range than low range when school readiness variables were considered individually.
Math	1. Evidence of stronger positive prediction of the subsequent level of reading and math for children in the normal range than in the low	1. Evidence of stronger positive prediction of the subsequent level of math skills and rate of learning to read for children in normal range than low range.

School Readiness Variable	NICHD SECCYD	ECLS-K
	range.	2. Some evidence that acquisition of academic skills was faster among children in the low than normal range.
Social Skills	1. Evidence of stronger positive prediction of the subsequent level of social skills for children in normal range than low range – but very strange conditional findings for predicting externalizing when all other school readiness variables were also considered. 2. In all analyses, it appears that children in the normal range showed greater increases in externalizing and more decline in social skills over time than did children in low range.	1. Evidence of stronger positive prediction of the subsequent level of social skills and less negative prediction of externalizing for children in normal range than low range. It appears that children in the normal range tended to show more declines in social skills but fewer increases in externalizing than did children in the low range.
Approaches to learning	1. Evidence of stronger prediction of the subsequent level of externalizing, social skills, and vocabulary skills in the normal range than in the low range. Also evidence of larger decline in externalizing over time in normal range than low range.	1. Evidence of stronger positive prediction of the subsequent level of math skills for children in the normal range than low range. 2. Evidence of prediction of the subsequent level of social skills and externalizing, but not of a threshold.
Executive Function	1. Evidence of stronger prediction of the subsequent level of math and social skills in the normal range than in the low range. 2. Evidence of negative association with the subsequent level of externalizing, but no evidence of a threshold	(Not applicable)

Do children who have qualitatively different patterns of school readiness skills differ in their likelihood of success based on our categorization of their fifth grade academic and social skills?

The regression analysis using the empirical method for defining outcomes in fifth grade found that children characterized as "in the running" in fifth grade were from more advantaged backgrounds at kindergarten entry, were more likely to be in the "On Track" or "High in Academics" school readiness profiles, and performed higher in each of the school readiness domains at kindergarten entry. These

findings were consistent across the full sample and a sample of children who lived in families with incomes less than 200% of the poverty threshold.

In addition, children who were categorized as "in the running" in fifth grade were performing significantly better in each of the school readiness domains at kindergarten entry than children who were not categorized as "in the running" in fifth grade. This pattern also held true for both the full sample and low-income (< 200% poverty) subsample.

The results using the conceptual method for defining outcomes in fifth grade showed the same pattern as the empirical method. Again, children from more advantaged backgrounds at kindergarten entry were more likely to be categorized as "in the running" in fifth grade on the conceptually-based indices of "in the running." And, children who were categorized as "in the running" on the conceptual versions of the indices in fifth grade were performing significantly better in each of the school readiness domains at kindergarten entry. As with the empirical method, these findings were true for the full sample and for the low-income subsample.

Overall, whether fifth grade outcomes were determined empirically or conceptually, scores on school readiness measures predicted to fifth grade outcomes that research indicated to be related to remaining in school.

IV. Discussion

These secondary data analysis findings have contributed to an emerging picture of school readiness skills and developmental trajectories. While there was not overwhelming evidence of thresholds in each of the four analyses, the piecewise analysis did uncover some evidence of partial catch-up for those children entering school with lower achievement levels or skills. This finding stresses the importance of helping all children improve their skills before school entry, even though there does not appear to be a single threshold of performance that serves as a springboard for future success. Additionally, the analyses highlighted many of the limits of the data sources available for analysis. Taken together, both the study's findings and limitations suggest potential directions for future data collection and research, as well as guidance for key decisions and goals facing educators and policymakers.

The multiple analytic strategies employed as part of the *In the Running* project were primarily exploratory in nature and involved using latent profile analysis, hierarchical linear modeling, piecewise analysis, and regression analysis. Regardless of the analytic strategy, a single story emerged with a relatively similar pattern of results across two different datasets. Below is a summary of what the findings from the different analytic approaches suggest about being "in the running" for later school success.

Key Conclusions from this Study

Overall, the school readiness skills with which a child enters school do seem to matter in terms of level and rate of acquisition of academic and social skills during elementary school, with some

evidence that whether those skills are in the normal range predict patterns of subsequent academic and social skill. The analyses presented in this study corroborated findings shown elsewhere: strong school readiness skills were associated with higher performance in later schooling, both for cognitive and behavioral outcomes. But, the effects of early skills on later achievement were probabilistic, not deterministic; children with lower school entry skills were likely to show lower achievement later in school, but children with lower levels of entry skills showed greater improvement over time than their peers with higher skills at school entry. This suggests that it might be important for children to enter school within the normal range (i.e., no lower than one standard deviation below the mean), or at least close to the normal range, to show a stronger likelihood for positive, linear growth in skills over time. But the findings also suggest that improving children's school readiness skills will benefit them no matter where they may be on the continuum. **Children do not need to reach the national average for achievement in order to be "in the running" for later school success, but the better a child's skills are when he or she enters school, the better his or her skills are likely to be in elementary school and beyond.**

This study shed new light on the concept of school readiness and its relationship with later outcomes. No one school readiness skill emerged as the strongest predictor of subsequent academic skills and behavior. Instead, the skill levels within that domain provided good prediction of subsequent skills. Further, the findings indicated that it appears that children who enter school with both strong process skills such as higher levels of executive functioning and approaches to learning and strong content skills such as stronger language and general knowledge skills are more likely to experience success in terms of both behavior and academic skills during their school years. **The fact that there was differential prediction from entry skills to later skills but no single school readiness skill emerged as the strongest predictor of both academic and behavioral outcomes emphasizes that children need to develop a constellation of school readiness skills in order to have a better chance of being successful in elementary school and beyond.**

Who is "in the running" for later school success?

While no children appeared to be primed for accelerated growth by being above a particular threshold at school entry, the findings across the four analytic strategies were informative about relationships between school readiness skills and subsequent academic and behavior skills during the school years. Latent profile analysis showed that a portrait of a child who was "in the running" for later school success was a child with higher school readiness skills at school entry. Children who performed at a high level in a certain domain at school entry were likely to perform at a high level in that same domain later in schooling. Similar patterns of association were found in the HLM analyses. Similarly, piecewise school readiness models also suggested that there may be certain levels of performance (i.e., no lower than one standard deviation below the mean) on math, social skills, approaches to learning, executive function, language, and reading that indeed prepared children for later school success. Finally, it was encouraging that the children who showed the larger gains in skill development over time tended to have started school with lower levels of skills. Although these children did not catch up with their peers who started school with substantially higher skill levels in terms of absolute level of performance, the

discrepancy or gap in performance levels decreased over time. This suggests that school itself is likely a critically important intervention for the most at-risk children.

Limitations of the Data and Study

While the *In the Running* project represented a more complex and thorough investigation of school readiness thresholds and trajectories than had previous existed in the literature, the analysis was challenged by limitations, including those stemming from the available data.

A major limitation of this study was the types of data sources available for analyses. Most large-scale national surveys did not use criterion-based measures (i.e., those that compare children to a baseline score rather than to other children) which lend themselves better to cutpoint analyses and which are more similar to the types of measures states and school systems are using currently to assess children's skill levels in kindergarten. Additionally, continuity within skill domains identified by the secondary data analyses may have reflected the types of measures used within versus across domains and may have obscured accurate assessments of children's skills in the same domain over time.

The measurements available in the datasets relied heavily on parent and teacher reports of child behavior or skills as opposed to direct assessments of children's skills and abilities across domains. Teacher- and parent-reports could be subject to response bias or context-specificity. Some national datasets considered for analysis that did contain criterion-based measures (e.g., FACES, NCEDL) unfortunately did not follow children into later elementary school and thus could not be used for prediction of longer-term outcomes. Much more work is needed in this largely unexplored area of study, especially with longitudinal datasets that contain more criterion-based measures. This study, therefore, points to future directions for new data collection efforts as well as for further prospective and retrospective data analyses.

Finally, many of the large-scale national surveys also did not sufficiently sample certain populations, notably dual language learners, or include measures of their development that permitted them to be included in analyses such as the ones conducted for this project.

Summary/Conclusion

One of the main areas of inquiry for the *In the Running* project was whether or not there is a threshold for school readiness skills, either individually or collectively across school readiness domains, that predicts successful outcomes for young children, especially those who are most disadvantaged. The concept of school readiness implies that there is some kind of marker for readiness, and, indeed, many states have attempted to articulate such benchmarks for particular skills and abilities, albeit without much research evidence to support the particular criteria they adopt. The results of the four analyses conducted as part of the *In the Running* project showed limited evidence of these thresholds, but confirmed strongly the importance of school entry skills in predicting later school outcomes. While there was little evidence for a clear "threshold" above which children showed accelerated growth in either academic or social outcomes over time, children who entered school with better skills also had higher

achievement in later elementary school, which suggested benefits associated with helping all children develop their cognitive, social-emotional, and attention skills as much as possible before school entry even if they are not able to reach the same skill levels as their better-performing peers. Collectively, these findings indicate that efforts to support children's school readiness skills prior to school entry are critically important, and that school itself may be an important intervention for those children most at risk of poor outcomes.

As discussed above, the measurement issues faced by this project and by the field in general were also contributors to the findings as well as to the need for future research to further address the questions examined by the *In the Running* project. Currently, there is difficulty in identifying an *a priori* cutpoint for continuous variables in existing datasets; there was some evidence that one standard deviation below the mean (the cutpoint used in these analyses) was a good estimate of children who are doing well versus not. However, a differently operationalized cutpoint that may have more accurately reflected the skill level at which children were truly at risk for poor later school outcomes may have yielded more conclusive or clear evidence of thresholds. Additionally, the lack of criterion-based measures (i.e., those that compared children to a baseline score and not to other children) within existing national, longitudinal datasets may have disguised thresholds that could have been used for other analyses.

Based on the *In the Running* findings along with this discussion of data limitations, recommendations for future research as well as policy and practice can be made. New research can build on the initial findings of the *In the Running* project by including dual language learners and other special populations of interest, incorporating more direct assessments of children's abilities, looking at the early life characteristics associated with different school entry profiles, and continuing to refine the statistical techniques employed in these analyses. Additionally, the comprehensive conceptualization of child development supported by these analyses could be translated into child assessments that view important criterion-based measures within a broader portrait of children's abilities across domains.

Implications and Recommendations for Future Research

Future research can address some of the data, sample, and measurement challenges highlighted in the *In the Running* project. Future data collection efforts can more completely and accurately include dual language learning children and their families by adequately sampling these populations and using appropriate measures of school readiness skills and later outcomes. Additionally, future data collection can use measurement that is more consistent across domains by including more direct assessments in place of teacher or parent reports for social-emotional, behavior regulation, and health outcomes.

The research currently available in the field as well as the non-linear patterns of growth found in the secondary data analysis suggest that development and skills before school entry are critical to later developmental trajectories and outcomes. Future research might examine the early experiences associated with different profiles of school entry skills.

While the examination of thresholds was the project's primary focus, other analytic techniques including looking back from later elementary school success to school readiness skills and creating skill profiles offered different ways to address the *In the Running* project's vital research questions. Future research can continue to develop and refine the technique used in the *In the Running* project: use of multiple analytic methods and replication of findings across multiple, national datasets to address a single, critical question in early childhood research, policy and practice.

Implications for Policy and Practice

Historically, there has been very little research focused on the trajectories and predictive power of kindergarten entry skills. Yet, despite the lack of empirical work to determine adequate school readiness levels within particular skill domains, many decisions are being made within states and school districts about determining children's school readiness. The *In the Running* project is exploratory and only a first step in looking at this important topic from a systematic, empirical standpoint. However, this initial research suggests implications for policy and practice.

While the secondary data analysis did not uncover strong evidence of school readiness thresholds needed to achieve later school success, the differential prediction to outcomes over time based on skill level at school entry still suggested important policy and practice implications. The fact that there was a slightly faster rate of acquisition of skills for children in the low range than for the children in the normal range again stressed the importance of getting each child to the highest level of school readiness skills possible to prime for later growth.

The goal of maximizing child growth before school entry rather than achieving specific skill thresholds has important implications for preschool programs, quality rating and improvement systems (QRIS), and school entry assessments. If children do not need to reach specific thresholds of skills before school entry, but do benefit from pre-kindergarten development as suggested by *In the Running* analyses, early care and education programs and the QRIS systems designed to evaluate them should focus on improving quality that leads to continuous development of children's skills across developmental domains rather than trying to get children to reach a single target or average for a particular skill. Measures that focus on getting a child to a specific skill threshold may too easily dismiss children at the low end of the scale, even though they could benefit tremendously from continued improvement even if they do not attain the national norm. Additionally, threshold-based child assessments may also dismiss the continued growth of children at or above the threshold as of lesser importance, although the better scores children have at school entry, the more likely they are to have better performance later in school. While criterion-based skill measures are critically important to identifying and tracking a child's development, they should not be used to create artificial thresholds of achievement.

School readiness assessments used by many states and school districts to determine whether children are ready to enter kindergarten may also benefit from this more comprehensive approach to using criterion-based measures of child development. Readiness assessments that rely on documentation of children's skills and abilities over time instead at a single time point may better gauge children's skills

and abilities, and are recommended for more accurately assessing the abilities of children with special needs. These “authentic” assessments may help to identify children in need of specific supports by collecting data on each child across a variety of cognitive, social-emotional, and behavioral variables and using this baseline data to tailor instruction specific to each child’s needs, in this way supporting children’s growth across all domains as they enter and progress through school.

References

Abbott-Shim, M., Lambert, R., & McCarty, F. (2003). A comparison of school readiness outcomes for children randomly assigned to a Head Start program and the program's wait list. *Journal of Education for Students Placed at Risk, 8*(2), 191-214.

Adams, A. M., Bourke, L., & Willis, C. (1999). Working memory and spoken language comprehension in young children. *International Journal of Psychology, 34*, 364-373.

Administration for Children and Families. (2005). Head Start Impact Study: First Year Findings. Washington, DC: U.S. Department of Health and Human Services.

Administration for Children and Families. (2010). *Head Start Impact Study. Final Report*. Washington, DC: U.S. Department of Health and Human Services.

Ames, C. (1992). Classrooms: Goals, structures, and student motivation. *Journal of Education Psychology, 84*(3), 261-271.

Annuziata, D., Hogue, A., Faw, L., & Liddle, H. A. (2006). Family functioning and school success in at-risk, inner-city adolescents. *Journal of Youth & Adolescence, 35*(1), 105-113.

Balfanz, R., Hezog, L., & Mac Iver, D. J. (2007). Preventing student disengagement and keeping students on the graduation path in urban middle-grades schools: Early identification and effective interventions. . *Educational Psychology, 42*(4), 223-235.

Barbarin, O., Bryant, D., McCandies, T., Burchinal, M., Early, D., Clifford, R., Pianta, R....Howes, C. (2006). Children enrolled in public pre-k: The relation of family life, neighborhood quality, and socioeconomic resources to early competence. *American Journal of Orthopsychiatry, 76*(2), 265-276.

Barkley, R. A. (1994). The assessment of attention in children. In G. R. Lyon (Ed.), Eds.). *Frames of reference for the assessment of learning disabilities: New views on measurement issues* (pp. 69-102). Baltimore, MD: Paul H. Brookes.

Barnard, W. M. (2004). Parent involvement in elementary school and educational attainment. *Children and Youth Services Review, 26*, 39-62.

Belsky, J., Burchinal, M., McCartney, K., Vandell, D. L., Clarke-Stewart, A., & Owen, M. T. (2007). Are there long-term effects of early child care? *Child Development, 78*(2), 681-701.

Bialystok, E. (2001). *Bilingualism in development: Language, literacy & cognition*. Cambridge, England: Cambridge University Press.

Bierman, K. L., Torres, M. M., Domitrovich, C. E., Welsh, J. A., & Gest, S. D. (2008). Behavioral and cognitive readiness for school: Cross-domain associations for children attending Head Start. *Social Development, 18*(2), 305-323.

Blair, C., & Razza, R. P. (2007). Relating effortful control, executive function, and false belief understanding to emerging math and literacy ability in kindergarten. *Child Develoment, 78*(2), 647-663.

Bodrova, E., & Leong, D. J. (2007). *Tools of the Mind: The Vygotskian approach to early childhood education* (2nd ed.). New York: Prentice Hall.

Borman, G. D., & Overman, L. T. (2004). Academic resilience in mathematics among poor and minority students. *The Elementary School Journal, 104*(3), 177-195.

Brewster, A. B., & Bowen, G. L. (2004). Teacher support and the school engagement of Latino middle and high school students at risk of school failure. *Child and Adolescent Social Work Journal, 21*(1), 47-67.

Brooks-Gunn, J., & Duncan, G. (1997). The effects of poverty on children. *The Future of Children, 7*(2).

Bull, R., & Scerif, G. (2001). Executive funtioning as a predictor of children's mathematics ability: Inhibition, switching, and working memory. *Developmental Neuropsychology, 19*(3), 273-293.

Bushnik, T., Barr-Telford, L., & Bussiere, P. (2004). In and out of high school: First results from the second cycle of the Youth in Transition Survey, 2002. Statistics Canada catalogue no. 81-595-MIE-No. 014. Ottawa, Canada.

Cairns, R. B., & Cairns, B. D. (1994). *Lifeline and risks: Pathways of youth in our time*. New York: Cambridge University Press.

Carpenter, M., Nagell, K., & Tomasello, M. (1998). Social cognition, joint attention, and communicative competence from 9 to 15 months of age. *Monographs of the Society for Research in Child Development, 63*(4), Serial No. 255.

Cassidy, J. (1994). Emotion regulation: Influences of attachment relationships. In N. A. Fox (Ed.), Eds.). *The development of emotion regulation and dysregulation: Biological and behavioral aspects* (pp. 228-249). Monographs of the Society for Research in Child Development: 59(2-3), Serial No. 240.

Centers for Disease Control. (2004). Preventing Chronic Diseases: Investing Wisely in Health, Preventing Dental Caries U.S. Department of Health and Human Services.

Chang, H. N., & Romero, M. (September 2008). Present, engaged, and accounted for: The critical importance of addressing chronic absence in the early grades. Retrieved from http://www.nccp.org/publications/pdf/text_837.pdf

Committee on Family and Work Policies. (2003). Working families and growing kids: Caring for children and adolescents. Washington, DC: National Academies Press.

Committee on the Prevention of Reading Difficulties in Young Children. (1998). Preventing Reading Difficulties in Young Children. National Academy of Sciences.

Damon, W., & Eisenberg, N. (Eds.). (1998). *Handbook of child psychology: Vol. 3. Social, emotional, and personality development*. New York: Wiley.

Denham, S. A. (1986). Social cognition, prosocial behavior, and emotion in preschoolers: Contextual validation. *Child Development, 57*, 194-201.

Denham, S. A., McKinley, M., Couchoud, E. A., & Holt, R. (1990). Emotional and behavioral predictors of preschool peer ratings. *Child Development, 61*, 1145-1152.

Diamond, A. (2002). Normal development of prefrontal cortex from birth to young adulthood: Cognitive functions, anatomy, and biochemistry. In D. Stuss & R. Knight (Eds.), Eds.). *Principles of frontal lobe function* (pp. 466-503). New York: Oxford.

Diamond, K. E., Reagan, A. J., & Bandyk, J. E. (2000). Parents' conceptions of kindergarten readiness: Relationships with race, ethnicity, and development. *The Journal of Educational Research, 94*(2), 93-99.

Dotterer, A. M., McHale, S. M., & Crouter, A. C. (2007). Implications of out-of-school activities for school engagement in African American adolescents. *Journal of Youth & Adolescence, 36*, 391-401.

Duchesne, S., Vitaro, F., Larose, S., & Tremblay, R. E. (2008). Trajectories of anxiety during elementary-school years and the prediction of high school noncompletion. *Journal of Youth & Adolescence, 37*, 1134-1146.

Eisenberg, N., & Fabes, R. A. (1998). Prosocial development. In W. Damon & N. Eisenberg (Eds.), Eds.). *Handbook of child pyschology: Vol. 3. Social, emotional, and personality development* (pp. 701-778). New York: Wiley.

Englund, M. M., Engeland, B., & Collings, W. A. (2008). Exceptions to high school dropout predictions in a low-income sample: Do adults make a difference. *Journal of Social Issues, 64*(1), 77-93.

Entwisle, D. R., & Alexander, K. L. (1999). Early schooling and social stratification. In R. C. Pianta & M. J. Cox (Eds.), Eds.). *The transition to kindergarten* (pp. 13-38). Baltimore, MD: Paul H. Brookes Publishing Co.

Espinosa. (2006). English-language learners as they enter school (DRAFT). Columbia, MO: University of Missouri.

Espinosa, L. M. (2006). *Young English language learners in the U.S*. Parents as Teacher News. Fall 2006.

Espy, K. A., McDiarmid, M. M., Cwik, M. F., Stalets, M. M., Hamby, A., & Senn, T. E. (2004). The contribution of executive functions to emergent mathematic skills in preschool children. *Developmental Neuropsychology, 26*(1), 465-486.

Estabrooks, P., Fisher, E., & Hayman, L. (2008). What is needed to reverse the trends in childhood obesity? A call to action. *Annals of Behavioral Medicine, 36*(3), 209-216.

Fabes, R. A., Gaertner, B. M., & Popp, T. K. (2006). Getting along with others: Social competence in early childhood. In K. McCartney & D. Phillips (Eds.), Eds.). *Blackwell handbook of early childhood development* (pp. 297-316). Malden, MA: Blackwell Publishing.

Fantuzzo, J., Perry, M. A., & McDermott, P. (2004). Preschool approaches to learning and their relationship to other relevant classroom competencies for low-income children. *School Psychology Quarterly, 19*(3), 212-230.

Feinstein, L., & Bynner, J. (2004). The importance of cognitive development in middle childhood for adulthood socioeconomic status, mental health, and problem behavior. *Child Development, 75*(5), 1329-1339.

Fenson, L., Dale, P. S., Reznick, J. S., Bates, E., Thal, D. J., & Pethick, S. J. (1994). Variability in early communicative development. *Monographs of the Society for Research in Child Development, 59*(5), Serial No. 242.

Finn, J. D., Gerber, S. B., & Boyd-Zaharis, J. (2005). Small classes in the early grades, academic achievement, and graduating from high school. *Journal of Educational Psychology, 97*(2), 214-223.

Fitzgerald, J. (1993). Literacy and students who are learning English as a second language. *The Reading Teacher, 46*(8), 638-647.

Fryer, R., & Levitt, S. (2004). Understanding the black-white test score gap in the first two years of school. *The Review of Economics and Statistics, 86*, 447-464.

Fuchs, L. S., Geary, D. C., Compton, D. L., Fuchs, D., Hamlett, C. L., & Bryant, J. D. (2010). The contributions of numerosity and domain-general abilities to school readiness. *Child Develoment, 81*(5), 1520-1533.

Gelman, R. (2000). The epigenesis of mathematical thinking. *Journal of Applied Developmental Psychology, 21*(1), 27-37.

Gelman, S. A. (2006). Early conceptual development. In K. McCartney & D. Phillips (Eds.), Eds.). *Blackwell handbook of early childhood development* (pp. 149-166). Malden, MA: Blackwell Publishing.

Ginsburg, H. P., Cannon, J., Eisenband, J., & Pappas, S. (2006). Mathematical thinking and learning. In K. McCartney & D. Phillips (Eds.), Eds.). *Blackwell handbook of early childhood development* (pp. 208-229). Malden, MA: Blackwell Publishing.

Gleason, P., & Dynarksi, M. (2002). Do we know whom to serve? Issues in using risk factors to identify dropouts. *Journal of Education for Students Placed at Risk, 7*(1), 25-41.

Gortmaker, S. L., Walker, D., Weitzman, M., & Sobol, A. (1990). Chronic conditions, socioeconomic risks, and behavioral problems in children and adolescents. *Pediatrics, 85*(3), 267-276.

Goswami, U. (2010). *The Wiley-Blackwell handbook of childhood cognitive development*. Hoboken, NJ: Wiley-Blackwell.

Gutman, L. M., Sameroff, A. J., & Cole, R. (2003). Academic growth curve trajectories from 1st grade to 12th grade: Effects of multiple social risk factors and preschool child factors. *Developmental Psychology, 39*(4), 777-790.

Hair, E., Halle, T., Terry-Humen, E., Lavelle, B., & Calkins, J. (2006). Children's school readiness in the ECLS-K: Predictions to academic, health, and social outcomes in first grade. *Early Childhood Research Quarterly, 21*, 431-454.

Halle, T., Forry, N., Hair, E., Perper, K., Wandner, L., & Vick, J. (2009). *Disparities in Early Learning and Development: Lessons from the Early Childhood Longitudinal Study – Birth Cohort (ECLS-B)*. Washington, DC: Child Trends.

Han, W. (2006). Academic achievements of children in immigrant families. *Educational Research and Review, 1*(8), 286-318.

Happaney, K., Zelazo, P. D., & Stuss, D. (2004). Development of orbitofrontal function: Current themes and future directions. *Brain and Cognition, 55*(1), 1-10.

Hedley, A. A., Ogden, C. L., Johnson, C. L., Carroll, M. D., Curtin, L. R., & Flegal, K. M. (2004). Prevalence of overweight and obesity among U.S. children, adolescents, and adults, 1999-2002. *Journal of the American Medical Association, 291*(23), 2847-2850.

Hill, J., Brooks-Gunn, J., & Waldfogel, J. (2003). Sustained effects of high participation in an early intervention for low-birth-weight premature infants. *Developmental Psychology, 39*(4), 730-744.

Hirschfeld, L. A., & Gelman, S. A. (1994). *Mapping the mind: Domain specificity in cognition and culture*. Cambridge: Cambridge University Press.

Hoff, E. (2006). Language experience and language milestones during early childhood. In K. McCartney & D. Phillips (Eds.), Eds.). *Blackwell handbook of early childhood development* (pp. 234-251). Malden, MA: Blackwell Publishing.

Howse, R. B., Lange, G., Farran, D. C., & Boyles, C. D. (2003). Motivation and self-regulation as predictors of achievement in economically disadvantaged young children. *Journal of Experimental Education, 71*, 151-174.

Hyson, M. (2008). *Enthusiastic and engaged learners: Approaches to learning in the early childhood classroom*. New York: Teachers College Press.

Jimerson, S., Egeland, B., Sroufe, A., & Carlson, B. (2000). A prospective longitudinal study of high school dropouts examining multiple predictors across development. *Journal of School Psychology, 38*(6), 525-549.

Justice, L. M., Bowles, R. P., Turnbull, K. L. P., & Skibbe, L. E. (2009). School readiness among children with varying histories of language difficulties. *Developmental Psychology, 45*(2), 460-476.

Kagan, S. L., Moore, E., & Bradekamp, S. (Eds.). (1995). *Reconsidering children's early learning and development: Toward common views and vocabulary (Report of the National Education Goals Panel, Goal 1 Technical Planning Group, No. ED 391 576*. Washington, DC: U.S. Government Printing Office.

Kim, J., Murdock, T., & Choi, D. (2005). Investigation of parents' beliefs about readiness for kindergarten: An examination of National Household Education Survey. *Educational Review Quarterly, 29*(2), 3-17.

Kirkham, N., Cruess, L., & Diamond, A. (2003). Helping children apply their knowledge to their behavior on a dimension-switching task. *Developmental Science, 6*, 449-476.

Knudsen-Lindauer, S. L., & Harris, K. (1989). Priorities for kindergarten curricula: Views of parents and teachers. *Journal of Research in Childhood Education, 4*, 51-61.

Kokko, K., Tremblay, R. E., Lacourse, E., Nagin, D. S., & Vitaro, F. (2006). Trajectories of prosocial behavior and physical aggression in middle childhood: Links to adolescent school dropout and physical violence. *Journal of Research on Adolescence, 16*(3), 403-428.

Konold, T. R., & Pianta, R. C. (2005). Empirically-derived, person-oriented patterns of school readiness in typically-developing children: Description and prediction to first-grade achievement. *Applied Developmental Science, 9*(4), 174-187.

Lamb, M. E. (1998). Nonparental child care: Context, quality, correlates. In W. Damon, I. E. Sigel & K. A. Renninger (Eds.), Eds.). *Handbook of child psychology, volume 4: Child psychology in practice* (5th ed., pp. 73-134). New York: Wiley.

Lee, V., & Burkham, D. (2002). Inequality at the starting gate: Social background differences in achievement as children begin school. Washington, DC: Economic Policy Institute.

Lehr, C. A., Sinclair, M. F., & Christenson, S. L. (2004). Addressing student engagement and truancy prevention during elementary school years: A replication study of the Check & Connect model. *Journal of Education for Students Placed at Risk, 9*(3), 279-301.

Lin, H., Lawrence, F. R., & Gorrell, J. (2003). Kindergarten teachers' views of children's readiness for school. *Early Childhood Research Quarterly, 18*(2), 225-237.

McCartney, K., Dearing, E., Taylor, B., & Bub, K. (2007). Quality child care supports the achievement of low-income children: Direct and indirect pathways through caregiving and the home environment. *Journal of Applied Developmental Psychology, 28*(5), 411-426.

McClelland, M. M., Acock, A. C., & Morrison, F. J. (2006). The impact of kindergarten learning-related skills on academic trajectories at the end of elementary school. *Early Childhood Research Quarterly, 21*(4), 471-490.

McClelland, M. M., Cameron, C. E., Wanless, S. B., & Murray, A. (2007). Executive function, behavioral self-regulation, and social-emotional competence. In O. Saracho & B. Spodek (Eds.), Eds.). *Contemporary perspectives on social learning in early childhood education* (pp. 83-107). Charlotte, NC: Information Age Publishing.

McClelland, M. M., & Morrison, F. J. (2003). The emergence of learning-related social skills in preschool children. *Early Childhood Research Quarterly, 18*(2), 206-224.

McLoyd, V. C. (1998). Socioeconomic disadvantage and child development. *American Psychologist, 53*, 185-204.

Meisels, S. (1999). Assessing readiness. In R. C. Pianta & M. J. Cox (Eds.), Eds.). *The transition to kindergarten* (pp. 39-66). Baltimore, MD: Paul H. Brookes Publishing.

Miyake, A. U., Friedman, N. P., Emerson, M. J., Witzki, A. H., & Howerter, A. (2000). The unity and diversity of executive functions and their contributions to complex 'frontal lobe' tasks: A latent variable analysis. *Cognitive Psychology, 41*, 49-100.

National Assessment of Educational Progress. (2009a). Grade 4 National Science Results. Retrieved April 22, 2011, from http://nationsreportcard.gov/math_2009/gr4_national.asp?tab_id=tab2&subtab_id=Tab_1#tabsContainer

National Assessment of Educational Progress. (2009b). National Grade 4 Math Results. Retrieved April 22, 2011, from http://nationsreportcard.gov/math_2009/gr4_national.asp?tab_id=tab2&subtab_id=Tab_1#tabsContainer

National Assessment of Educational Progress. (2009c). National Reading Results Grade 12. Retrieved April 22, 2011, from http://nationsreportcard.gov/reading_2009/

National Association for the Education of Young Children. (2009). Developmentally appropriate practice in early childhood programs serving children from birth through age 8. Washington, DC: Author.

National Institute of Child Health and Human Development Early Child Care Research Network. (2000). The relation of child care to cognitive and language development. *Child Development, 71*(4), 960-980.

National Institute of Child Health and Human Development Early Child Care Research Network. (2003). Social functioning in first grade: Associations with earlier home and child care predictors and with current classroom experiences. *Child Development, 74*(6), 1639-1662.

National Research Council. (1998). *Preventing reading difficulties in young children*. Washington, DC: National Academy Press.

Natriello, G., McDill, E. L., & Pallas, A. M. (1990). *Schooling disadvantaged children: Racing against catastrophe*. New York: Teachers College Press.

NICHD Early Child Care Research Network. (1997). Familial factors associated with the characteristics of nonmaternal care for infants. *Journal of Marriage and the Family, 59*(2).

NICHD Study of Early Child Care and Youth Development Phase I Instrument Document. (2004). Observational Record of the Caregiving Environment (ORCE): Behavior scales, qualitative scales, and observed structural variables for 6, 15, 24, & 36 months. http://secc.rti.org/instdoc.doc

North Carolina Family Impact Seminar. (2008). Dropout prevention: Strategies for improving high school graduation rates. Durham, NC: Center for Child and Family Policy, Duke University.

O'Donnell, K. (2008). *Parents' reports of the school readiness of young children from the National Household Education Surveys Program of 2007. (NCES 2008-051)*. Washington, DC: National Center for Education Statistics, Institute of Education Science, U.S. Department of Education.

Oller, D. K., & Jarmulowicz, L. (2007). Language and literacy in bilingual children in the early school years. In E. Hoff & M. Shatz (Eds.), Eds.). *Blackwell Handbook of Language Development* (pp. 368-386). Malden, MA: Blackwell Publishing.

Peisner-Feinberg, E., & Burchinal, M. R. (1997). Relations between preschool children's child-care experiences and concurrent development: The cost, quality, and outcomes study. *Merrill-Palmer Quarterly, 43*(3), 451-477.

Peters, R. D., Bradshaw, A. J., Petrunka, K., Nelson, G., Herry, Y., & Craig, W. M., ...Rossiter, M. D. . (2010). The Better Beginnings, Better Futures Project: Findings from grade 3 to grade 9. *Monographs of the Society for Research in Child Development, 75*(3), 53.

Pianta, R., Belsky, J., Vandergrift, N., Houts, R., & Morrison, F. (2008). Classroom effects on children's achievement trajectories in elementary school. *American Educational Research Journal, 45*(2), 365-397.

Piek, J. P., Dyck, M. J., Nieman, A., Anderson, M., Hay, D., Smith, L. M., McCoy, M....Hallmayer, J. (2004). The relationship between motor coordination, executive functioning and attention in school aged children. *Archives of Clinical Neuropsychology, 19*, 1063-1076.

Piotrkowski, C. S., Botsko, M., & Matthews, E. (2000). Parents' and teachers' beliefs about children's school readiness in a high-need community. *Early Childhood Research Quarterly, 15*(4), 537-558.

Pungello, E. P., Iruka, I. U., Dotterer, A. M., Mills-Koonce, R., & Reznick, J. S. (2009). The effects of socioeconomic status, race, and parenting on language development in early childhood. *Developmental Psychology, 45*(2), 544-557.

Randolph, K. A., Rose, R. A., Fraser, M. W., & Orthner, D. K. (2004). Promoting school success among at risk youth. *Journal of Poverty, 8*(1), 1-22.

Rathbun, A. H., West, J., & Hausken, E. G. (2003). Young children's access to computers in the home and at school in 1999 and 2000. Washington, DC: US Department of Education, Office of Educational Research and Improvement.

Ream, R. K., & Rumberger, R. W. (2008). Student engagement, peer social capital, and school dropout among Mexican American and non-Latino white students. *Sociology of Education, 81*, 109-139.

Reynolds, A. J., & Temple, J. A. (1998). Extended early childhood intervention and school achievement: Age thirteen findings from the Chicago Longitudinal Study. *Child Development, 69*(1), 231-246.

Reynolds, A. J., Temple, J. A., Robertson, D. L., & Mann, E. A. (2001). Long-term effects of an early childhood intervention on educational achievement and juvenile arrest. A 15-year follow-up of low-income children in public schools. *JAMA, 285*(18), 2339-2346.

Rider, R. J. (1997). On the nature of cognitive style. *Educational Psychology, 17*(1-2), 29-49.

Rodriguez, L. F., & Conchas, G. Q. (2009). Preventing truancy and dropout among urban middle school youth: Understanding community-based action from the student's perspective. *Education and Urban Society, 41*(2), 216-247.

Romano, E., Babchishin, L., Pagani, L. S., & Kohen, D. (2010). School readiness and later achievement: Replicatio and extension using a nationwide Canadian survey. *Developmental Psychology, 46*(5), 995-1007.

Rubin, K. H., Bukowski, W., & Parker, J. G. (1998). Peer interactions, relationships, and groups. In W. Damon & N. Eisenberg (Eds.), Eds.). *Handbook of child psychology: Vol. 3. Personality and social development* (pp. 619-700). New York: Wiley.

Rumberger, R., & Lim, S. A. (2008). Why students drop out of school: A review of 25 years of research. Santa Barbara, CA: California Dropout Research Project, UC Santa Barbara, Gevirtz Graduate School of Education.

Rumberger, R. W., & Palardy, G. J. (2005). Test scores, dropout rates, and transfer rates as alternative indicators of high school performance. *American Educational Research Journal, 42*(1), 3-42.

Saarni, C. (1990). *The development of emotional competence*. New York: Guilford Press.

Schank, R. C., & Abelson, R. P. (1977). *Scripts, plans, and understanding: An inquiry into human knowledge structures*. Hillsdale, NJ: Erlbaum.

Schmalz, D. L., Deane, G. D., Birch, L. L., & Davison, K. K. (2007). A longitudinal assessment of the links between physical activity and self-esteem in early adolescent non-Hispanic females. *Journal of Adolescent Health, 41*, 559-565.

Scott-Little, C., Lesko, J., Martella, J., & Milbum, P. (2007). Early learning standards: Results from a national survey to document trends in state-level policies and practices. *Early Childhood Research & Practice, 9*(1).

Snow, C. (2006). What counts as literacy in early childhood? In K. McCartney & D. Phillips (Eds.), Eds.). *Blackwell handbook of early childhood development* (pp. 274-294). Malden, MA: Blackwell Publishing.

Snow, C. E., Burns, M. S., & Griffin, P. (1998). *Preventing Reading Difficulties in Young Children*. Washington, D.C.: National Academy Press.

Stedron, J. M., & Berger, A. (2010). State approaches to school readiness assessment. Washington, DC: National Conference of State Legislatures.

Temple, J. A., Reynolds, A. J., & Miedel, W. T. (2000). Can early intervention prevent high school dropout? Evidence from the Chicago Child-Parent Centers. *Urban Education, 35*, 31-56.

Thompson, R. A., & Lagattuta, K. H. (2006). Feeling and understanding: Early emotional development. In K. McCartney & D. Phillips (Eds.), Eds.). *Blackwell handbook of early childhood development* (pp. 317-337). Malden, MA: Blackwell Publishing.

Tramontina, S., Martins, S., Michalowski, M. B., Ketzer, C. R., Eizirik, M., Biederman, J., & Rohde, L. A. (2001). School dropout and conduct disorder in Brazilian elementary school students. *Canadian Journal of Psychiatry, 46*, 941-947.

Vitaro, F., Brendgen, M., Larose, S., & Tremblay, R. E. (2005). Kindergarten disruptive behaviors, protective factors, and educational achievement by early adulthood. *Journal of Educational & Psychology, 97*(4), 617-629.

Votruba-Drzal, E., Coley, R. L., & Chase-Lansdale, P. L. (2004). Child care and low-income children's development: Direct and moderated effects. *Child Development, 75*(1), 296-312.

Wesley, P. W., & Buysse, V. (2003). Making meaning of school readiness in schools and communities. *Early Childhood Research Quarterly, 18*(3), 351-375.

Woolley, M. E., & Bowen, G. L. (2007). In the context of risk: Supportive adults and the school engagement of middle school students. *Family Relations, 56*, 92-104.

Wynn, K. (1992). Addition and subtraction in human infants. *Nature, 358*, 749-750.

Technical Appendices

Appendix A: Data Sources

NICHD Study of Early Child Care and Youth Development (NICHD SECCYD)

For the NICHD SECCYD dataset, seven school readiness skills and traits were examined. The seven categories are language, social-emotional, executive functioning, math, reading, approaches to learning and health.

NICHD SECCYD data consist almost exclusively of direct assessments and parent or teacher ratings. Very few criterion-referenced assessments were available that could be used for the follow-up analyses.

The following table gives the variable name, what measure the variable came from, the type of measure, what age the measure was administered at and the dataset within the NICHD SECCYD the variable is from.

Table 1. NICHD SECCYD: Description of school readiness measures

Measure by Domain	Variable	Informant/Type of Measure	Wave/Age at Assessment	Dataset
LANGUAGE				
PLS-Language Comprehension	plsasc54	Child-stand test	54m	Cout54
PLS-Expressive Language	plsesc54	Child-stand test	54m	Cout54
WJ-R Picture Vocabulary	wjpvsc54	Child-stand test	54m	Cout54
SOCIAL-EMOTIONAL				
CBCL Internalizing	bin_tm54	Mother-questionnaire	54m	Cout54
CBCL Externalizing	bex_tm54	Mother-questionnaire	54m	Cout54
SSRS Social Skills	sstssm54	Mother questionnaire	54m	Cout54
CBCL Internalizing	bex_ttkf	K Teacher-questionnaire	K-fall	Tchrkf
CBCL Externalizing	bin_ttkf	K Teacher-questionnaire	K-fall	Tchrkf
SSRS Social Skills	sstsstkf	K Teacher-questionnaire	K-fall	Tchrkf
HEALTH				
Parental global	hlthbm54	Mother-rating	54m	Cout54

Measure by Domain	Variable	Informant/Type of Measure	Wave/Age at Assessment	Dataset
rating				
APPROACHES TO LEARNING				
Child Behavior Questionnaire	cbqafm54	Mother-questionnaire	54m	Cout54
EXECUTIVE FUNCTIONING				
CPT	cpcorc54	Child-direct assmt	54m	Cout54
Stroop	implsc54	Child-direct assmt	54m	Cout54
Delay of Gratification	dogpfo54	Child-direct assmt	54m	Cout54
READING				
WJ-R Letter Word Identification	wjlwsc54	Child-stand test	54m	Cout54
WJ-R Incomplete Words	wjiwsc54	Child-stand test	54m	Cout54
ARS Literacy & Language	asllstkf	K Teacher-questionnaire	K-fall	Tchrkf
MATH				
WJ- Applied Problems	wjapsc54	Child-stand test	54m	Cout54
ARS Math	asmtstkf	K Teacher-questionnaire	K-fall	Tchrkf

Source: NICHD SECCYD

Early Childhood Longitudinal Study – Kindergarten Class 1998-1999 (ECLS-K)

School Readiness Measures

For the ECLS-K dataset, psychometric analyses on the variables in six school readiness domains: cognitive, social-emotional, health, approaches to learning, reading, and math were conducted. The majority of the variables identified are composite variables that are created based on a set of indicators from various data sources, including direct child assessments, parent interviews, and teacher questionnaires.

Below is a detailed description of the original ECLS-K variables in each of the school readiness domain.

Many of the variables in the data set use "-9" to represent the missing data, therefore all the variables were recoded, except for *MATHfk*, that have a minimum value of "-9". Some of the variables in the social-emotional domain were also reverse coded, since the originals were coded in the opposite direction to the other items in the same school readiness domain.

Table 2: ECLS-K: Description of school readiness measures in fall kindergarten wave

Variable Names	Variable Description	Direct vs. Indirect Assessment	Composite vs. Single Item
COGNITIVE			
C1RGSCAL	General knowledge IRT scale score	Direct	Composite
SOCIAL-EMOTIONAL			
EXTERN0	Teacher-rated externalizing (fall 98-K)	Indirect	Composite/Recode
CONTROL0	Teacher-rated self-control (fall 98-K)	Indirect	Composite/Recode
T1INTERN	Teacher-rated internalizing	Indirect	Composite
T1INTERP	Teacher-rated interpersonal skills	Indirect	Composite
P1CONTRO	P1 Self-control	Indirect	Composite
P1SOCIAL	P1 Social interaction	Indirect	Composite
P1SADLON	P1 Sad/lonely	Indirect	Composite
P1IMPULS	P1 Impulsive/overactive	Indirect	Composite
HEALTH			
P1HSCALE	P1 Scale of child's health	Indirect	Composite
C1WEIGHT	C1 Round 1 child composite weight (pounds)	Direct	Composite
C1HEIGHT	C1 Round 1 child composite height (inches)	Direct	Composite
HEALTHYWT 0 (RECODE OF C1BMI)	C1 Round 1 child composite BMI	Direct	Composite
C1GMOTOR	Gross motor skills	Direct	Composite

Variable Names	Variable Description	Direct vs. Indirect Assessment	Composite vs. Single Item
C1CMOTOR	Composite motor skills	Direct	Composite
C1FMOTOR	Fine motor skills	Direct	Composite
APPROACHES TO LEARNING			
T1LEARN	T1 Approach to learning	Indirect	Composite
P1LEARN	P1 Approach to learning	Indirect	Composite
READING			
READfk	IRT Read scale scores fall K	Direct	Composite
T1RARSLI	Reading ARS score	Indirect	Composite
C1R4RPB1	C1 Letter recognition	Direct	Single
C1R4RPB2	C1 Beginning sounds	Direct	Single
C1R4RPB3	C1 Ending sounds	Direct	Single
C1R4RPB4	C1 Sight words	Direct	Single
C1R4RPB5	C1 Word in context	Direct	Single
C1RRPRIN	C1 Print familiarity	Direct	Composite
T1READS	T1 Reads simple books independently	Indirect	Single
T1CMPSEN	T1 Uses complex sentence structure	Indirect	Single
T1PRINT	T1 Understands conventions of print	Indirect	Single
T1STORY	T1 understands and interprets story read to him/her	Indirect	Single
T1PRDCT	T1 Predicts what happens in stories	Indirect	Single

Variable Names	Variable Description	Direct vs. Indirect Assessment	Composite vs. Single Item
T1LETTER	T1 Child names upper and lower case	Indirect	Single
T1WRITE	T1 Shows early writing behaviors	Indirect	Composite
MATH			
MATHfk	IRT math scale scores fall K	Direct	Composite
T1RARSMA	Math ARS score	Indirect	Composite

Source: ECLS-K

Appendix B: Sample

NICHD Study of Early Child Care and Youth Development (NICHD SECCYD)

The NICHD SECCYD is a comprehensive longitudinal study initiated by The National Institute of Child Health and Human Development (NICHD) in 1989 to answer the many questions about the relationship between child care experiences and characteristics and children's developmental outcomes. Conducted by a network of investigators, the study followed a diverse sample of children and their families from birth through adolescence.

Non-experimental longitudinal data from the NICHD SECCYD are drawn from a multisite study of births in 1991 (see http://rti.seccyd.org or NICHD Early Child Care Research Network, 2005 for details). Participants were recruited from hospitals located at 10 sites across the United States. During 24-hr sampling periods, 5,265 new mothers met the selection criteria and agreed to be contacted after returning home from the hospital. Slightly over 50% of those contacted agreed to participate in the study. At 1 month of age, 1,364 healthy newborns were enrolled in the study, and over 1,200 children were still enrolled when children entered kindergarten. Although it is not nationally representative, the study sample closely matches national and census tract records with respect to some demographic variables such as ethnicity and household income. However, the sample under represents poor families and families likely to move. It is also important to note that children who could not be assessed in English were not included in the “in the running” analyses. The majority of children in the sample are White, 12% are African American, and 11% are Hispanic or of another ethnicity. About 30% of mothers had a high school education or less, and 14% were single parents (NICHD Early Child Care Research Network, 1997).

Family, child care, and child outcome variables were measured in home- and lab-based assessments when the children were 6, 15, 24, 36, and 54 months and in grades 1, 3, and 5. Assessments includes

repeated assessments of demographic and parental characteristics, quality of parenting, type, amount and quality of child care, and children's social, language, cognitive, and academic skills. Child care settings were rated using The Observational Report of the Caregiving Environment (NICHD Study of Early Child Care and Youth Development Phase I Instrument Document, 2004). The ORCE was designed specifically for the NICHD SECCYD to assess the quality of caregiver-child interaction experienced by individual children in all types of child care settings. The ORCE global quality measures the positive caregiving rating composite. Scores range from 1 (unresponsive or harsh caregiving) to 4 (frequent responsive and stimulating caregiving).

Early Childhood Longitudinal Study – Kindergarten Class 1998-1999 (ECLS-K)

This study focuses on children's early school experiences beginning with kindergarten and following children through middle school. The ECLS-K data provide descriptive information on children's status at entry to school, their transition into school, and their progression through eighth grade. It can be used to describe and to understand better children's development and experiences in the elementary and middle school grades, as well as how their early experiences relate to their later development, learning, and experiences in school.

The sample consisted of 20,000 kindergarten children in year 1. They were from both public and private schools and attended both full-day and part-day kindergarten programs. They came from diverse socioeconomic and racial/ethnic backgrounds. Also participating in the study were the children's parents, teachers, and schools. It is important to note that children who could not be assessed in English were not included in the "in the running" analyses. Data were collected in the fall and the spring of kindergarten (1998-99), the fall and spring of first grade (1999-2000), the spring of third grade (2002), the spring of fifth grade (2004), and the spring of eighth grade (2007).

The ECLS-K assesses children's cognitive, social-emotional, and physical development through direct and indirect methods. Direct child assessment scores refer to children's performance on the ECLS-K cognitive and social-emotional batteries. Indirect child assessments refer to parent and teacher ratings of children's cognitive and social-emotional development. Physical development is measured directly.

Appendix C: School Readiness and Outcomes Measures

NICHD Study of Early Child Care and Youth Development (NICHD SECCYD)

Factor analyses were conducted to determine if composite variables for each category (language, social-emotional, executive functioning, math, reading, approaches to learning and health) could be formed for the seven categories are. Composite variables were formed if the factor analysis produced an Eigen value of 1 or higher for a factor and an alpha coefficient of .6 or higher. Variables were dropped if they did not load on the factor at |.3| or higher. Descriptive statistics are provided for the school readiness variables in Tables 1 and 2. Table 3 is a correlation matrix for the school readiness variables. Below, the NICHD SECCYD measures used for each domain are explained.

Language

Preschool Language Scale (PLS-3) (Zimmerman, Steiner, & Pond, 1979)

At 54 months, language competence was assessed using measures of a range of language behaviors, including vocabulary, morphology, syntax, and integrative thinking, which are grouped into two subscales: Auditory Comprehension and Expressive Language. The test is standardized to have a mean of 100 and a standard deviation of 15. (Cronbach alphas = .89 and .92 respectively in the current study).

Woodcock-Johnson Picture Vocabulary (Woodcock & Mather, 1989)

Comprehension-knowledge was assessed by the Picture Vocabulary subtest, which measures the ability to recognize or to name pictured objects. The first 6 items are in a multiple-choice format. The child is asked to point to the picture that shows the object mentioned by the examiner. Subsequent items require the child to name familiar and unfamiliar pictured items. The split-half reliability for children tested at age 5 was .70 for Picture Vocabulary.

Language Analysis Variable

A composite variable was formed using the variables plsasc54, plsesc54, and wjpvsc54. The Eigen value for this factor was 1.472 and Cronbach's alpha was computed to be .822. The summary variable was formed as the mean of the standardized scores on the three means. All three are norm-referenced to have a mean of 100 and SD of 15 in the general population. The composite variable is called langss.

Social-Emotional

Social Skills Rating System (SSQ; Gresham & Elliott, 1990)

Mothers at the 54 month visit and kindergarten teachers in the fall completed the 38-item Social Skills Questionnaire from the Social Skills Rating System (SSQ). Mothers responded on a 3-point scale reflecting how often their child exhibited each behavior. Items are grouped into four areas: cooperation (e.g., keeps room neat and clean without being reminded), assertion (e.g., makes friends easily), responsibility (e.g., asks permission before using a family member's property), and self-control (controls temper when arguing with other children). The total score is the sum

of all 38 items, with higher scores reflecting higher levels of perceived social competence. The SSQ was normed on a diverse, national sample of children in the 3-5 year age range and shows high levels of internal consistency (median = .90) and test-retest reliability (.75 to .88).

Child Behavior Checklist (Achenbach, 1991)

The parent version lists 113 problem behaviors and the teacher version includes 100 roughly parallel items. The parent rates each as not true (0), somewhat true (1), or very true (2) of her child. Both the parent and teacher version contain two subscales: Internalizing Problems (e.g., too fearful and anxious) and Externalizing Problems (e.g., argues a lot). Achenbach reports test-retest reliability of .89, inter-parent agreement of .70, and stability of scale of .71 over 2 years. Cronbach alphas for the mother version in the current sample were .81 for internalizing and .88 for externalizing. For the teacher version, Cronbach alphas were .90 for internalizing and .95 for externalizing in the current sample. For both subscales as well as for the Total Problem score, raw scores were converted into standard T-scores, based on normative data for children of the same age.

Social-Emotional Composite Score

A composite variable which was formed for social-emotional using the mother and teacher ratings of social skills and behavior problems: bin_tm54, bex_tm54, bex_ttkf, bin_ttkf, sstssm54, and sstsstkf. Each variable was standardized within the sample to have a mean of 0 and standard deviation of 1, and then the mean of the standardized scores was computed. The Eigen value for this factor was 1.472 and Cronbach's alpha was computed to be .619. The composite variable is called socioemss.

Health

Child Health

The measure was obtained from an interview with the mother in the home. General health of the child was measured at 54 months.

Health Summary Variable

No composite variable was made for health since only one variable was used to measure health, which was hlthbm54. This variable is a measure of the general health of the child.

Approaches to Learning

Child Behavior Questionnaire

The mother of the child completed a questionnaire during the 54 month visit composed of 80 questions, which were part of 8 scales. The scale of interest is the attention focusing subscale. The attention focusing subscale was created from taking the mean of 8 items. The items are on a 7-point scale, with 1 being extremely untrue and 7 being extremely true of the child's reactions over the past 6 months. In the dataset the alphas for the subscales ranged from .67 to .94.

Approaches to Learning Summary Variable

No composite variable was made for approaches to learning since only one variable of approaches to learning is in the data set. The variable used to measure approaches to learning is cbqafm54.

Executive Functioning

Continuous Performance Task (Rosvold, Mirsky, Sarason, Bransome, & Beck, 1956)

This task was administered to each child individually towards the end of a 2 ½-hour laboratory visit. With an experimenter in the room, the child was seated at a table in front of a 2-inch square screen and a red button. Dot-matrix pictures of 10 familiar objects (e.g., butterfly, fish, flower) were generated by a computer and presented on the screen. The child was asked to press the button "as fast as you can" each time a target stimulus (a chair) appeared on the screen. A total of 220 stimuli were presented in 22 blocks. The target stimulus was randomly presented within each block and appeared twice within each block for a total of 44 presentations, leaving 176 presentations of non-target stimuli. Each stimulus appeared on the screen for 500 milliseconds, with 1500 millisecond inter-stimulus intervals. The child's task was twofold: (a) to press the red button as soon as he or she saw the image of the chair on the screen, and (b) to refrain from pressing the button at the appearance of other non-target stimuli. The task took 7 minutes 20 seconds. Children's performance on the CPT has high construct validity as a measure of attention (Halperin et al., 1991), and adequate predictive validity (e.g., Barkley, 1994; Barkley, Brodzinsky, & DuPaul, 1992; Campbell et al., 1994).

Stroop Task (Gerstadt, Hong, & Diamond, 1994)

The measure uses 18 cards; the first two are practice and 16 cards are used during the test. 9 of the cards are black with a moon and stars, 9 are white with a sun. When the child sees the white card with the sun, they are instructed to say night, when the child sees the black card with moon and stars, instructed to say day. Three variables are scored from the test, 1-percentage of usable data, 2-number of times instructions are repeated, and 3-percent incorrect. The variable of interest is the percent incorrect.

Delay of Gratification

An experimenter conducted observations of the child at 54 months. The experimenter identifies which of three foods the child likes the most and the child is then forced to make a decision, either wait seven minutes and then receive more of the food of choice, or ring a bell to bring the experimenter back in and the child receives a smaller portion of the food of choice. The variable of interest is child outcome, pass or fail.

Executive Functional Summary Variable

A composite variable was created for executive function. Originally the variables implsc54 and dogpfo54 were included in the factor analysis along with cpcorc54 to determine if a composite

variable could be formed, but those analyses resulted in a low alpha of .09. The variable used was from the CPT, the most widely accepted measure of EF among those used in this battery.

Reading

Woodcock-Johnson Letter-Word Identification Test

At 54 months, children were administered selected scales from the Woodcock Johnson Achievement and Cognitive Batteries (1990). The Letter-Word Identification test measures skills at identifying letters and words. The first 5 items involve symbolic learning, or the ability to match a pictographic representation of a word with an actual picture of the object. The remaining items require identifying isolated letters and words that appear in large type. Standard scores range from 63 to 180, with values above 100 indicating that the raw score was above the mean score of children on whom the test was standardized.

Woodcock-Johnson Incomplete Words Test

At 54 months, children were administered selected scales from the Woodcock Johnson Achievement and Cognitive Batteries (1990). Internal consistency reliability ranged from .94 to .98. The instrument was administered to the child in the lab setting. Standardized scores were computed based on norms with a mean of 100 and standard deviation of 15.

Academic Rating Scale

Teachers rated each child during their kindergarten year using this scale developed first for the ECLS-K survey. The academic rating scale of interest is the language and literacy scale. Each skill is rated on a 5-point scale, ranging from not yet demonstrated to proficient. The scale is comprised of 13 items. Reliability for the scale is .87.

Reading Analysis Variable

We did not use a composite because the factor analysis and subsequent examination of internal consistency of the first factor, alpha=.42, did not support a single composite. The WJ Letter-Word score was chosen, as the most widely recognized measure of early reading skills.

Math

Woodcock-Johnson Applied Problems

At 54 months, children were administered selected scales from the Woodcock Johnson Achievement and Cognitive Batteries (1990). The Applied Problems test measures skill in analyzing and solving practical problems in mathematics. Standard scores range from 41 to 157, with values above 100 indicating that the raw score was above the mean score of the standardization sample. Standardized scores were computed based on norms with a mean of 100 and standard deviation of 15.

Academic Rating Scale

Teachers rated each child during their kindergarten year. Each skill is rated on a 5-point scale, ranging from not yet demonstrated to proficient. The scale is comprised of 28 items. Reliability for the scale is .92.

Math Analysis Variable

A composite was not formed because the internal consistency for the two measures was unacceptable, .08. We chose to use the WJ Applied Problems because it the most widely used measure of early math skills.

Table 3. NICHD SECCYD: Descriptive statistics for school readiness variables

SR Variables	N	Mean	SD	Missing	Alpha
LANGUAGE					
Language Composite	1078	99.67	15.99	286	0.82
SOCIAL-EMOTIONAL					
Social-emotional Composite	1101	98.53	8.96	263	0.62
HEALTH					
Parent rating of health	1083	3.39	0.65	281	
APPROACHES TO LEARNING					
Approaches to Learning	1023	4.71	0.85	341	
EXECUTIVE FUNCTIONING					
CPT Incorrect: cpcorc54	1002	32.61	8.42	362	
READING					
WJ Letter-Word: wjlwsc54	1056	98.93	13.52	308	
MATH					
WJ Applied Problems: wjapsc54	1053	102.94	15.63	311	

Source: NICHD SECCYD

This table provides information on the correlations among the proposed the school readiness domains. For the most part, the correlations are small to modest (0.02 to 0.32), however, the correlations for the domains of reading, math, and language are relatively high, ranging from 0.55 to 0.69. Since there is a range in level of strength of the correlations, we did not create an omnibus measure of school readiness.

Table 4. NICHD SECCYD: Correlations of school readiness variables

	Language	Social-emotional (Reverse Coded)	Health	Approaches to Learning	Executive Functioning	Reading	Math
Language	1.00						
Social-emotional (Reverse Coded)	0.09**	1.00					
Health	0.12***	0.04	1.00				
Approaches to Learning	0.31***	0.15***	0.12***	1.00			
Executive Functioning	0.30***	0.08*	0.02	0.08*	1.00		
Reading	0.55***	0.05	0.07*	0.29***	0.23***	1.00	
Math	0.69***	0.03	0.08*	0.31***	0.32***	0.57***	1.00

** p<0.05, ** p<0.01, *** p<0.001*

Source: NICHD SECCYD

Early Childhood Longitudinal Study – Kindergarten Class 1998-1999 (ECLS-K)

The majority of the ECLS-K variables identified are composite variables for the six school readiness domains (cognitive, social-emotional, health, approaches to learning, reading, and math) that are created based on a set of indicators from various data sources, including direct child assessments, parent interviews, and teacher questionnaires. Below, the ECLS-K measures used for each domain are explained.

Cognitive

The data set includes direct cognitive assessments of child's reading, math and general knowledge. C1RGSCALE is a continuous, composite variable representing IRT scale scores of children's general knowledge in science and social studies. IRT score reflects children's performance on a set of questions with a broad range of difficulty and was obtained through the Item Response Theory (IRT) procedure based on the raw scores of general knowledge.

Social-Emotional

A modified version of the Social Skills Rating Scale (SSRS) was used to assess how often children demonstrate the social skills or behaviors described in the questionnaire. Both the teacher and the

parent were asked to rate children on a scale of "never", "sometimes", "often", and "very often" on a range of social-emotional items, such as "acts as sad or depressed", "respect property rights", and "express feelings".

A composite variable *SOCIOEMO* was created to represents child's social-emotional skills. The descriptive statistics for *SOCIOEMO* is provided in Table 2.

Health

An indirect assessment of health came from the parents. They rated their children's health on a scale of "excellent", "very good" and "good".

The ECLS-K parent report of the child's overall health variable P1HSCALE corresponds well to the NICHD SECCYD variable; using the parent report measure provides consistency across the datasets. The Cronbach's alpha for the measures in this domain was low.

Approaches to Learning

A composite variable, *T1LEARN,* was created based on a set of SSRS items for the teacher and the parent who were asked to rate their children's approach to learning on such items as "persists in completing tasks" and "eagerness to learn" on a scale of "never", "sometimes", "often" and "very often".

Reading

READfk is a composite variable that represent child's IRT reading scale score. IRT is a direct assessment of children's reading skill, and ARS reflect teachers' evaluations of students' academic achievement. Teachers rate each child's skills, knowledge, and behaviors on a range of items from "Not Yet", "Beginning" and "In progress" to "intermediate" and "Proficient". IRT was employed to calculate scores for the ARS in order to compare performance of students from the fall to the spring of kindergarten and to be able to compare students who were not rated on all items. In the fall of kindergarten, a large percentage of the teachers had not introduced at least some of the items to the classroom setting, resulting in a large number of missing ratings for all but four items. The ARS Scores were rescaled to have a low of one and a high of five to correspond to the five-point rating scale that teachers used in rating children on these items.

The ARS rating could be used in the subsequent criterion-based analyses designed to examine measures that are closer to those used by states to create their entry-to-school standards.

Math

MATHfk is a direct assessment of children's math skills. It represents an IRT math scale score obtained through the IRT procedure based on the raw math score.

The ARS rating could be used in the subsequent analyses designed to examine measures that are closer to those used by states to create their entry-to-school standards.

Table 5 provides information on the correlations among the proposed the school readiness domains. For the most part, the correlations are small to modest (0.10 to 0.32), however, the correlations for the domains of reading, math, and cognitive are relatively high, ranging from 0.50 to 0.72.

In addition, the correlation between approaches to learning and the social-emotional domain is also strong (0.56). Since the approaches to learning domain and the measures comprising the social-emotional domain are all derived from modified SSRS, the strong correlation is not surprising.

However, since there is a range in level of strength of the correlations, an omnibus measure of school readiness was not used.

Table 5. ECLS-K: Correlations of school readiness domain

	Cognitive	Social-emotional	Health	Approaches to Learning	Reading	Math
Cognitive	1.00					
Social-emotional	0.28***	1.00				
Health	0.18***	0.18***	1.00			
Approaches to Learning	0.28***	0.56***	0.10***	1.00		
Reading	0.50***	0.23***	0.12***	0.27***	1.00	
Math	0.62***	0.27***	0.16***	0.32***	0.72***	1.00

** p<0.05, ** p<0.01, *** p<0.001*
Source: ECLS-K

School Outcome Measures

In each dataset, four domains of school outcomes were identified (language, social-emotional, reading, and math).

Variables for each of the domains of school outcomes were taken from measures of children's skills after entry in school starting in the spring of kindergarten and, for some datasets, including later time points. For each variable in the school outcome domains, the descriptive statistics for the variables (mean, standard deviation, distribution, missingness) were examined.

In the ECLS-K and the NICHD SECCYD datasets, constructs were chosen that were measured at each of the time points so that growth curve analyses could be performed.

NICHD SECCYD

Woodcock-Johnson Picture Vocabulary, Passage Comprehension, Applied Problems

In Grades 1, 3, 5, and at 15 years of age, children were administered selected scales from the Woodcock Johnson Achievement and Cognitive Batteries (1990). The Picture Vocabulary test measures skill in receptive language. The Passage Comprehension scale measures the child's ability to read and comprehension texts of increasing difficulty. The Applied Problems scales the child's ability to solve mathematical problems of increasing difficulty. W-scores reflect content skills as derived with a Rasch-model item response analysis. The mean level varies over time, with an expected mean of 500 in grade5.

Social Skills Rating System (SSQ; Gresham & Elliott, 1990)

Mothers at the 54 month visit and kindergarten teachers in the fall completed the 38-item Social Skills Questionnaire from the Social Skills Rating System (SSQ). Mothers responded on a 3-point scale reflecting how often their child exhibited each behavior. Items are grouped into four areas: cooperation (e.g., keeps room neat and clean without being reminded), assertion (e.g., makes friends easily), responsibility (e.g., asks permission before using a family member's property), and self-control (controls temper when arguing with other children). The total score is the sum of all 38 items, with higher scores reflecting higher levels of perceived social competence. The SSQ was normed on a diverse, national sample of children in the 3-5 year age range and shows high levels of internal consistency (median = .90) and test-retest reliability (.75 to .88).

Child Behavior Checklist (Achenbach, 1991)

The parent version lists 113 problem behaviors and the teacher version includes 100 roughly parallel items. The parent rates each as not true (0), somewhat true (1), or very true (2) of her child. Both the parent and teacher version contain two subscales: Internalizing Problems (e.g., too fearful and anxious) and Externalizing Problems (e.g., argues a lot). Achenbach reports test-retest reliability of .89, inter-parent agreement of .70, and stability of scale of .71 over 2 years. Cronbach alphas for the mother version in the current sample were .81 for internalizing and .88 for externalizing. For the teacher version, Cronbach alphas were .90 for internalizing and .95 for externalizing in the current sample. For both subscales as well as for the Total Problem score, raw scores were converted into standard T-scores, based on normative data for children of the same age. Table 6 below summarizes the school-age outcome measures available across the datasets.

Table 6. School-age outcome measures available in the two datasets

School Outcomes Measures		ECLS-K	NICHD SECCYD
Language	**Measures**	No measure	WJ-R PV
	Time Points		G1, G3, G5, 15y
Social-emotional	**Measures**	SSRS (externalizing, self-control) (teacher report)	Social Skills (parent and teacher report) Externalizing (parent and teacher report)
	Time Points	K, 1st, 3rd, 5th	G1-G6, 15y
Reading	**Measures**	Reading Direct Assessment	WJ-R Passage Comprehension
	Time Points	K, 1st, 3rd, 5th, 8th	G3, G5, 15y
Math	**Measures**	Math Direct Assessments	WJ-R Applied Problems
	Time Points	K, 1st, 3rd, 5th, 8th	G1, G3, G5, 15y

Appendix D: Variable Creation

Psychometric analyses were completed for the school readiness measures and school outcome variables in both the NICHD SECCYD and ECLS-K 1998 Cohort datasets.

Readiness Measures

In each dataset, eight school readiness domains were identified:

1. Social-emotional
2. Health
3. Approaches to learning
4. Reading
5. Math
6. Cognitive
7. Executive functioning
8. Language

All variables except cognitive were used in the NICHD SECCYD dataset, while there were no language or executive function measures in the ECLS-K dataset.

Variables identified for each of the school readiness domains are taken from measures of children's skills before or at the very beginning of entry into kindergarten (e.g., in the fall of kindergarten or spring of prekindergarten). For each variable in the school readiness domains, the descriptive statistics for the variables (mean, standard deviation, distribution, missingness) were examined. For domains with multiple measures, Cronbach's alphas and factor analyses were conducted to see if the items could be combined into a single composite measure.

Table 7 below summarizes the school readiness variables available across the datasets.

Table 7. School readiness measures available by school readiness domain

School Readiness Measures	ECLS-K	NICHD SECCYD
	K fall	54m
Cognitive	IRT composite score: general knowledge	No measure
Language	No measure	Create a composite from the Preschool Language Scale Language Comprehension and Expressive Language, and the WJ-R Picture Vocabulary

School Readiness Measures	ECLS-K	NICHD SECCYD
	K fall	**54m**
Social-emotional	Create a composite from the Modified Social Skills Rating System (SSRS) (externalizing, internalizing, self-control) (parent and teacher report)	Create composite from Social Skills Rating System (mother and teacher report) and CBCL (mother & teacher report)
Health	Global rating (parent report)	Global rating (mother report)
Approaches to Learning	Approaches to Learning (teacher report)	Child Behavior Questionnaire Task Orientation
Executive Functioning	No measure	Continuous Performance Task
Reading	IRT composite: Reading	WJ-R Letter Word Identification
Math	IRT composite: Math.	WJ-R Applied Problems

School Outcome Measures

In each dataset, four domains of school outcomes were identified:

1. Language,
2. Social-emotional,
3. Reading, and
4. Math

Variables for each of the domains of school outcomes were taken from measures of children's skills after entry in school starting in the spring of kindergarten and, for some datasets, including later time points. For each variable in the school outcome domains, the descriptive statistics for the variables (mean, standard deviation, distribution, missingness) were examined.

In the ECLS-K and the NICHD SECCYD datasets, constructs were chosen that were measured at each of the time points so that growth curve analyses could be performed.

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Woodcock-Johnson Picture Vocabulary, Passage Comprehension, Applied Problems

In Grades 1, 3, 5, and at 15 years of age, children were administered selected scales from the Woodcock Johnson Achievement and Cognitive Batteries (1990). The Picture Vocabulary test measures skill in receptive language. The Passage Comprehension scale measures the child's ability to read and comprehension texts of increasing difficulty. The Applied Problems scales the

child's ability to solve mathematical problems of increasing difficulty. The mean level varies over time, with an expected mean of 500 in grade5.

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Table 8. School-age outcome measures available in the two datasets

School Outcomes Measures		ECLS-K	NICHD SECCYD
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	Time Points		G1, G3, G5, 15y
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	Time Points	K, 1st, 3rd, 5th	G1-G6, 15y
Reading	**Measures**	Reading Direct Assessment	WJ-R Passage Comprehension

	Time Points	K, 1st, 3rd, 5th, 8th	G3, G5, 15y
Math	**Measures**	Math Direct Assessments	WJ-R Applied Problems
	Time Points	K, 1st, 3rd, 5th, 8th	G1, G3, G5, 15y

Covariates

Several covariates were selected for inclusion in the analyses:

- Gender
- Race
- Parent's characteristics (parent's education and family income)
- Family structure
- Parenting
- Home environment
- School/teacher characteristics

These covariates represent relatively stable aspects of the children's characteristics or environment. Covariates were not chosen which would explain variation in the school readiness measures such as parenting during the early childhood period or participation in child care.

In the ECLS-K and the NICHD SECCYD, parenting and school characteristics that could be measured at multiple waves (time-varying covariates) were selected to control for variance in the outcome variables in the growth models.

The tables below summarizes the covariates available in each dataset.

Table 9. Covariates in NICHD SECCYD

Covariates	NICHD SECCYD
Gender	Dummy variable of child's gender
Race	Dummy variable of race (categorized as White, Black, Hispanic, or other)
Parental Characteristics	Mother's education at the child's birth, family income to poverty threshold (based on reported income, household size, and federal poverty threshold for that ear. Computed as the mean of the income/needs ratio from 6, 15, 24, 36, and 55 month assessments
Family Structure	Married, partner, single; Biological mother or father; Other family members in household
Parenting	Maternal sensitivity (at 54 months, 1st, 3rd grade, 5th grade, and 15 years)

Covariates	NICHD SECCYD
Home Environment	H.O.M.E. Total score (at 54 months, 3rd grade, 5th grade, and 15 years)
School/Teacher Characteristics	Class size, Teacher education and certificate, Type of school Teacher total quality (at 1st, 3rd, and 5th grades); Time observed on math and language arts (at 1st, 3rd, and 5th grades)

Table 10. Covariates in ECLS-K.

Covariates	ECLS-K
Gender	Dummy variable of child's gender
Age	Continuous variable of child's age
Race	Dummy variable of race (categorized as White, Black, Hispanic, Asian, and other)
Primary Home Language	Dummy variable categorized as English, and not English Parent report
Disability Status	Dummy variable: whether a child is disabled Parent report
Parental Characteristics	Parent highest education level (less than high school; high school diploma or GED; some college; Bachelor's degree; higher than a Bachelor's degree); family's income-to-poverty ratio less than 2 (based on reported income, the number of members of the household, and federal poverty thresholds)
Marital Status	Mother's marital status. Dummy variable categorized as married and not married)
Sampling	Kindergarten weight

Appendix E: Analyses

Latent Profile

Latent profile analysis was used to investigate whether children with qualitatively different patterns of school readiness skills have qualitatively different academic and social trajectories in later elementary school. Each of the school readiness measures were converted into z-scores prior to running the latent profile analysis. For the ECLS-K, the kindergarten weights were used in the multinomial analyses and the growth curve analyses. For the NICHD, site was included as a covariate.

For the latent profile analysis, multi-nominal regressions were used to predict four classes, or categories, of children in the dataset sample. Each class represents a different profile of strengths and weaknesses. Below is a table describing the skill levels and relative risk of each of the four classes.

Table 11a. Profiles from latent profile analysis in NICHD SECCYD

Profile	Features
Class I	High risk in all school readiness domains; 7% of the sample
Class II	Moderate risk in all school readiness domains; 26% of the sample
Class III	At the mean; 43% of the sample
Class IV	Strengths in all school readiness domains; 24% of the sample

Table 11b. Profiles from latent profile analysis in ECLS-K

Profile	Features
Class I	Risk in all school readiness domains; 37% of the sample
Class II	At mean in all school readiness domains; 48% of the sample
Class III	On track ; 14% of the sample
Class IV	On track reading and math strengths; 1% of the sample

In the ECLS-K classes, “on track” denotes being above the mean.

For the NICHD dataset, compared to children in Class I (risk in all school readiness domains), children in the other classes were more likely to be female, less likely to be a minority compared to white, more likely to be have a mother with a higher education, more likely to come from a family with a higher income to poverty threshold (Class III and IV), more likely to be in a married family (Class III and IV), and less likely to be disabled.

For the ECLS-K dataset, compared to children in Class 1 (risk in all school readiness domains), children in the other classes are more likely to be female, more likely to speak English at home, more likely to be older, less likely to be a minority, less likely to come from a family below 200% of the poverty threshold, more likely to be from married family, and less likely to have a disability.

Using these distinct profiles, growth curve analyses were completed to see whether a certain risk-level profile at school entry predicted to later school outcomes.

Hierarchical Linear Modeling

Analysis Models: Two sets of Hierarchical Linear Model were conducted twice. The two set of analyses were designed to test for thresholds in associations between the school readiness skills and developmental trajectories in academic and social skills between entry to school and adolescence. A quadratic model tested whether we could estimate cut-points that defined thresholds while the piecewise approach tested whether a priori-defined cut-point reflected thresholds.

Each school readiness variable was examined in separate analysis, and also examined in combination with the other school readiness variables.

We excluded children not proficient in English in analyses of academic skills in the ECLS-K because their assessments were not comparable to the other assessments. Grade was centered at grade 3 for the ECLS-K and NICHD SECCYD data. All variables were standardized (sample mean=0, sample SD=1) so that coefficients could be interpreted as effect sizes.

Quadratic: These analyses examined the extent to which the school readiness variables showed a linear or quadratic association with either the level or rate of change in child outcomes from entry to school into adolescence.

$$Y_{ij} = B_{0i} + B_{1i}\,\text{Grade}_{ij} + B_{2i}\,\text{Grade}_{ij}^2 + B_3\,\text{school readiness}_{ij} + B_4\,\text{school readiness}_{ij}^2 + B_5\,\text{Grade}_{ij} \times \text{school readiness}_{ij} + B_6\,\text{Grade}_{ij} \times \text{school readiness}_{ij}^2 + \underline{B\,\text{covariates}} + \underline{B\,\text{Grade x covariates}} + e_{ij}$$

Variance terms:

Level 1 – residual e_{ij}

Level 2 – variance and covariance for individual intercept and slope

Piecewise: These analyses examined whether the association between school readiness skills and either level or rate of change in child outcome over time was stronger or weaker when children entered school in normal range or low range on that school readiness variable. One standard deviation below the mean was selected as the prior cut-point because performing one standard deviation below the mean is a

widely accepted marker of being in an at-risk range of performance on a measure (for example, the Achenbach Child Behavior Checklist). The definitions of normal and low are below, followed by presentation of the model. The tables show the normal and low groups in the two samples

- Normal: child's score is at above 1 SD below the mean
- Low: child's score is at or below 1 SD below the mean

$Y_{ij} = B_{0i} + B_{1i}\,Grade_{ij} + B_{2i}\,Grade_{ij}^2 + B_3\,school\ readiness_{ij} + B_4\,school\ readiness^{ij}*low\ range_{ij} + B_5\,Grade_{ij}\ x\ school\ readiness_{ij} + B_6\,Grade_{ij}\ x\ school\ readiness_{ij}*low\ range_{ij} + \underline{B\ covariates} + \underline{B\ Grade\ x\ covariates} + e_{ij}$

Level 1 – residual e_{ij}

Level 2 – variance and covariance for individual intercept and slope

Table 12. NICHD SECCYD: Variables used in piecewise analyses

	N	Means	SD
Language			
Normal (≥83.68)	871	105.39	11.60
Low (< 83.68)	207	75.60	6.91
Social Skills			
Normal (≥ 85.23)	852	106.46	10.94
Low (< 85.23)	154	73.18	10.02
Exec. Functioning			
Normal (≥24.19)	817	35.79	5.15
Low (< 24.19)	185	18.57	4.93
WJ Letter Word			
Normal (≥ 85.41)	920	102.04	11.33
Low (< 85.41)	136	77.93	6.63
WJ Applied Problems			
Normal (≥ 87.31)	890	107.71	11.12
Low (< 87.31)	163	76.94	10.20
Approaches to Learning			
Normal (≥3.86)	875	4.95	.64
Low (< 3.86)	148	3.29	.49
Health			
Normal (≥2.74)	990	3.52	.50
Low (< 2.74)	93	1.95	.23

Note: Above cut point variable was constructed by subtracting the score on the assessment/questionnaire from the cut point and then setting the below the cut point values to zero.
Below the cut point variable is the score on the assessment/questionnaire. Values above the cut point were set to zero.

Table 13. ECLS-K: Variables used in piecewise analyses

	N	Means	SD
Social Skills			
Normal (≥7.88)	12746	10.14	1.27
Low (<7.88)	1825	6.35	0.81
Reading			
Normal (≥25.19)	14312	36.04	9.64
Low (<25.19)	1282	24	0.88
Math			
Normal (≥17.32)	13771	27.78	8.38
Low (<17.32)	1819	15	1.63
Approaches to Learning			
Normal (≥2.32)	12949	3.2	0.51
Low (2.32)	2522	1.94	0.25
Health			
Normal (≥2.54)	13217	3.62	0.48
Low (<2.54)	2410	1.82	0.41
General Knowledge			
Normal (≥14.95)	12801	24.59	6.14
Low (<14.95)	2747	12.02	1.94

Covariates: All analyses include family income or poverty status, parental education, age, whether the parents were married, disability status, gender, and ethnicity as covariates. In addition, the analysis of the NICHD SECCYD included site and of the ECLS-K included whether English was spoken in the home (note – there was no variation within NICHD SECCYD on language spoken in the home due to inclusion criteria).

Missing Data: All analyses involved multiple imputations (MI), imputing 10 datasets to account for missing data. The MI involved

- Wide datasets
- All analysis variables plus a few additional covariates in NICHD SECCYD from early childhood to enhance imputation.
- Limited to children with any 54m data for NICHD SECCYD to allow imputation models to converge

Separate analyses for each school readiness variable and combined analyses

- First we examined each school readiness variables as a predictor of each outcome in separate analyses

- Then we examined all school readiness variables as predictors of each outcome, Including statistically significant linear and quadratic school readiness variables from first set of models in the second set of models

The following hierarchical linear model was created for the mixed model analysis:

$Y_{ij} = B_{0i} + B_{1i}\,Grade_{ij} + B_{2i}\,Grade_{ij}^2 + B_3\,school\ readiness_{ij} + B_4\,school\ readiness_{ij}^2 + B_5\,Grade_{ij}\ x\ school\ readiness_{ij} + B_6\,Grade_{ij}\ x\ school\ readiness_{ij}^2 + B\,covariates + e_{ij}$

Two-level hierarchical linear models were conducted, estimating separate intercepts and slopes for the school-age outcome for all children. The slopes were allowed to be fixed-effects instead of random effects when the preliminary results indicated there was insufficient individual variability to estimate random-effect slopes.

Comparison of children in the "normal" and "low" groups in the piecewise analyses

Preliminary Analyses, prior to piecewise regression analyses. A small set of background characteristics were examined in relation to being in the "low" versus "normal" groups according to the piecewise analyses. As expected, children from more advantaged backgrounds at kindergarten entry were more likely to fall within the normal range on school readiness skills at kindergarten entry. Specifically, children in the normal range were more likely than children in the low range to be in two-parent/married families, to live above the 200% poverty threshold for household income, and to have a mother with a bachelor's degree or higher. On the other hand, children in the low range on school readiness skills were more likely than their peers in the normal range to have a mother with a high school degree or less; they also tended to be in households where English was not the primary language (although this varied by the specific school readiness skill).

Participation in center-based versus home-based child care prior to kindergarten was not consistently associated with being in the low or normal ranges on school readiness skills; it varied according to specific outcomes. For example, within the NICHD SECCYD dataset, children in the normal range on Applied Problems were more likely than those in the low range on this skill to spend more time in center-based care over the early childhood years. But children in the low range on social-emotional outcomes were more likely than those in the normal range on this school readiness skill to spend more time in center-based care during the early childhood years. Children in the normal range on language outcomes in kindergarten were more likely than those in the low range to spend more time in home-based care during the early childhood years.

Participating in center-based or home-based care in the year prior to kindergarten was related to being in the low vs. normal range for the cognitive outcomes only within the NICHD SECCYD

dataset. Specifically, children were more likely to be in the for the normal range on Woodcock-Johnson Letter-Word and Applied Problems outcomes if they were in center-based care only the year prior to kindergarten; they were more likely to be in the low range on both outcomes if they were in home-based care only in the year prior to kindergarten. There was no effect of child care participation in the year prior to kindergarten on language, social-emotional, executive function, or health outcomes.

Findings from the ECLS-K data indicated that for reading, math, and general knowledge outcomes at kindergarten entry, children in the normal range on these skills were more likely than those in the low range to have been in center-based care in the year prior to kindergarten. Conversely, children in the low range on these skills, compared to those in the normal range, were generally more likely to have spent time in home-based care or in parental care the year prior to kindergarten. The opposite pattern existed with regard to those in the normal versus low ranges on social skills at kindergarten entry: those children in the normal range for social-emotional outcomes in kindergarten were *less* likely than those in the low range to have spent time in center-based care in the year prior to kindergarten. Conversely, those in the normal range on social-emotional outcomes were more likely than their peers in the low range to have spent time in home-based care or in the care of their parents in the year prior to kindergarten. There was no relation of child care participation in the year prior to kindergarten to low versus normal group categorizations for health or approaches to learning skills in kindergarten within the ECLS-K dataset.

Regression Analysis

In order to explore whether there were early predictors of being "in the running" for later school success, the research team identified fifth-grade indicators of later school success and created indices of being "in the running" which were then predicted by kindergarten characteristics of the child, including the child's school readiness profile membership (derived from earlier LCA analyses).

Two methods were employed to create the "In the Running" (ITR) indices using data from the fifth grade data wave of the ECLS-K—an "empirical" and a "conceptual" method. For each method, continuous and dichotomous versions of "In the Running" indices were created based on the individual indicators.

Three sub-domains of being "in the running" were created for each method. Index sub-domains of being "in the running" are school engagement, social-emotional adjustment, and cognitive/academic skills. Engagement indicators child self-report of interest in school; school report of total absences for the year, and whether the child was performing below, on or above grade level. Social-emotional indicators were self-report of peer relations and externalizing behavior problems. Cognitive/academic indicators were direct child assessments of reading, math, and science. Logistic regression was used to determine demographic and school readiness predictors of the ITR domain-specific indices.

Below is a table that includes the constructs included in each of the "In the Running" indices.

Table 14. ECLS-K: variables included in the "In the Running" indices for the fifth grade data

Construct	Cognitive	Social	Engagement
Grade Level			**x**
Interest in School (1= not true at all, 2= a little bit true, 3 = mostly true, 4 = very true)			**x**
Total Absences **(excused and unexcused)**			**x**
Peer Relations (1= not true at all, 2= a little bit true, 3 = mostly true, 4 = very true)		**x**	
Externalizing Problem Behaviors **(reverse coded)** (1= not true at all, 2= a little bit true, 3 = mostly true, 4 = very true)		**x**	
Reading IRT Score	**x**		
Math IRT Score	**x**		
Science IRT Score	**x**		

Empirical Method

Table 15. Mean scores for each of the empirically-based indices, by key percentile distribution points

Percentile	Cognitive	Social	Engagement
Lowest	-5.60	-4.83	-14.91

Percentile	Cognitive	Social	Engagement
25%	-0.96	-0.67	-0.48
40%	-0.20	-0.23	-0.05
50%	0.23	0.12	0.18
75%	1.19	0.88	0.71
Highest (100%)	3.19	2.05	1.95

Source: ECLS-K fifth grade wave

For the "empirical" method, a composite was constructed with principal component factor analysis that weighted the contributions of individual indicators within the continuous factor. Three different indices were created: cognitive, social, and engagement. The cutpoints for the binary ITR variables using this method were set at 40% of the distribution on the continuous measures for each index. This cutpoint was based on the idea that, on a normally distributed variable with a mean of 50 and standard deviation of 10, performance at 1 standard deviation below the mean is generally recognized as poor performance.

A higher score on the continuous factor indicated that a child was more "in the running" than children with lower scores. As noted above, the cut-point for being "in the running" was set at the 40th percentile for the binary version of these indices. For the total score, the cut-point was set at -0.17.Thus, children above -0.17 on the composite, continuous factor are considered "in the running," whereas children below are not. For the Cognitive sub-domain, the cut-point was set at -0.20. For the Social sub-domain, the cut-point was set at -0.23. And for the Engagement sub-domain, the cut-point was set at -0.05.

Logistic regression analyses used the kindergarten School Readiness profiles and covariates to predict the binary versions of the empirically-derived "in the running" indices for the full sample (in Appendix A). As expected for each of the empirically-based indices, children from more advantaged backgrounds at kindergarten entry were more likely to be categorized as "in the running" in fifth grade. In addition, children who were categorized as "in the running" in fifth grade were performing significantly better in each of the school readiness domains at kindergarten entry than children who were not categorized as "in the running" in fifth grade. The pattern held true for both the full sample as well as the sample of children who lived in families with incomes less than 200% of the poverty threshold**.**

Conceptual Method

For the "conceptual" method, an *a priori* cutpoint was determined for each individual indicator of being "in the running."Cutpoints were based on the research literature. For example, research indicates that total absences of 18 days or more per year in early schooling is significantly associated with the likelihood of dropping out of school (Chang & Romero, September 2008).Therefore, the cutpoint on the indicator of Total Absences was set at 18 or more days vs. 17 days or less. Similarly, the cutpoint for Grade Level was put between being "below" grade level and "on or above grade level." For indicators that had four categorical response options from "not at all true" (1) to "very true" (4), the cutpoint was placed between "a little bit true" (2) and "mostly true" (3).The cutpoints for the continuous reading, math and science scores were placed at 40% of the distribution. This decision was based, in part, on the

trends seen in the latest NAEP results, but also based on the notion that performance at 1 standard deviation below the mean (assuming a normal distribution) is indication of poor performance. Specifically, the 2009 NAEP data indicates that 67% of fourth graders are performing at or above "basic" in reading(National Assessment of Educational Progress, 2009c); 82% of fourth graders were at or above basic in math in 2009 (National Assessment of Educational Progress, 2009b), and 72% of fourth graders were at or above basic in science in 2009 (National Assessment of Educational Progress, 2009a). (See Table 15 below for a full listing of the conceptual cutpoints for each indicator and the distribution of the sample associated with these cut points.) The cutpoints for the binary ITR variables were made at approximately 40% of the distribution on continuous measures, based on the idea that performance at 1 standard deviation below the mean (assuming a normal distribution) is indication of poor performance.

Table 16. Conceptual Method Cutpoints

Percentile	Total Score	Cognitive	Social	Engagement
Lowest	0	0	0	0
25%	4	1	1	2
50%	5	2	1	2
75%	7	3	2	3
Highest	8	3	2	3

Range: 0-8 Minimum: 0 Maximum: 8
Source: ECLS-K fifth grade wave

For the Cognitive sub-domain, the cut-point was set at a score of 2, indicating that approximately 62% of children were "in the running" in the cognitive domain in fifth grade. For the Social sub-domain, the cut-point was set at 1, indicating that 80% of fifth graders were "in the running". For the Engagement sub-domain, the cut-point was set 2, indicating that 91% of fifth graders are "in the running" for engagement.

Table 17. Conceptual cutpoints used for the conceptual version of the In the Running index

Construct	Cutpoint for "Conceptual" version of In the Running Index (noted by *)
Grade Level	**At or above grade level*:** 9712 (89.93%) **Below grade level:** 1075 (9.97%)
Interest in School	**Score of 3 or 4*:** 4762 (42.21%)

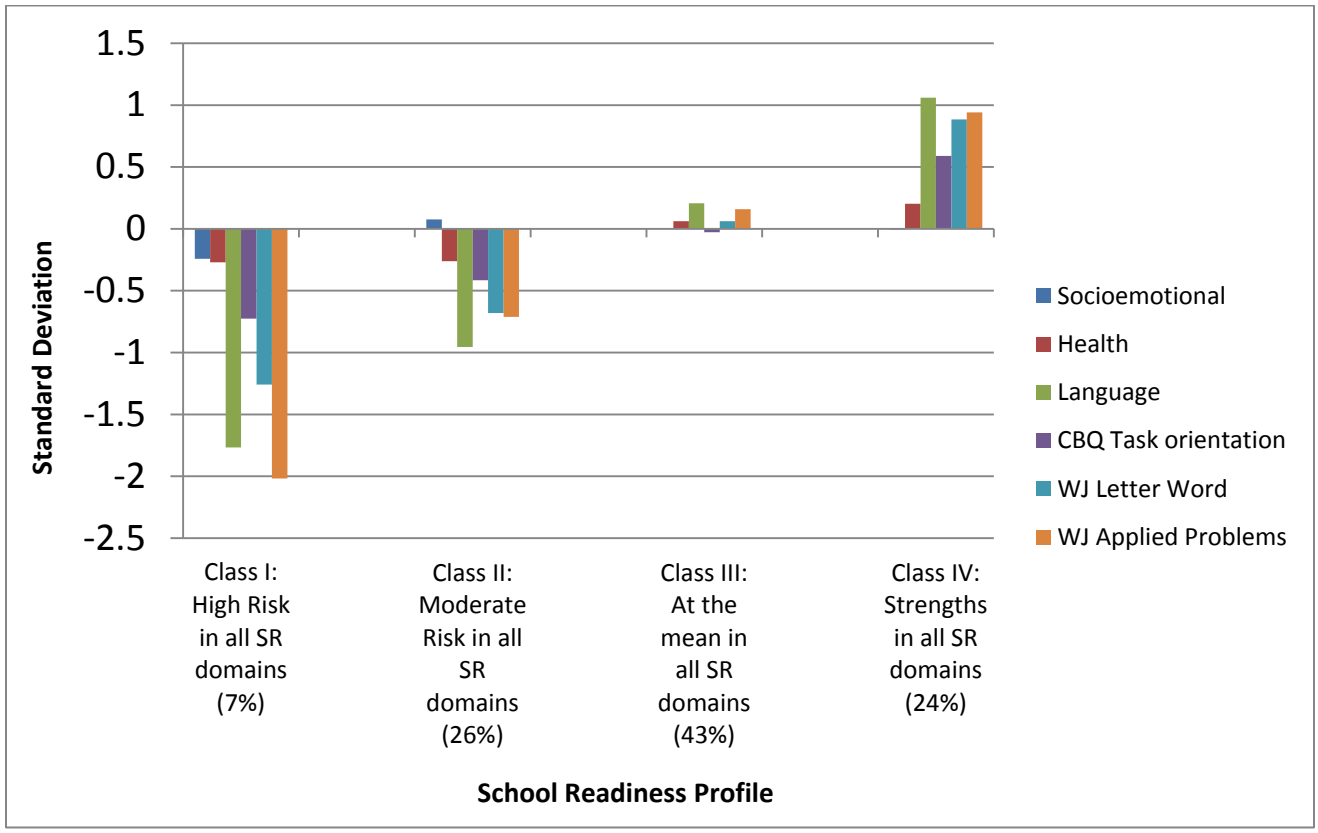
Construct	Cutpoint for "Conceptual" version of In the Running Index (noted by *)
(1= not true at all, 2= a little bit true, 3 = mostly true, 4 = very true)	**Score of 1 or 2:** 6520 (57.79%)
Total Absences **(excused and unexcused)**	**0-17.99*:** 9306 (94.08%) **18+:** 586 (5.92%)
Peer Relations (1= not true at all, 2= a little bit true, 3 = mostly true, 4 = very true)	**Score of 3 or 4*:** 6505 (57.66%) **Score of 1 or 2:** 4777 (42.34%)
Externalizing Problem Behaviors (1= not true at all, 2= a little bit true, 3 = mostly true, 4 = very true)	**Score of 1 or 2*:** 7005 (62.09%) **Score of 3 or 4:** 4277 (37.91%)
Reading IRT Score	**Score greater than 135.52**
Math IRT Score	**Score greater than 111.96**
Science IRT Score	**Score greater than 55.66**

As with the Empirical Method of creating the "in the running" variable, logistic regression analyses used the kindergarten School Readiness profiles and covariates to predict the binary versions of the conceptually-created "in the running" variables.

Appendix F: Additional Tables and Charts

Latent Profile Analyses Tables and Figures

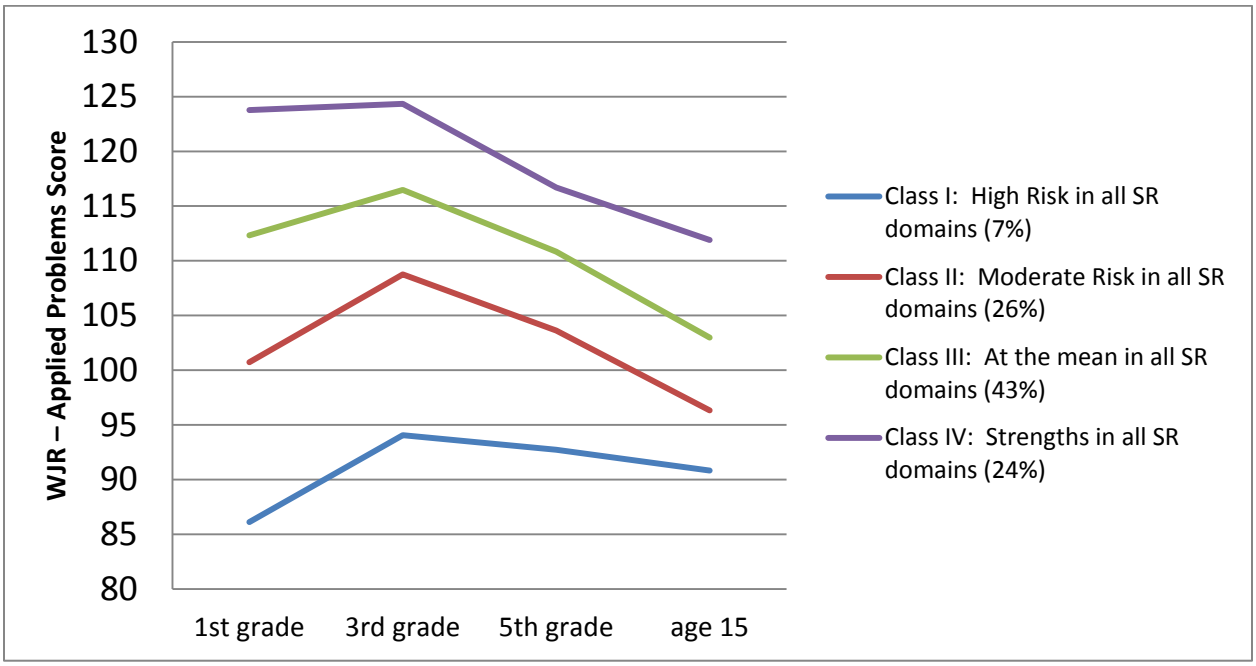
Figure 1. Latent class analyses of school readiness at 54 months in the NICHD SECCYD



Source: NICHD SECCYD

Figure 1 shows the standard deviation of scores in each school readiness domain for the four classes that were formed by the latent profile analysis with the NICHD SECCYD dataset. Class 1 is comprised of children with risk in all school readiness domains assessed with this dataset. Each subsequent class represents children with less risk.

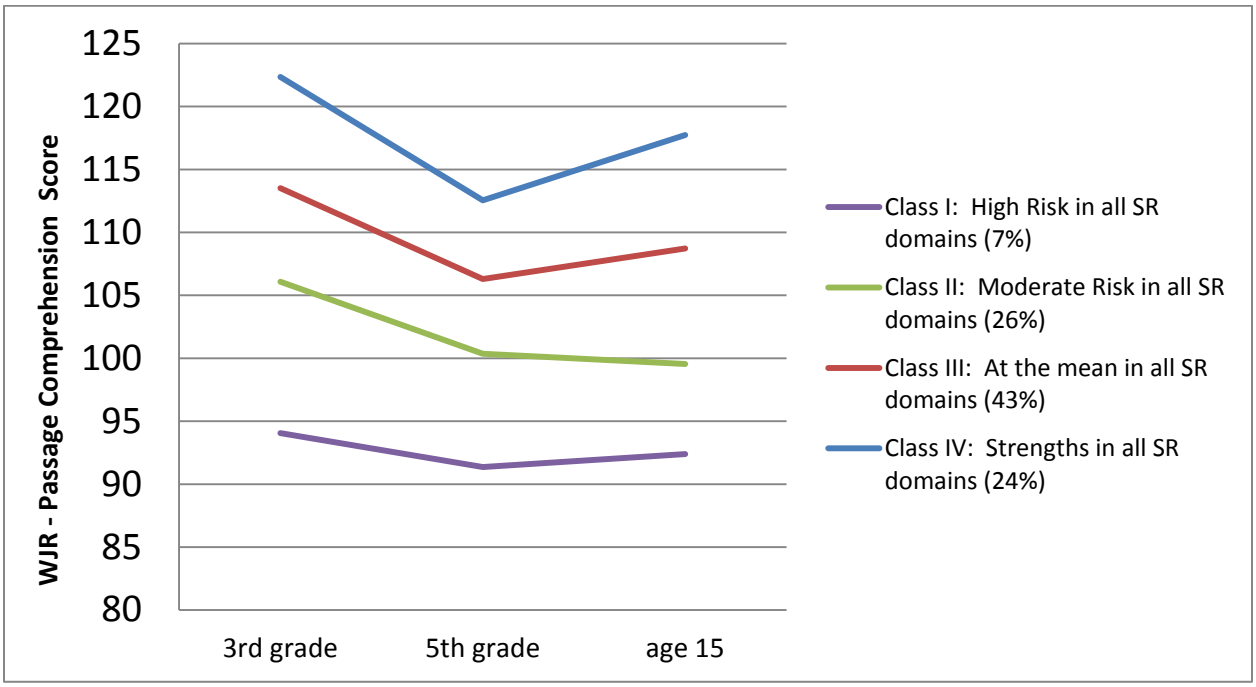
Figure 2. NICHD SECCYD: Developmental trajectories for math from the first grade to age 15 by school readiness profile



Source: NICHD SECCYD

Figure 2 shows the developmental trajectories in math from first grade through age 15 in the NICHD SECCYD dataset for each of the four classes identified by latent profile analysis. Compared to the children in Class I (high risk in all school readiness domains), children in all other groups scored higher on their math assessments in the first grade. A hierarchical progression was apparent with each group performing better than the previous group. And, compared to children in Class I, children in all other groups grew at a faster rate between first grade and age 15 on their math skills.

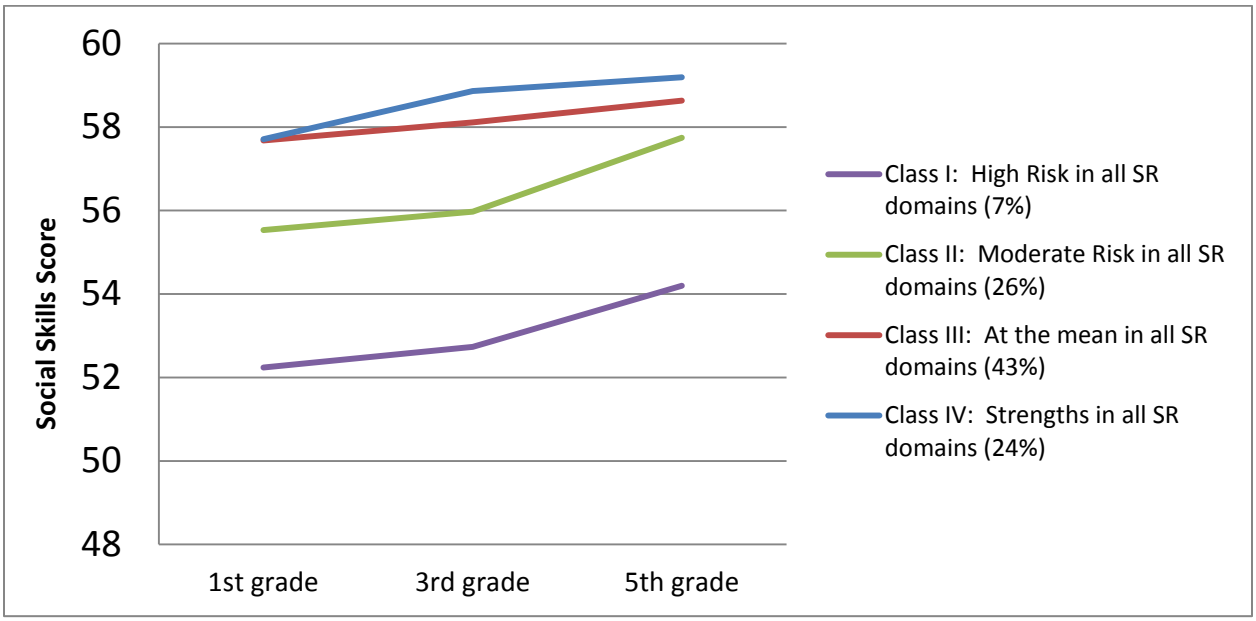
Figure 3. NICHD SECCYD: Developmental trajectories for reading from the third grade to age 15 by school readiness profile



Source: NICHD SECCYD

Figure 3 shows the developmental trajectories in reading from third grade through age 15 for each of the four classes identified by latent profile analysis in the NICHD SECCYD dataset. Compared to the children in Class I (high risk in all school readiness domains), children in all other groups scored higher on their reading assessments in the third grade. A hierarchical progression was apparent with each group performing better than the previous group.

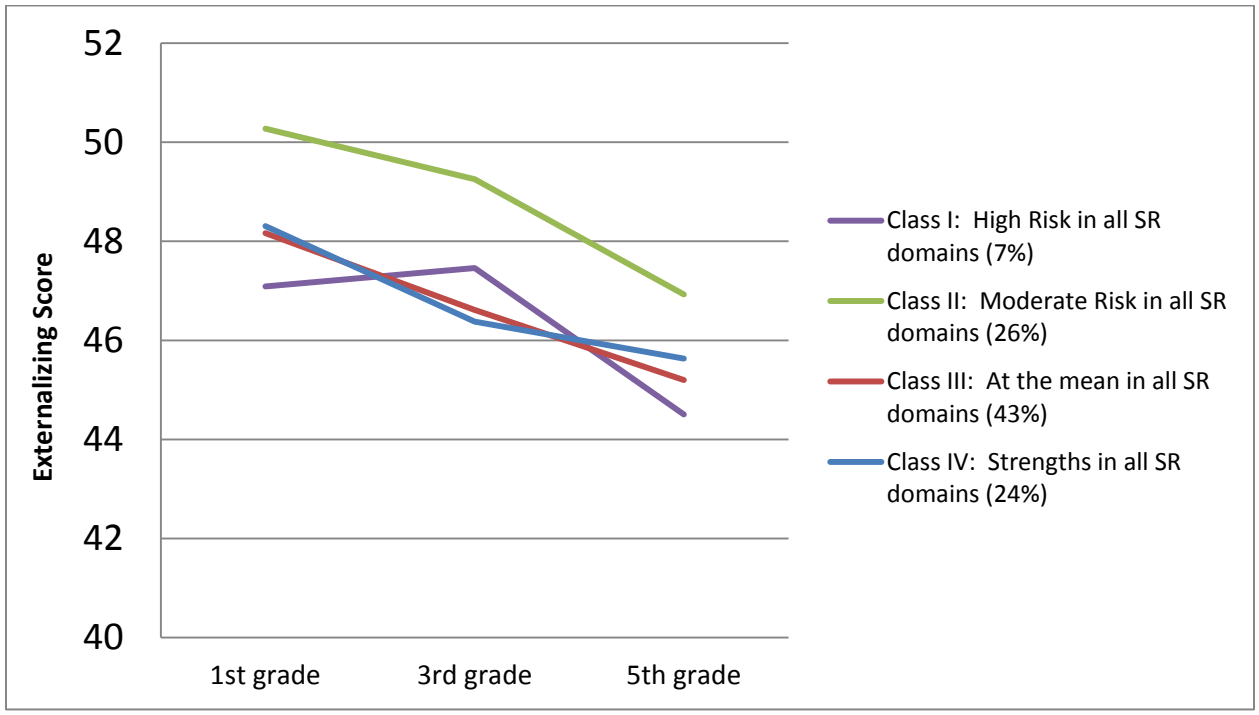
Figure 4. NICHD SECCYD: Developmental trajectories for social skills from the first grade through fifth grade by school readiness profile



Source: NICHD SECCYD

Figure 4 shows the developmental trajectories in social skills from first grade through fifth grade for each of the four classes identified by latent profile analysis in the NICHD SECCYD dataset. Compared to the children in Class I (high risk in all school readiness domains), children in all other groups had higher social skills in the first grade. A hierarchical progression was apparent with each group performing better than the previous group.

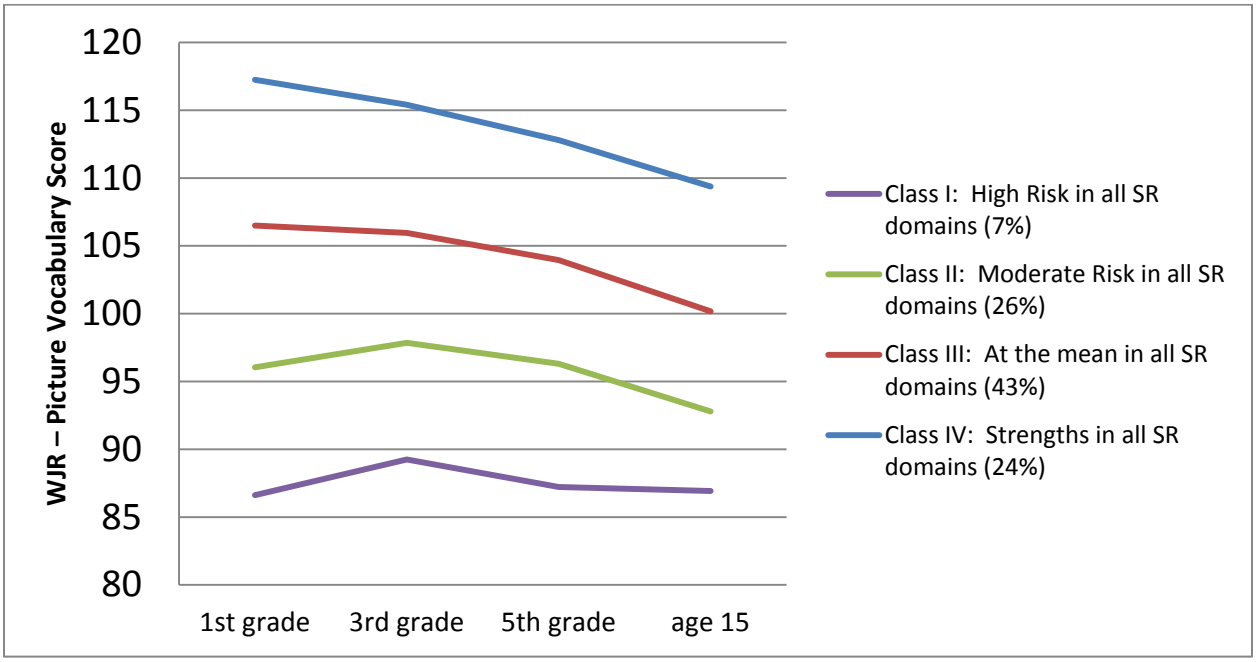
Figure 5. NICHD SECCYD: Developmental trajectories for externalizing from the first grade through fifth grade by school readiness profile



Source: NICHD SECCYD

Figure 5 shows the developmental trajectories in externalizing behavior problems for each of the four classes identified by latent profile analysis in the NICHD SECCYD dataset.

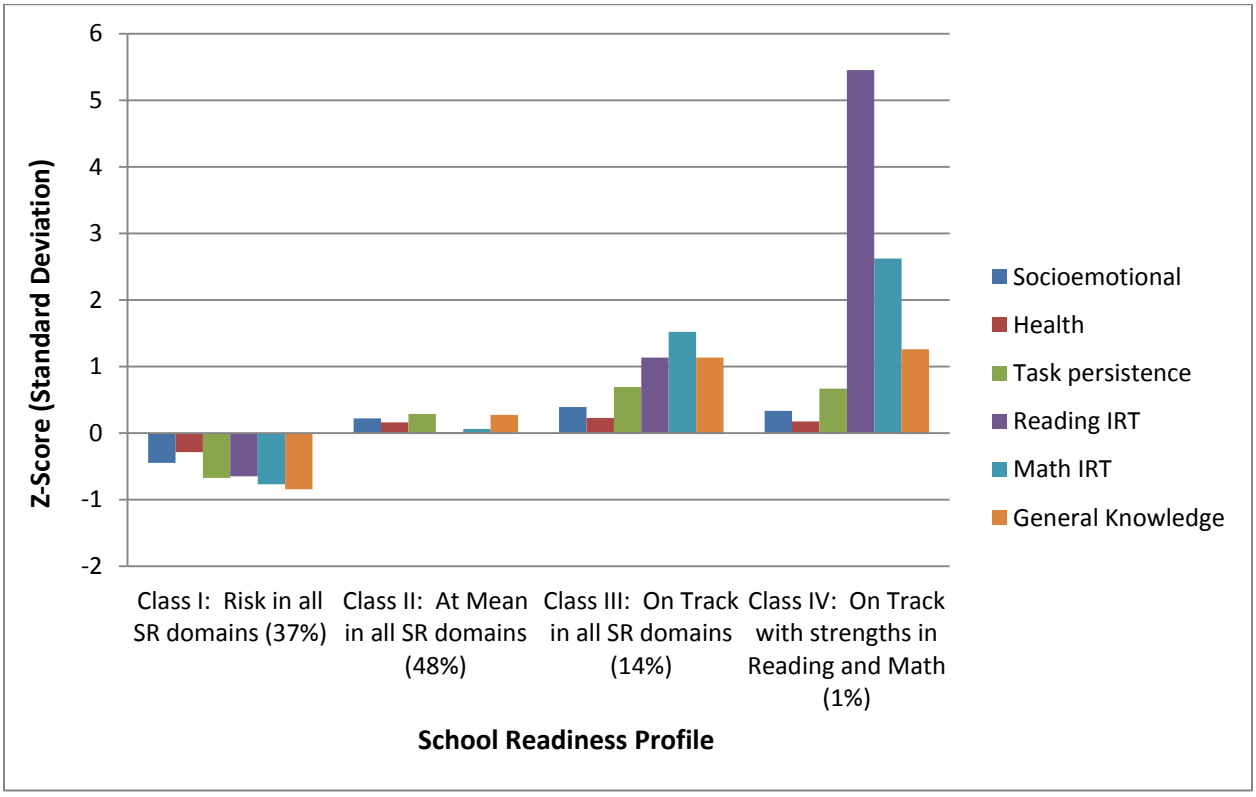
Figure 6. NICHD SECCYD: Developmental trajectories for language from the first grade to age 15 by school readiness profile



Source: NICHD SECCYD

Figure 6 shows the developmental trajectories in language skills for each of the four classes identified by latent profile analysis in the NICHD SECCYD dataset. Compared to the children in Class I (high risk in all school readiness domains), children in all other groups had higher social skills in the first grade. A hierarchical progression was apparent with each group performing better than the previous group.

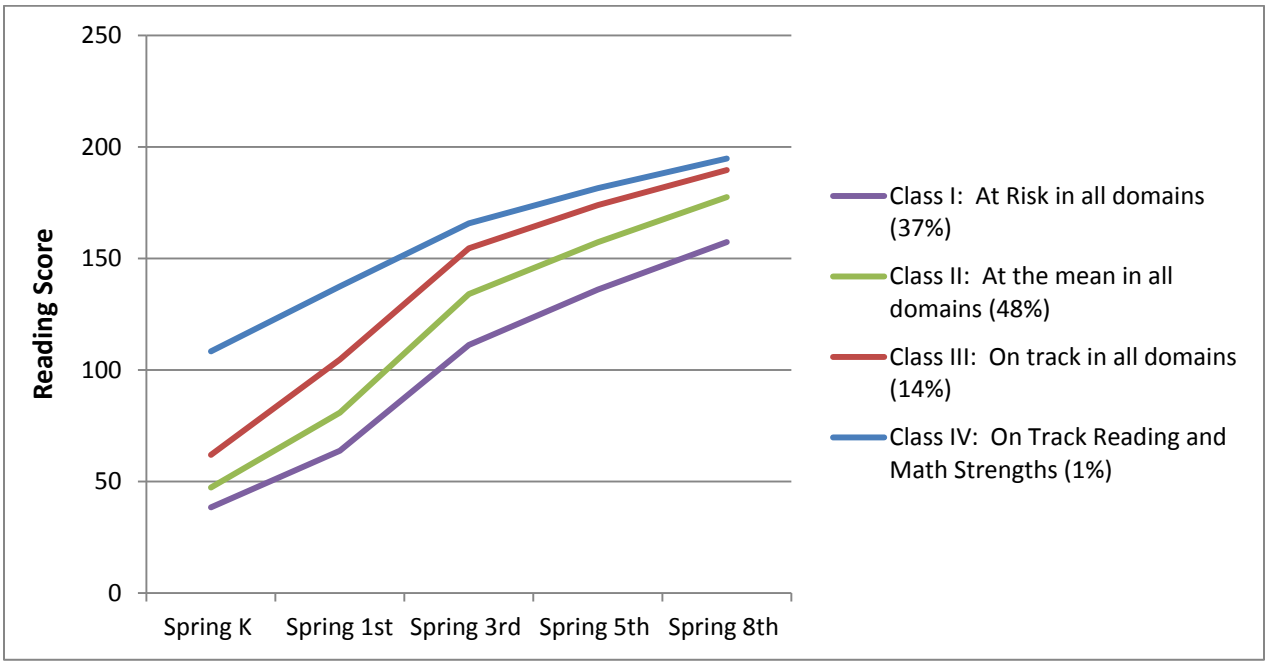
Figure 7. ECLS-K: Latent profile analyses of school readiness at kindergarten entry



Source: ECLS-K

Figure 7 shows the standard deviation of scores in each school readiness domain for the four classes that were formed by the latent profile analysis with the ECLS-K dataset. Class 1 represents children with risk in all school readiness domains and each subsequent class represents less risk with Class IV indicating particular strengths in reading and math.

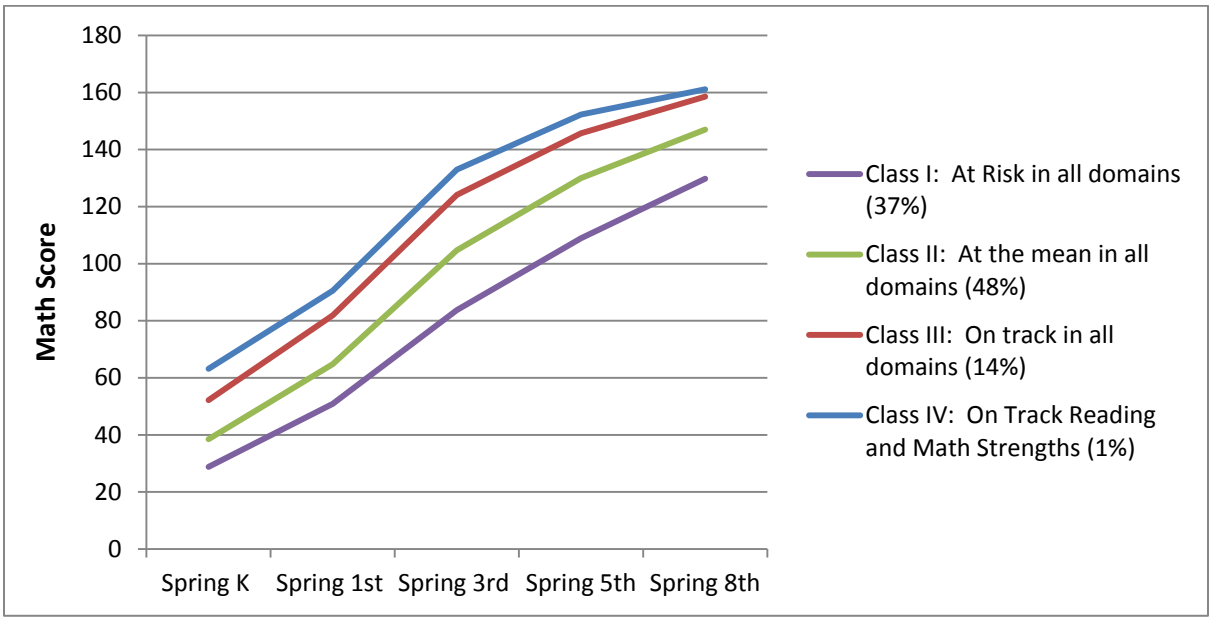
Figure 8. ECLS-K: Developmental trajectories for reading from the spring of kindergarten to eighth grade by school readiness profile



Source: ECLS-K

Figure 8 shows the developmental trajectories in reading skills for each of the four classes identified by latent profile analysis in the ECLS-K dataset. Compared to the children in Class I (risk in all school readiness domains), children in all other groups scored higher on their reading assessments at the Spring of Kindergarten. A hierarchical progression was apparent, with each subsequent class performing better than the previous group. And, compared to children in Class I, children in all other groups grew at a faster rate between the spring of Kindergarten and the spring of eighth grade on their reading skills.

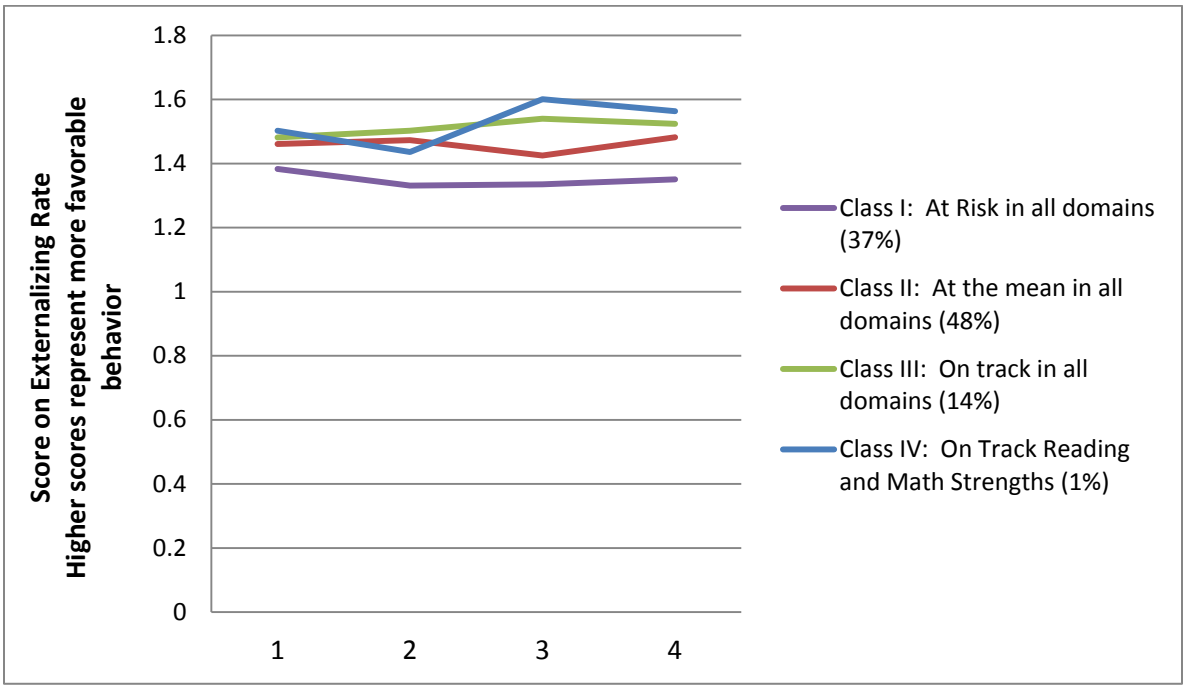
Figure 9. ECLS-K: Developmental trajectories for math from the spring of kindergarten to eighth grade by school readiness profile



Source: ECLS-K

Figure 9 shows the developmental trajectories in math skills for each of the four classes identified by latent profile analysis in the ECLS-K dataset. Compared to the children in Class I (risk in all school readiness domains), children in all other groups scored higher on their math assessments at the Spring of Kindergarten. A hierarchical progression was apparent, with each subsequent class performing better than the previous group. And, compared to children in Class I, children in all other groups grew at a faster rate between the spring of Kindergarten and the spring of eighth grade on their math skills.

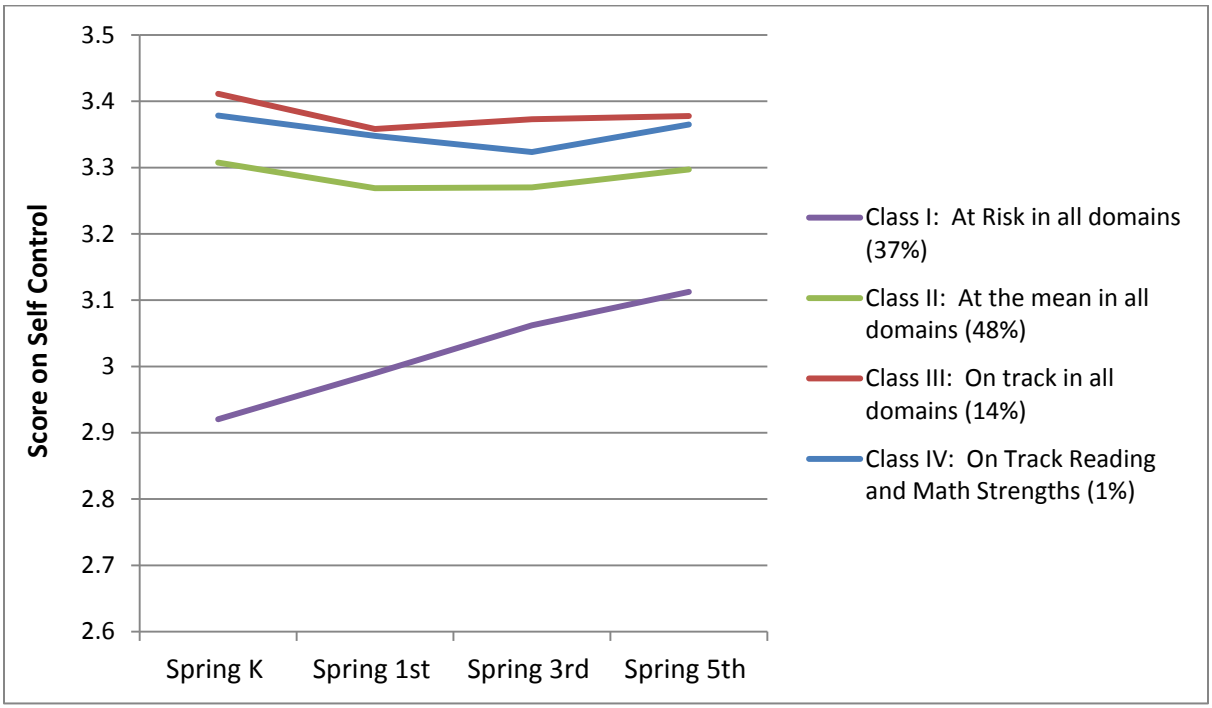
Figure 10. ECLS-K: Development trajectories for externalizing behaviors (higher scores represent more favorable behavior) by school readiness class



Source: ECLS-K

Figure 10 shows the developmental trajectories in externalizing behavior problems for each of the four classes identified by latent profile analysis in the ECLS-K dataset. Children in Class I (at risk in all domains) grew more slowly in terms of social skills and had a faster rate of growth on externalizing behavior problems as compared to their peers in the other three classes. In this figure, higher externalizing behavior scores represent more favorable behavior.

Figure 11. ECLS-K: Development trajectories for self-control by school readiness class



Source: ECLS-K

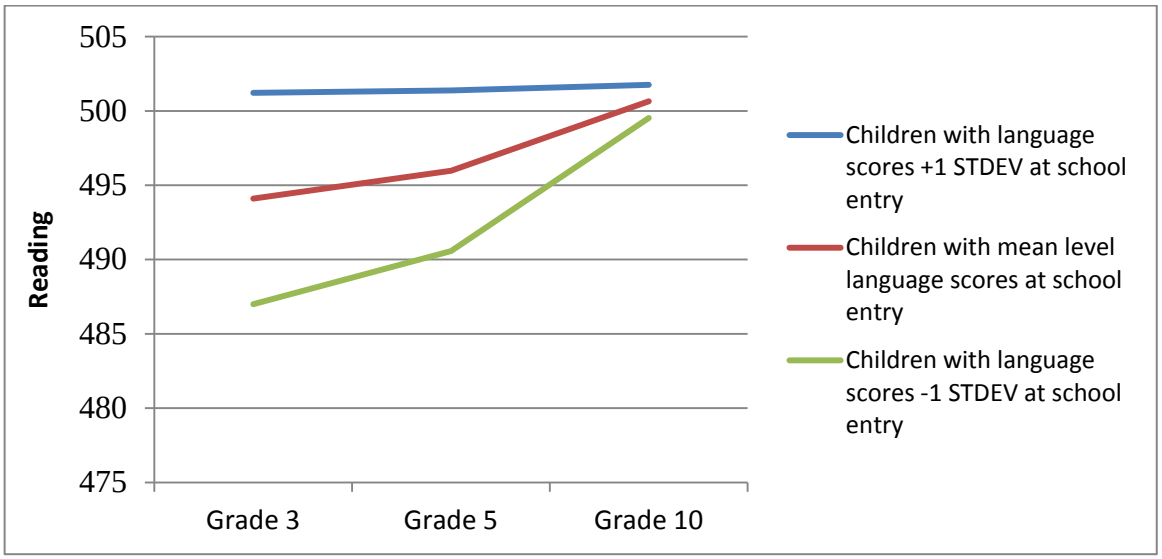
Figure 11 shows the developmental trajectories in self-control skills from kindergarten through fifth grade for each of the four classes identified by latent profile analysis in the ECLS-K dataset. Compared to the children in Class I (risk in all school readiness domains), children in all other groups had higher social skills in the first grade. A hierarchical progression was apparent with each group performing better than the previous group. However, while children in Class I never fully caught up to their peers, they did grow more over time than did the children in the other three classes.

HLM (Quadratic and Piecewise) Analyses Tables and Figures

Quadratic School Readiness Analyses:

The first set of HLM analyses tested whether school readiness skills predicted level or change in children's academic and social trajectories when the models allowed those associations to be both linear and quadratic. Selected results are shown in the following tables. The tables show the effect sizes when the association between school readiness was statistically significant ($p < .05$). The tables show the results on the left side for analyses that included a single school readiness variable and on the right side for analyses that included all school readiness variables that were related to the trajectories in the analyses reported on the left.

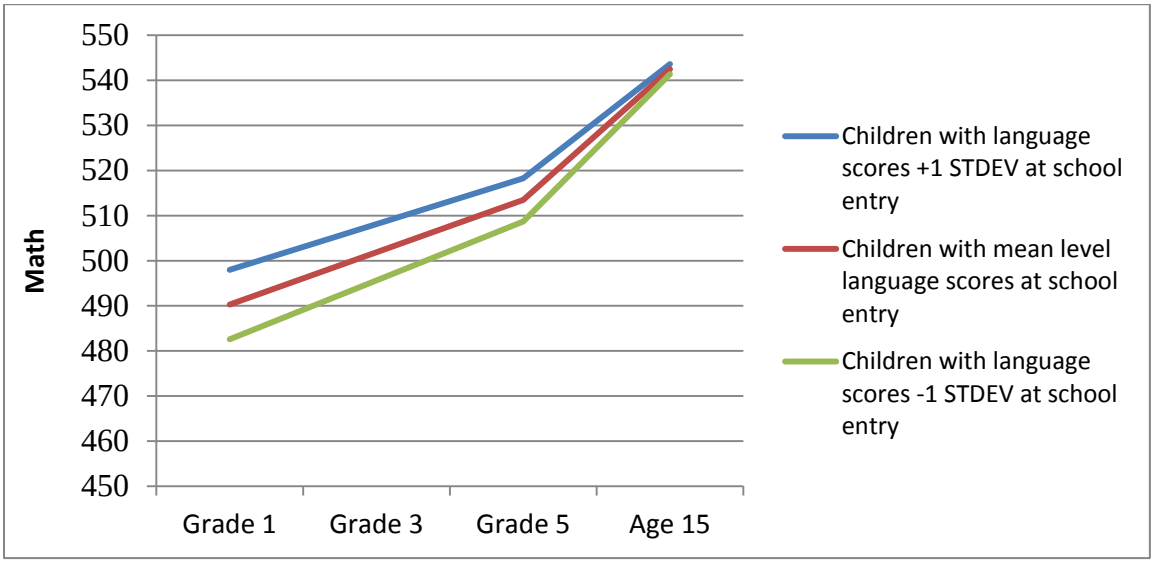
Figure 12. NICHD SECCYD: Quadratic analyses of language and reading trajectory



Source: NICHD SECCYD

Figure 12 shows that children with higher language skills at entry to school tended to have higher reading skills during the school years but the rate of change over time in language skills was very slightly higher between grades 3 and 5 for children who entered with lower skill levels. Between grades 3 and 5, reading scores when examined in relation to language skills, showed a particular rate of growth. However, between grade 5 and age 15, growth was accelerated, as denoted by the steeper slope of the reading score line.

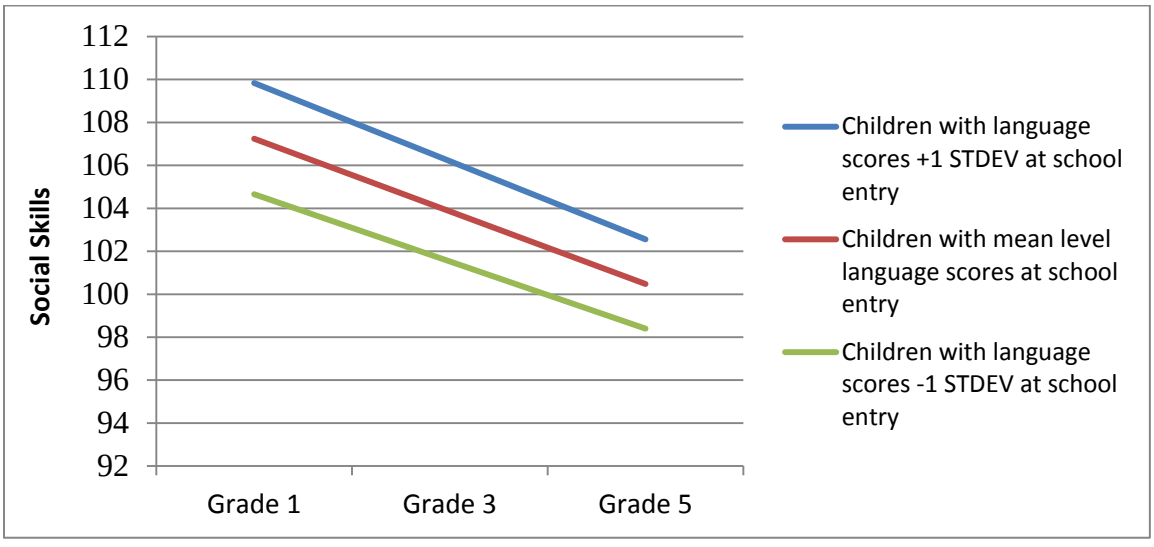
Figure 13. NICHD SECCYD: Quadratic analyses of language and math trajectory



Source: NICHD SECCYD

Figure 13 shows the change in math scores from first grade through age 15 in an analysis of language scores. Here, students showed a higher rate of development in math skills earlier in elementary school and then the rate of growth tapered off in later elementary school and through age 15. This means that when examined alone, higher school-entry skills related to later math skills (d=.47) with a very slight quadratic curvature for math outcomes. When examined with other school readiness skills, higher school-entry skills again related to higher math skills (d=.19) with slightly smaller math gains (d=-.05) over time.

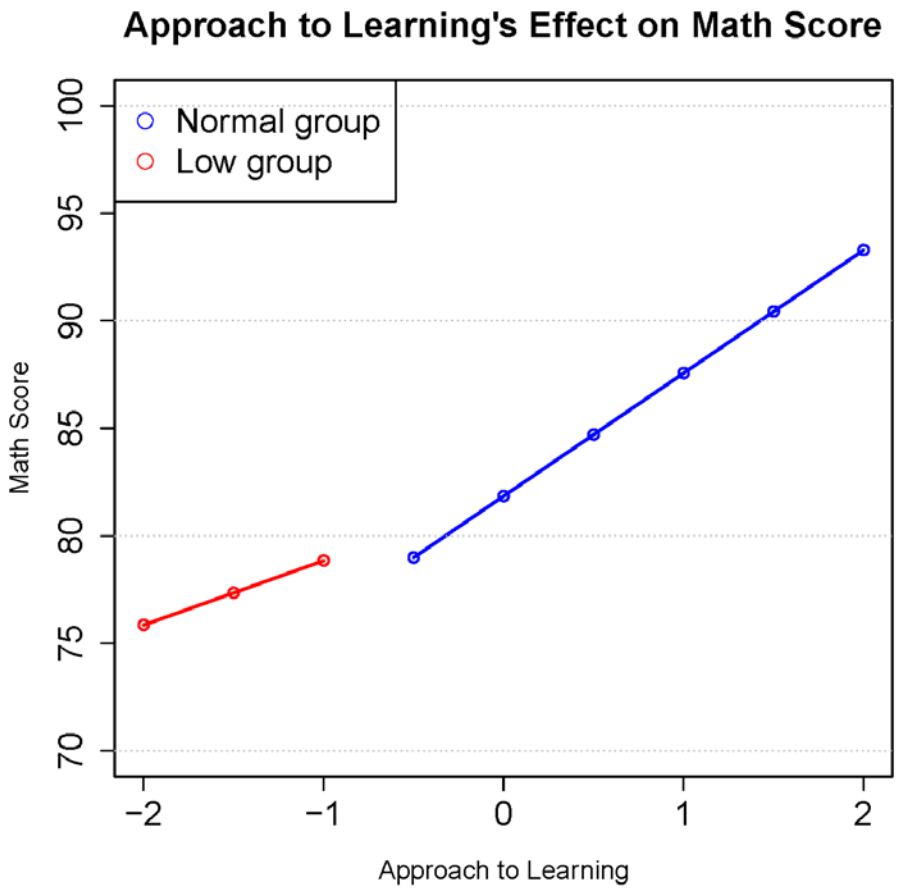
Figure 14. NICHD SECCYD: Quadratic analyses of language and social skills



Source: NICHD SECCYD

Figure 14 shows the change in social skills from first grade through fifth grade in an analysis of language scores. When examined alone, higher school-entry skills related to later social skills (d=.19) and fewer behavior problems (d = -.10) with a very slight quadratic curvature for social skills outcomes. When examined with other school readiness skills, higher school-entry skills again related to higher social skills (d=.14).

Figure 15. Piecewise analyses: approaches to learning and math

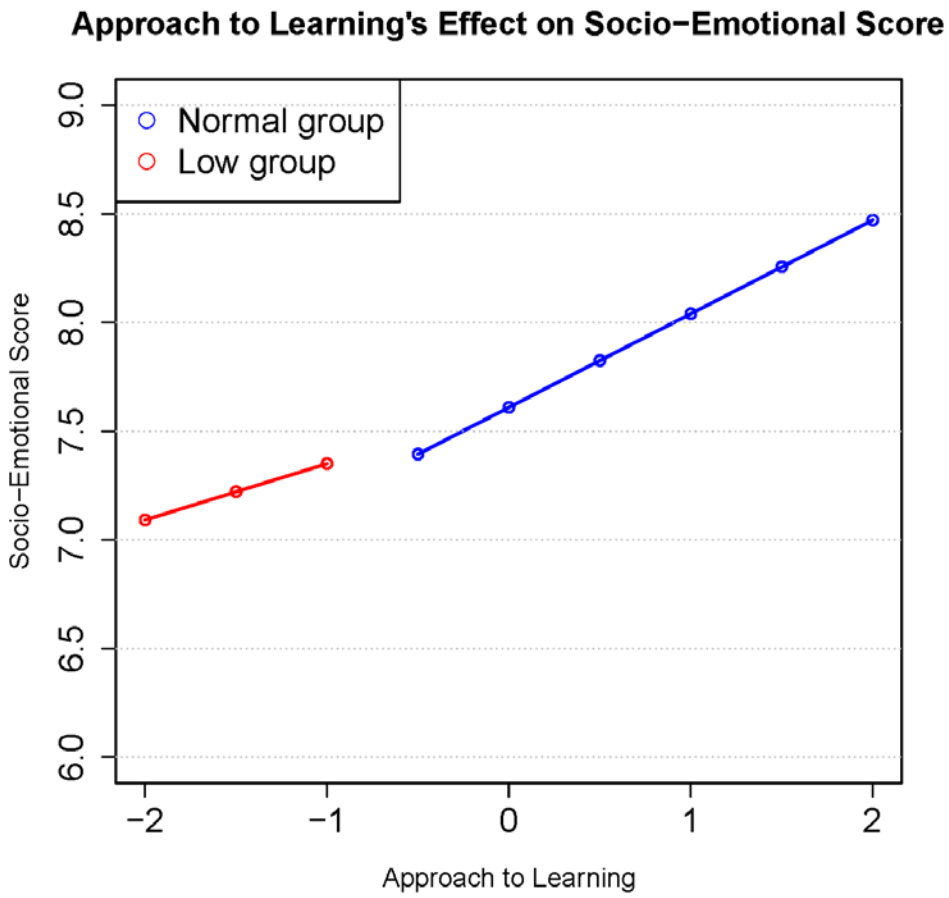


Source: ECLS-K dataset

Figures 15 and 16 (next page) show the effects on the intercept (evaluated in grade 3) predicted regression line for school-readiness variables for low and normal groups.

Figure 15 shows approaches to learning's effect on math scores. The analysis found stronger prediction in the normal range than low range, as evidenced by the steeper slope of the blue line representing the normal group as compared to the red line representing the low group; the steeper slope of the normal group shows a stronger predictive power between the approaches to learning and math skills.

Figure 16. Piecewise analyses: approaches to learning and social-emotional score



Source: ECLS-K dataset

Figure 16 shows approaches to learning's effect on social-emotional scores; the plot shows the same pattern as the analysis with approaches to learning. The fact that the low and normal groups had differing slopes in figures 15 and 16 suggested that where children entered school (in this case above or below a skill cutpoint) did indeed impact their later rate of growth and that children who entered school with different skill levels had different outcomes. This finding showed evidence of thresholds.

Table 1. NICHD SECCYD: Effect sizes for quadratic models that considered each school readiness variable separately and together

School Readiness Variable	WJ Reading Comprehension		WJ Applied Problems		CBCL Externalizing		SSRS Social Skills		WJ Vocabulary	
Models include school readiness variables	**Separate**	**Together**	**Separate**	**Together**	**Separate**	**Together**	**Separate**	**Together**	**Separate**	**Together**
Language	**0.500**	**0.227**	**0.469**	**0.188**	**-0.068**		**0.194**	**0.078**	**0.607**	**0.50**
Language squared	**-0.073**	**-0.081**	**-0.149**	**-0.101**						
Language x time	**-0.057**		**-0.063**		**0.015**				**-0.028**	**-0.01**
Lang^2 x time			**-0.018**							
Lang x time^2	**0.006**		**0.010**						**0.003**	
Lang^2 x time^2			**0.003**							
Social Skills	**0.127**		**0.157**		**-0.29**		**0.284**		**0.107**	
Social Skills squared							**0.052**			
Social Skills x Time			**-0.022**						**-0.016**	
Social ^{2}x time			**-0.010**				**0.000**			
Social x time^2			**0.004**		**0.032**		**0.031**		**0.002**	
Social^2 x time^2			**0.002**							
EF	**0.171**		**0.213**		**-0.114**	**-0.11**	**0.127**	**0.091**	**0.107**	
EF squared			**0.069**							
EF x time	**-0.007**		**-0.042**							

Reading	**0.469**	**0.243**	**0.404**	**0.177**	**-0.066**		**0.120**		**0.412**	**0.19**
Reading squared			**-0.053**				**-0.061**	**-0.061**		
Reading x time	**-0.071**	**-0.02**	**-0.053**							
Reading x time^2	**0.007**		**0.010**							
Math	**0.449**	**0.133**	**0.52**	**0.365**	**-0.086**		**0.188**	**0.078**	**0.383**	
Math squared			**-0.069**							
Math x time	**-0.057**		**-0.076**		**0.020**		**-0.027**	**-0.026**		
Math^{2}x time			**-0.020**							
Math x time^2	**0.007**		**0.012**							
Math^2 x time^2			**0.004**							
Approaches to Learning	**0.143**	**0.052**	**0.129**		**-0.158**	**-0.136**	**0.143**	**0.102**	**0.174**	**0.05**
AppL squared			**-0.016**							
AppL x time			**0.004**		**0.005**					
Health x time					**0.006**				**0.001**	

Source: NICHD-SECCYD

Table 2. ECLS-K: Effect Sizes – looking for thresholds predicting school-age trajectories from school readiness skills in a single analysis

School Readiness Variable	**Reading**		**Math**		**Social-Emotional**		**Externalizing**	
Models include school readiness variables	**Separate**	**Together**	**Separate**	**Together**	**Separate**	**Together**	**Separate**	**Together**
General Knowledge above	**0.263**	*0.113*	**0.228**	**0.071**	*0.067*	*0.009*	*-0.047*	*-0.004*
General Knowledge below	**0.117**	*0.130*	**0.129**	**0.148**	*0.050*	*0.009*	*-0.029*	*-0.004*
General Knowledge above x time	*0.014*	**0.022**	*0.005*	*0.006*	*-0.005*	0.000	0.005	
General Knowledge below x time	*0.008*	**0.004**	*0.008*	*0.006*	*-0.006*	0.000	0.001	
Social above	**0.094**	*0.039*	**0.101**	*0.045*	**0.313**	**0.278**	*-0.282*	**-0.254**
Social below	**0.047**	*0.034*	**0.044**	*0.030*	**0.263**	**0.255**	*-0.320*	**-0.313**
Social Skills above x Time	*0.006*	*0.006*	*0.006*	*0.005*	**-0.076**	**-0.073**	**0.053**	**0.050**
Social Skills below x Time	*0.005*	*0.005*	*0.003*	*0.003*	**-0.048**	**-0.046**	**0.081**	**0.078**
Appr to Learning above	**0.160**	*0.058*	**0.171**	**0.070**	**0.194**	*0.090*	**-0.164**	*-0.072*
Appr to Learning below	**0.082**	*0.075*	**0.104**	**0.098**	**0.100**	*0.077*	**-0.090**	*-0.062*
App to Learning above x Time	*0.003*	*0.003*	*0.006*	*0.004*	**-0.031**	*-0.009*	*0.024*	*0.009*

App to Learning below x Time	*0.008*	*0.007*	*0.007*	*0.006*	**-0.017**	*-0.015*	*0.024*	*0.018*
Health above	*0.016*	*0.003*	0.012		0.002		-0.005	
Health below	*0.028*	*0.003*	0.015		0.026		-0.018	
Health above x Time	-0.001		0		-0.002		-0.001	
Health below x Time	0.002		0.003		-0.003		0.003	
Reading above	**0.368**	0.245	**0.283**	0.088	**0.072**	0.008	-0.056	
Reading below	**-0.114**	-0.132	**-0.099**	-0.087	**-0.040**	-0.087	0.026	
Reading above x Time	**-0.025**	*-0.036*	-0.001	-0.001	-0.004	0.000	0.004	
Reading below x Time	**0.007**	*0.010*	-0.003	-0.006	0.003	0.004	-0.008	
Math above	**0.347**	*0.145*	**0.384**	**0.289**	**0.090**	0.017	*-0.068*	*-0.003*
Math below	**0.090**	*0.120*	**0.095**	**0.089**	**0.043**	0.027	*-0.024*	*-0.003*
Math above x Time	**-0.005**	**0.007**	**-0.001**	**-0.005**	-0.004	0.006	0.004	
Math below x Time	**0.010**	**0.006**	**0.007**	**0.007**	-0.003	0.001	0.000	

Source: ECLS-K

Note: bolded cell entries indicate significantly different coefficients for children with low school readiness (1+ SD below mean) than for other children. Italizaed entries indicate that the school readiness variable was a signficiant predictor even when there was not evidence of a threshold.

Table 3. NICHD SECCYD: Piecewise regression results

	Effect sizes for outcomes considered separately						Effect sizes for outcomes considered together.				
	Reading	**Math**	**Ext.**	**SSRS**	**WJ PV**		**Reading**	**Math**	**Ext.**	**SSRS**	**WJ PV**
Language											
High (>= 83.68)	**.24**	**.31**	-.02	**.10**	**.41**		**.11**	**.10**	*.05*	.03	**.35**
Low (< 83.68)	**-.04**	**-.04**	.01	**-.02**	**-.02**		**-.02**	**-.02**	*.05*	-.01	**-.01**
High*Time	.00	.01	.01	-.01	.00		.00	.00	*.00*	.01	-.01
Low*Time	.00	.01	.00	.00	.00		.00	.00	*.00*	.00	.00
Social Skills											
High (>= 85.23)	**.06**	**.08**	**-.26**	**.26**	**.07**		.00	.01	**.35**	**.24**	.00
Low (< 85.23)	**-.02**	**-.02**	**.03**	**-.01**	**.00**		-.01	-.01	**-.01**	**-.01**	.00
High*Time	.00	.01	**.06**	**-.06**	.00		.00	.01	**.07**	**-.06**	.00
Low*Time	.00	.00	**-.01**	**.01**	.00		.00	.00	**-.01**	**.01**	.00
Exec. Function											
High (>= 24.19)	**.10**	**.15**	**-.08**	**.09**	**.05**		.01	**.03**	***-.07***	**.04**	-.04
Low (< 24.19)	**.00**	**-.01**	**.00**	**.00**	**.00**		-.01	**.02**	***-.07***	**-.01**	-.02
High*Time	.00	.00	.01	-.01	.00		.00	.00	*-.01*	.00	.00
Low*Time	.00	.01	.01	-.01	.00		.00	.01	*-.01*	-.01	.00
WJ Letter Word											
High (>= 85.41)	**.27**	**.31**	.00	**.03**	**.29**		**.15**	**.13**	.01	-.05	**.15**
Low (< 85.41)	**-.04**	**-.02**	.01	**-.02**	**-.02**		**-.03**	**-.01**	.01	-.01	**-.01**
High*Time	**-.01**	.01	.00	-.01	.00		-.01	.01	.00	-.01	.00
Low*Time	**.00**	.00	.00	.00	.00		.00	.00	.00	.00	.00
WJ App Problems											
High (>= 87.31)	**.24**	**.38**	**-.04**	**.11**	**.23**		**.07**	**.24**	.04	.03	-.02
Low (< 87.31)	**-.04**	**-.05**	**.01**	**-.03**	**-.04**		**-.02**	**-.02**	.01	-.01	-.03
High*Time	.00	.00	**.01**	**-.02**	.00		.01	.00	.00	-.02	.00
Low*Time	.00	.01	**.00**	**.00**	.00		.00	.00	.00	.00	.00
App to Learning											
High (>= 3.86)	**.09**	**.11**	**-.07**	**.10**	**.12**		.03	.02	**-.05**	**.06**	**.04**
Low (< 3.86)	**-.02**	**-.02**	**.03**	**-.02**	**-.01**		-.01	-.01	**.03**	**-.01**	**-.01**
High*Time	.00	.01	.00	-.01	.01		.00	.01	**-.01**	.00	.01
Low*Time	.00	.00	.00	-.01	.00		.00	.00	**.00**	-.01	.00
Health											
High (>= 2.74)	.00	-.02	.01	-.01	.01						
Low (< 2.74)	-.01	.00	.01	-.01	.00						
High*Time	.00	.00	.00	-.01	.00						
Low*Time	.00	.00	.00	.00	.00						

Source: NICHD SECCYD

Note. Time is centered at grade 3. Covariates include gender, race, site, maternal education, proportion of time married (6-54 months), low-income status (6-54 months) and disability status. Time was removed as a random variable for school readiness variables predicting WJ AP, CBCL Externalizing. SSRS and WJ Picture Vocabulary. Terms that are bolded are significantly different from each other. Health was not included in the models. Coefficients were entered as linear effects in model looking at outcomes together if they contributed but there was not differential effect above and below the cut-off. Bolded cell entries indicate significantly different coefficients for children with low school readiness (1+ SD below mean) than for other children. Italizaed entries indicate that the school readiness variable was a signficiant predictor even when there was not evidence of a threshold.

Table 4. ECLS-K: Piecewise regression results

	Effect sizes for outcomes considered separately				Effect sizes for outcomes considered together			
	Reading	**Math**	**Social-Emotional**	**Ext.**	**Reading**	**Math**	**Social-Emotional**	**Ext.**
General Knowledge above	**0.391**	**0.346**	*0.110*	*-0.077*	**0.173**	*0.110*	*0.045*	-.005
General Knowledge below	**0.175**	**0.199**	*0.101*	*-0.063*	**0.095**	*0.112*	*0.045*	-.005
Gen Knowledge above*Time	*0.023*	**0.010**	-0.002	*0.009*	**0.038**	*0.011*		-.002
Gen Knowledge below*Time	*0.024*	**0.018**	-0.004	*0.007*	**0.018**	*0.011*		-.002
Math above	**0.418**	**0.460**	*0.111*	*-0.085*	*0.174*	**0.368**	0.008	-.004
Math below	**0.285**	**0.286**	*0.112*	*-0.096*	*0.159*	**0.175**	0.008	-.004
Math above*Time	**-0.005**	**0.000**	0.002	0.005	*0.007*	**-0.006**		
Math below*Time	**0.024**	**0.027**	0.000	0.005	*0.010*	**0.016**		
Reading above	**0.405**	*0.315*	*0.084*	*-0.063*	**0.218**	**0.024**	-.009	-.001
Reading below	**0.284**	*0.303*	*0.095*	*-0.066*	**0.082**	**0.064**	-.009	-.001
Reading above*Time	**-0.026**	**0.000**	-0.001	0.005	**-0.044**	**-0.003**		
Reading below*Time	**0.035**	**0.024**	-0.003	0.008	**0.011**	**0.006**		
Social above	**0.132**	**0.142**		**-0.400**	*0.024*	*0.027*		*-0.382*
Social below	**0.038**	**0.037**		**-0.358**	*0.014*	*0.008*		*-0.350*
Social above*Time	*0.008*	*0.009*		*0.074*	*0.004*	*0.004*		*0.079*
Social below*Time	*0.004*	*0.004*		*0.076*	*0.002*	*0.002*		*0.077*
Health above	*0.027*	*0.022*	*0.003*	*-0.007*	*0.011*	0.006	0.006	0.002
Health below	*0.039*	*0.037*	*0.031*	*-0.023*	*0.011*	0.006	0.006	0.002
Health above*Time	-0.002	0.000	-0.002	-0.002				
Health below*Time	0.005	0.005	-0.002	0.004				
Appr to Learning above	**0.220**	**0.233**	**0.245**	**-0.228**	*0.040*	*0.056*	**0.235**	*-0.030*
Appr to Learning below	**0.108**	**0.122**	**0.148**	**-0.158**	*0.034*	*0.049*	**0.142**	*-0.029*
AppLearn above*Time	**0.004**	*0.008*	*-0.015*	*0.033*	*0.003*	*0.005*	*-0.015*	*-0.008*
AppLearn below*Time	**0.014**	*0.012*	*-0.007*	*0.025*	*0.007*	*0.006*	*-0.007*	*-0.002*

Source: ECLS-K

Note: bolded cell entries indicate significantly different coefficients for children with low school readiness (1+ SD below mean) than for other children. Italizaed entries indicate that the school readiness variable was a signficiant predictor even when there was not evidence of a threshold.

Quadratic and Piecewise Analysis

Results are shown in the next two tables and in the appendices. The tables show the effect sizes. The bolded coefficients are significantly different from each other – suggesting we have some evidence of a threshold in the association between the school readiness variable and subsequent school-age trajectories for academic skills and behaviors. The italicized coefficients are significant predictors of subsequent trajectories, but are for school readiness variables in which there was no evidence of a threshold. The tables show the results on the left side for analyses that included a single school readiness variable and on the right side for analyses that included all school readiness variables that were related to the trajectories in the analyses reported on the left.

Table 5. Quadratic and Piecewise Analysis Results

School readiness skills	NICHD SECCYD quad	ECLS-K quad	NICHD SECCYD-piecewise	ECLS-K piecewise	Summary
Lang/ knowledge	*Strong predictor with some evidence of very modest catch-up for reading, math, language- both considered alone and with other SR variables *modest predictor of externalizing and social skills when considered alone	*Strong predictor with some evidence of very modest catch-up for reading, math, language- both considered alone and with other SR variables *modest predictor of externalizing and social skills when considered alone	*Moderate predictor in normal range of level on reading, math, language- both considered alone and with other SR vars *modest predictor in normal range of social skills when considered alone	*stronger prediction in normal range of level for reading and math but bigger gains over time in low range for math when considered alone and of reading when considered with other SR variables *modest prediction of social skills and externalizing- both when considered along and with other SR variables	* Evidence of stronger prediction of level in normal range for reading, math, and language * some evidence of modest reduction in ach gap over time for reading, math, and language * modest predictor of social outcomes
Reading	*Strong predictor with some evidence of very modest catch-up for reading, math, language- both considered alone and with other SR variables *modest predictor of	*Strong predictor with some evidence of very modest catch-up for reading, math, language- both considered alone and with other SR variables *modest predictor of	*Moderate predictor in normal range of level on reading, math, language- both considered alone and with other SR variables *modest predictor in	*stronger prediction in normal range of level for reading but bigger gains over time in low range for reading and math when considered alone and with other SR variables	* Evidence of stronger prediction of level in normal range for reading, math, and language * some evidence of modest reduction in

School readiness skills	NICHD SECCYD quad	ECLS-K quad	NICHD SECCYD-piecewise	ECLS-K piecewise	Summary
	externalizing and social skills when considered alone and together	externalizing and social skills and some very modest evidence of catch up when considered alone	normal range of social skills when considered alone	*modest prediction of social skills and externalizing- both when considered along	ach gap over time for reading, math, and language * modest predictor of social outcomes
Math	*Strong predictor with some evidence of very modest catch-up for reading, math, language- both considered alone and with other SR variables *modest predictor of externalizing and social skills when considered alone	*Strong predictor with some evidence of very modest catch-up for reading, math, language, externalizing- both considered alone and with other SR variables *modest predictor of social skills and some very modest evidence of catch up when considered alone	*Moderate predictor in normal range of level on reading, math, language- both considered alone and with other SR varibles *modest predictor in normal range of social skills & externalizing with some very modest evidence of catch up in the low range when considered alone	*stronger prediction in normal range of level for reading and math but bigger gains over time in low range when considered alone and for math with other SR variables *modest prediction of social skills and externalizing- both when considered along with other SR variables	* Evidence of stronger prediction of level in normal range for reading, math, and language * some evidence of modest reduction in ach gap over time for reading, math, and language * modest predictor of social outcomes
Social Skills	*Modest predictor of reading, math, language when considered alone *modest predictor of social skills and externalizing with some evidence of bigger differences over time	*Modest predictor of reading, math, language when considered alone *moderate predictor of social skills and externalizing with some evidence of bigger differences over time- when considered alone and with other SR variables	*Modest predictor in normal range of level on reading, math, language- when considered alone *Moderate predictor in normal range of social skills & externalizing with some very modest evidence of catch up in the low range when considered alone	*stronger prediction in normal range of level for reading ,math, and externalizing when considered alone *modest prediction of reading, math,, and externalizing when considered along with other SR variables	*Modest predictor of reading, math, language when considered alone *moderate predictor of social skills and externalizing with some evidence of bigger differences over time- when considered alone and with other SR variables

School readiness skills	NICHD SECCYD quad	ECLS-K quad	NICHD SECCYD-piecewise	ECLS-K piecewise	Summary
App to Learning	* Modest predictor level and reading, math, language, social skills, externalizing when considered alone and of level in reading, language, externalizing, social skills when considered together	*modest predictor with some evidence of very modest catch-up for reading, math, language, social skills externalizing- both considered alone and with other SR variables	*Modest predictor in normal range of level on reading, math, language, social skills, and externalizing when considered alone and with other SR variables *modest predictor in normal range of social skills & externalizing with some very modest evidence of catch up in the low range when considered with other SR variables	*stronger prediction in normal range of level for reading, math, social skills, and externalizing but bigger gains over time in low range for reading when considered alone and of level for externalizing when considered with other SR variables *modest prediction of math, reading and externalizing when considered along with other SR variables	*Modest predictor in normal range of level on reading, math, language, social skills, and externalizing when considered alone and with other SR variables *modest predictor in normal range of social skills & externalizing with some very modest evidence of catch up in the low range when considered with other SR variables
Attention (CPT)	*Modest predictor of level on reading, math, language, social skills, and externalizing when considered alone and with other SR variables for ext, and social skills * THRESHOLD? Some evidence of disproportionately higher levels of math skills if start school with higher attention skills, but slower rates of gains over time with higher skills		*Modest predictor in normal range of level on reading, math, language, social skills, and externalizing when considered alone and with other SR variables for math, ext, and social skills		

School readiness skills	NICHD SECCYD quad	ECLS-K quad	NICHD SECCYD-piecewise	ECLS-K piecewise	Summary
Health	Little association	Little association	No association	Modest predictor when considered alone, but not with other SR variables	