Georgia State University

ScholarWorks @ Georgia State University

Educational Policy Studies Dissertations

Department of Educational Policy Studies

1-2-2009

Emerging Paths to Literacy: Modeling Individual and Environmental Contributions to Growth in Children's Emergent Literacy Skills

Deanne W. Swan

Follow this and additional works at: https://scholarworks.gsu.edu/eps_diss

 Part of the Education Commons, and the Education Policy Commons

Recommended Citation

Swan, Deanne W., "Emerging Paths to Literacy: Modeling Individual and Environmental Contributions to Growth in Children's Emergent Literacy Skills." Dissertation, Georgia State University, 2009.
doi: https://doi.org/10.57709/1060083

This Dissertation is brought to you for free and open access by the Department of Educational Policy Studies at ScholarWorks @ Georgia State University. It has been accepted for inclusion in Educational Policy Studies Dissertations by an authorized administrator of ScholarWorks @ Georgia State University. For more information, please contact scholarworks@gsu.edu.

ACCEPTANCE

This dissertation, EMERGING PATHS TO LITERACY: MODELING INDIVIDUAL AND ENVIRONMENTAL CONTRIBUTIONS TO GROWTH IN CHILDREN'S EMERGENT LITERACY SKILLS, by DEANNE W. SWAN, was prepared under the direction of the candidate's Dissertation Advisory Committee. It is accepted by the committee members in partial fulfillment of the requirements for the degree Doctor of Philosophy in the College of Education, Georgia State University.

The Dissertation Advisory Committee and the student's Department Chair, as representatives of the faculty, certify that this dissertation has met all standards of excellence and scholarship as determined by the faculty. The Dean of the College of Education concurs.

_____
Carolyn Furlow, Ph.D.
Committee Chair

_____
Ann Cale Kruger, Ph.D.
Committee Member

_____
Philo Hutcheson, Ph.D.
Committee Member

_____
Frances McCarty, Ph.D.
Committee Member

_____
Date

_____
Sheryl A. Gowen, Ph.D.
Chair, Department of Educational Policy Studies

_____
R. W. Kamphaus, Ph.D.
Dean and Distinguished Research Professor
College of Education

AUTHOR'S STATEMENT

By presenting this dissertation as partial fulfillment of the requirements for the advanced degree from Georgia State University, I agree that the library of Georgia State University shall make it available for inspection and circulation in accordance with its regulations governing material of this type. I agree that permission to quote, to copy from, or to publish this dissertation may be granted to the professor under whose direction it was written, by the College of Education's director of graduate studies and research, or by me. Such quoting, copying, or publishing must be solely for scholarly purposes and will not involved potential financial gain. It is understood that any copying from or publication of this dissertation which involves potential financial gain will not be allowed without my written permission.

_____

Deanne W. Swan

NOTICE TO BORROWERS

All dissertations deposited in the Georgia State University library must be used in accordance with the stipulation prescribed by the author in the preceding statement. The author of this dissertation is:

Deanne Wren Swan
2630 Regency Drive West
Tucker, GA 30084

The director of this dissertation is:

Dr. Carolyn Furlow
Department of Educational Policy Studies
College of Education
Georgia State University
Atlanta, GA 30303-3083

VITA

Deanne W. Swan

ADDRESS: 2630 Regency Drive West
Tucker, GA 30084

EDUCATION:

Ph.D.	2008	Georgia State University Educational Policy Studies
M.S.	1998	Georgia State University Educational Psychology
B.A.	1993	Auburn University Mass Communications

PROFESSIONAL EXPERIENCE:

2007 – present	Data Analyst Emory University, Atlanta, GA
2005 – 2007	Graduate Teaching Assistant Georgia State University, Atlanta, GA
2003 – 2007	Analyst, Financial Development Arthritis Foundation, Atlanta, GA
2001 – 2002	Visiting Professor of Psychology Wesleyan College, Macon, GA

PUBLICATIONS AND PRESENTATIONS:

Hermstad, A., Swan, D. W., Kegler, M. C., Barnette, J.K., & Glanz, K. (2008). Individual and environmental correlates of dietary fat intake in rural communities: A structural equation model analysis. *Manuscript submitted for publication.*

Swan, D. W. (2006, February). *Whose knowledge is power? Using the paradigm wars to stifle scholarship.* Paper presented at the 57th annual meeting of the Southeast Philosophy of Education Society, Atlanta, GA.

Swan, D. W. (2003). How to build a lexicon: A case study of lexical errors and innovations. In S. Dobbinson, P. Griffiths, & K. Trott (Eds.), *The Child Language Reader* (pp. 165-178). London: Routledge. [Reprint of Swan (2000)].

Swan, D. W. (2000). How to build a lexicon: A case study of lexical errors and innovations. *First Language.20,* 187-204.

Nersessian, N. J. & Swan, D. W. (1999, August). *Conceptual change: Development, learning, and science.* Paper presented at the annual Cognitive Science Conference, Vancouver, BC.

Swan, D. W. & Cienki, A. J. (1999, July). *Constructions, blending, and metaphors: The influence of structure.* Paper presented at the 6th International Cognitive Linguistics Conference, Stockholm, Sweden.

Swan, D. W. (1998, April). *Two-year-olds' sensitivity to the knowledge of others in interactions with naive and knowledgeable adults.* Poster session presented at the 11th biennial International Conference on Infancy Studies, Atlanta, GA.

Swan, D. W., Brooks, P. J., Stern, E. & Derman, L. (1997, April). *Two- and three-year-olds learn to produce passive sentences in scaffolded discourse.* Poster session presented at the biennial meeting of the Society for Research in Child Development, Washington, DC.

Swan, D. W. (1996, March). *Embedding lexical innovations within a context of linguistic development: a case study.* Poster session presented at the biennial Conference on Human Development, Birmingham, AL.

El-Sheikh, M., Swan, D. & Reiter, S. L. (1995, July). *Gender-related effects in emotional responding to resolved and unresolved interadult conflict.* Poster session presented at the 7th annual convention of the American Psychological Society, New York City, NY.

PROFESSIONAL SOCIETIES AND ORGANIZATIONS:

Society for Research in Child Development
American Educational Research Association
International Cognitive Linguistics Association
Kappa Delta Pi

ABSTRACT

EMERGING PATHS TO LITERACY: MODELING INDIVIDUAL AND ENVIRONMENTAL CONTRIBUTIONS TO GROWTH IN CHILDREN'S EMERGENT LITERACY SKILLS
by
Deanne W. Swan

What is the developmental trajectory of the skills that underlie emergent literacy during the preschool years? Are there individual characteristics which predict whether a child will be at-risk for difficulties in acquiring literacy skills? Does a child's experience in a high-quality early care and education environment enhance the development of his or her emergent literacy? The present study is an investigation of the individual and environmental factors relevant to children's emergent literacy skills as they unfold in time.

Using a combination of principal components analysis, growth modeling with a multi-level approach, and propensity score analysis, the trajectories of growth in emergent literacy were examined. In addition to child characteristics, the effects of early child environments on emergent literacy were also examined. The effects of home literacy environment and of high-quality early care and education environments were investigated using propensity score matching techniques. The growth in emergent literacy was examined using a nationally representative dataset, the Early Childhood Longitudinal Study – Birth cohort (ECLS-B).

Child characteristics, such as primary home language and poverty, were associated with lower initial abilities and suppressed growth in emergent literacy. A high-quality home literacy environment had a strong effect on the growth of children's emergent abilities, even after controlling for child characteristics. High-quality early care and education environments, as defined by structural attributes of the program such as class size, had a modest impact on the growth of emergent literacy skills for some but not all children. When high-quality early education was defined in terms of teacher interaction, children who are exposed to such care experienced an increase in growth of their emergent literacy abilities.

This study provides an examination of individual and group paths toward literacy as an element of school readiness, including the role of environment in the development of literacy skills. These findings have implications for early education policy, especially relevant to state-funded preschool programs and Early Head Start, to provide insight into contexts in which policy and the investment of resources can contribute most effectively to early literacy development.

EMERGING PATHS TO LITERACY: MODELING INDIVIDUAL AND ENVIRONMENTAL CONTRIBUTIONS TO GROWTH IN CHILDREN'S EMERGENT LITERACY SKILLS

by

Deanne W. Swan

A Dissertation

Presented in Partial Fulfillment of Requirements for the
Degree of
Doctor of Philosophy
in
Educational Policy Studies
in
the Department of Educational Policy Studies
in
the College of Education
Georgia State University

Atlanta, GA
2008

Copyright by
Deanne W. Swan
2008

ACKNOWLEDGEMENTS

The completion of this dissertation would not have been possible without the help of many people along the way. The good parts are owed to the influence of the following people. The errors which remain are mine.

First, I extend thanks to the members of my committee, who are not only wonderful scholars, but also some of the best people I know. Carolyn Furlow, my advisor, has been a blessing. I have been fortunate to find someone who could provide guidance when needed, as well as give me encouragement go off exploring on my own. I am also lucky to call her a friend. Ann Cale Kruger has accompanied me from the beginning of my journey through graduate school. She is one of the smartest, most interesting people I know, and I treasure our conversations. Philo Hutcheson demands excellence from his students, and this had made me a better scholar. Whenever I go off on a "what-we-ought-to-do" tangent, he reminds me that for an idea to be good, it must also be feasible. Frances McCarty is always willing to discuss and read even half-baked ideas. Her knowledge of both the content and the method has been a god-send. I thank each one of you for making me the best scholar I can be.

Second, I thank my family for making me the person I am today. Each of them has provided love and support, without which I could not have finished this long journey. I thank my mom and dad, for letting me come home every time I needed to start over (every time!), for letting me learn my own lessons even when it hurt them to watch, and for always believing that I could do this. I thank my brothers and sister, each of whom influenced the person I have become in their own distinctive way. To my sister, Shannon, who was always proud of me – I thank you for teaching me to stop long enough to enjoy my accomplishments. To my brother, Bryan, who dared me to jump off the high dive when I was young – I thank you for teaching me to face my fears. And to my brother, Jerry, who would have thought this was cool – I wish you were here.

Finally, I owe many thanks to my husband and best friend, Phill Gagné. Not only has he put up with my longer-than-necessary explanations to ask simple questions, but for the past six months he has relinquished the couch, the laptop, the DVD player, and the remote so I could get through this. But more than that, he has shown me what true love can be like – the kind that goes out to get you chicken soup when your nose is runny and doesn't get upset when you are grouchy from not enough sleep. Thank you, Phill. Because of you I am part of a "wonderful one times one."

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

AAP	American Academy of Pediatricians
BSF-R	Bayley Short Form – Research edition
CAPI	Computer Assisted Parent Interview
ECCRN	Early Child Care Research Network
ECE	Early Care and Education
ECEP	Early Care and Education Provider
ECLS-B	Early Childhood Longitudinal Study – Birth Cohort
FDCRS	Family Day Care Rating Scale
HLE	Home Literacy Environment
HLM	Hierarchical Linear Modeling
ITERS-R	Infant and Toddler Environment Rating Scale – Revised version
K-12	Kindergarten through 12th Grade
NAEYC	National Association for the Education of Young Children
NCATS	Nursing Child Assessment Teaching Scale
NCCP	National Center for Children in Poverty
NCES	National Center for Education Statistics
NCHS	National Center for Health Statistics
NCLB	No Child Left Behind
NICHHD	National Institute of Child Health and Human Development
NIEER	National Institute for Early Education Research
NRC	National Research Council

PCA	Principal Components Analysis
Pre-K	Pre-Kindergarten
PSM	Propensity Score Model
PSU	Primary Sampling Unit
SAQ	Self-Administered Questionnaire
SES	Socio-Economic Status

CHAPTER 1

INTRODUCTION

Literacy – the ability to read and write – is arguably the most important skill necessary for success in school. Children who enter school with low literacy skills tend to have lower academic achievement throughout their education (Bayder, Brooks-Gunn, & Furstenberg, 1993; Cunningham & Stanovich, 1997). Even before children enter school, literacy skills begin to emerge (Adams, 1990; Burgess, Hecht, & Lonigan, 2002). Although much has been documented about the development of literacy skills during the elementary school years, the research base of factors that contribute to emergent literacy in the preschool years is less plentiful. It is, however, in the formative experiences from birth through entry to formal schooling in which critical developmental milestones toward language and literacy development are reached. In the first 5 years of life, children acquire the skills and knowledge about language that are developmental precursors to conventional forms of reading and writing (Evangelou, Brooks, & Smith, 2007; Sulzby & Teale, 1991; Teale & Sulzby, 1986; Whitehurst & Lonigan, 1998). This constellation of skills and knowledge, including oral language development in vocabulary, concepts of print, a core of basic world knowledge, and motor skills necessary for writing, is referred to as *emergent literacy*.

Instead of starting at the endpoint of conventional literacy, an emergent literacy perspective begins with the child's initial competence. This perspective was introduced by Clay (1966) and then reiterated by Sulzby and Teale (1996):

> Emergent literacy is concerned with the earliest phases of literacy development, the period between birth and the time when children read and write conventionally. The term *emergent literacy* signals a belief that, in a literate society, young children – even 1- and 2-year-olds – are in the process of becoming literate. (p. 728)

This suggests that literacy development is a continuous process throughout which skills emerge from the most basic biologically and socially based human activities (Dickinson & McCabe, 2001; Scarborough, 2001). Emergent literacy concerns all of the different ways that humans communicate – through reading, writing, speaking, and listening – in real life situations. When a child is engaged with a picture book or scribbling on a drawing tablet, she is becoming a reader and a writer, engaging in these activities at her own level of competence.

In addition to a child's individual abilities, both the home and early education environments are vital to literacy development (Foster, Lambert, Abbott-Shim, & McCarty, 2005; Huttenlocher, Haight, Bryk, Seltzer, & Lyons, 1991; NICHD ECCRN, 2005; Pan, Rowe, Singer & Snow, 2005). Environments of the homes and the child care centers in which children spend their days differ in terms of the literacy-specific affordances (Gibson, 1979; Gibson & Pick, 2000), and these differences may either enhance or constrain literacy development. The present study was grounded in social-ecological and bioecological theories of human development (Bronfenbrenner, 1979, 1986; Bronfenbrenner & Ceci, 1994; Ceci, 1993). These theories portray human development as occurring within a dynamic environment consisting of nested, interactive,

and interdependent systems that directly and indirectly influence the developmental course.

Statement of the Problem

Literacy is not a spontaneous achievement. Unlike spoken language, to which children come through natural engagement with their social world, conventional literacy requires a set of skills that must be learned through interactions with print. From an evolutionary perspective, literacy is new. Oral communication has served the species well for centuries, but the requirement of literacy, both reading and writing of symbols, has only proliferated through the masses within the last century. Put another way, the developmental function for learning to read and write is cultural and exogenous, not biological and endogenous. Literacy skills are built upon prior abilities, such as language development and symbolic understanding.

Literacy is a critical skill for children as they enter formal educational environments, but children do not wait to acquire the skills necessary for reading and writing. These skills emerge in the first 5 years of life. Emergent literacy is a construct that, by design and by definition, is constantly changing. A child of 9 months might be developing interest in literacy-related activities like shared book reading, whereas a child of 4 years will have a rich repertoire of words and world experiences. These children look very different on the surface, but according to the definition from Sulzby and Teale cited above, each of these children may be equally competent within their developmental range. Emergent literacy is a continuum of skills which unfolds in time. We still do not know much about what these skills look like at the earliest ages, especially in the first year, or how they change over the first few years of a child's life. This simple, descriptive

understanding of emergent literacy is necessary if we are to be able to identify children who might be at risk for poor literacy development.

Children from disadvantaged backgrounds tend to enter school behind their middle-income peers in terms of literacy skills. This disadvantage is not necessarily cognitive, but comes from deficiencies in their environments.

> Children exposed to a poor-quality environment, whether at home or outside the home, are less likely to be prepared for school demands and more likely to have their socio-emotional development derailed. The inadequate outcomes of children in poor-quality care often cannot be fully remediated in the formal structure of the K-12 educational system because of the need for noneducational services such as mental and behavioral health care. To focus only on the education of children beginning with kindergarten is to ignore the science of early development and deny the importance of early experiences. (Committee on Early Childhood, Adoption, and Dependent Care, 2005, p. 187)

In addition to a basic account of the growth of emergent literacy in the first 4 years, we also need to know more about the effect of early environments on children's emergent literacy growth. We must consider not only the academic development of children, but the comprehensive array of services young children need for healthy development. In the present political climate of accountability as illustrated in the *No Child Left Behind* (NCLB) legislation, we need to look at how to serve children so they enter school ready to learn. It is in the preschool experiences, particularly those in early care and education (ECE) environments, where policies can influence and positively affect children who are at risk for inadequate literacy skills.

One trend that has promise is the increase in state-funded preschool programs. According to the annual report on early education in the U.S., *The State of Preschool 2007*, 22% of all 4-year-olds in the nation were served by state-funded pre-K programs in 2006-2007, a number which has risen from 14% over the last 5 years (Barnett et al.,

2007). This is in addition to the children served through other programs, such as federally-funded Head Start and special education. Across the nation, states spent $3.7 billion on preschool initiatives. States with pre-K programs met a median of 6.8 out of the 10 benchmarks for quality set by the National Institute for Early Education Research (NIEER), including program characteristics such as learning standards and teacher degree requirements.

Although these are positive trends in the early education of our nation's children, there are gross disparities in access to preschool. The chance that a child will benefit from a state-funded pre-K program is largely determined by the state in which he or she lives. Some states, including Georgia and Oklahoma, have made a commitment to provide universal preschool for 4-year-olds; 12 states, including New Hampshire and Mississippi, have no program, even for their most disadvantaged children. Only half of the states provide preschool for 3-year-olds, even though the effects of poor or no educational opportunities for children at risk begin to emerge as early as age 3 years (National Research Council, 2000; NICHD Early Child Care Research Network, 2000b; Campbell et al., 2001). The funding stream for state pre-K programs has declined over the past several years in terms of per-child spending – from $4,342 in 2002 to $3,642 in 2007 (adjusted for inflation). This decline in funding is particularly disturbing because the positive effects from early care and education can only be maintained when the quality remains high (Barnett & Masse, 2007).

This dilemma yielded the problems that motivated the present study. First, there is a descriptive aspect: What does emergent literacy look like as it develops over the first years of life? This question was addressed using a combination of principal components

analysis, to comprise the structure of the emergent construct, and growth modeling, to examine the change over time. Second, policymakers need to know whether a policy is effective and worth the investment: While controlling for the effect of the home literacy environment, what is the impact of high-quality early care and education on emergent literacy growth? The estimation of causal effects from observational data requires that a researcher be able to examine what would have happened if a person did not experience a particular intervention. In the present case, we need to know what a child's emergent literacy growth would have looked like if he or she did not attend a high-quality ECE program. To estimate the causal effects of ECE environment, as well as the home environment, propensity score analysis was used to match children and to create comparison groups.

Conceptual Model

Complex interrelations of people and environments shape children's cognitive, social, and physical development. These influences and their relationship to children's emergent literacy development are illustrated in the conceptual framework for the present study, presented in Figure 1. In this conceptual framework, which draws on social- and bioecological theories of development (Bronfenbrenner, 1979; Tseng & Seidman, 2007), the child is nested within a variety of contexts, all of which are interrelated and which exert different effects on the child. The social ecology of the child includes influences proximal to the child, such as parent-child interactions and the home literacy environment, and distal influences, including the pervasive effects of economic poverty and the policies which shape early education environments. These influences create a day-to-day reality that shapes a child's social and cognitive development.

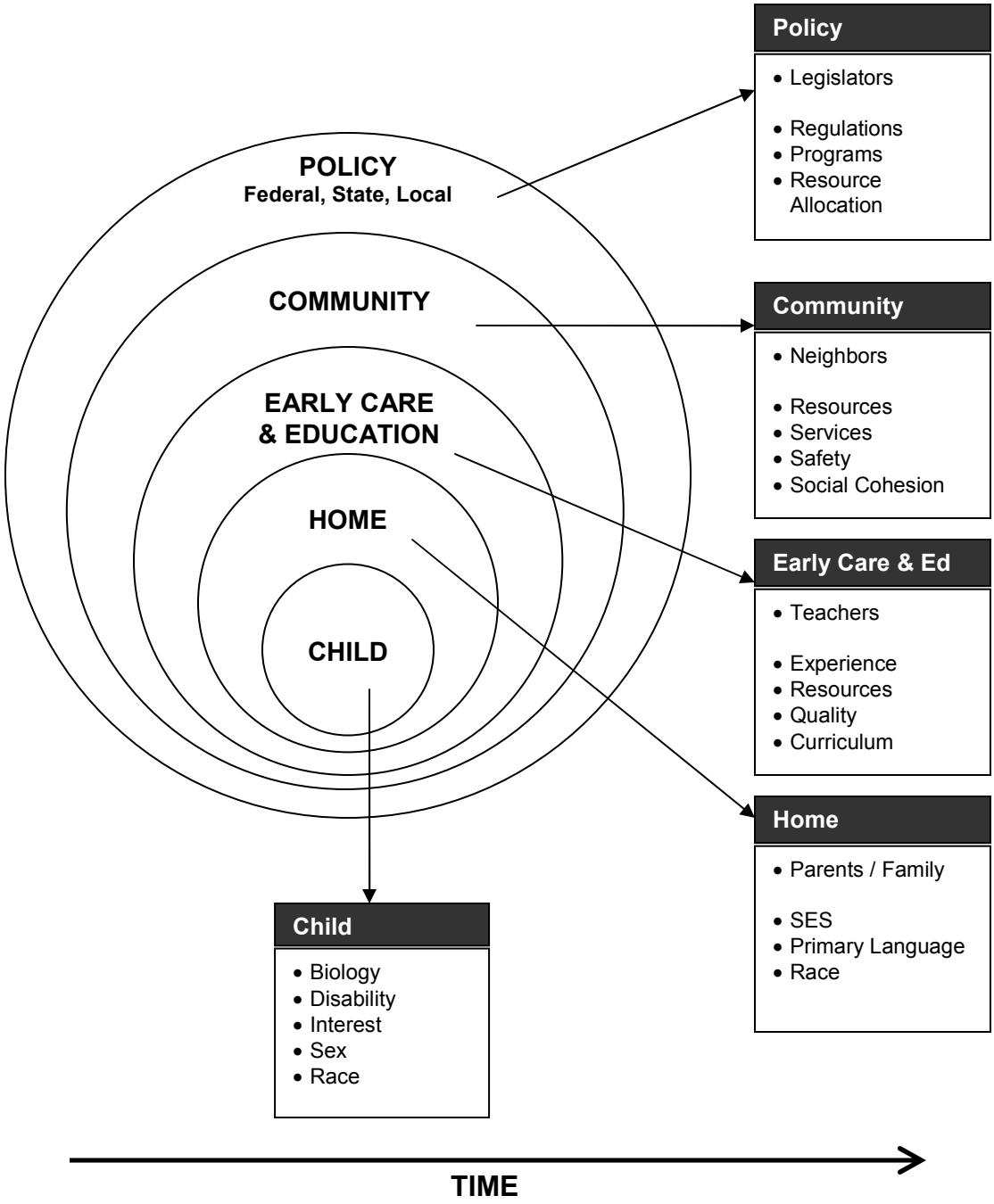

Figure 1. Conceptual Model of Environmental and Individual Factors in Emergent Literacy Development

In this framework, the child's place is primary and constitutes the central core of the relationships. The family context – health, economic, and educational resources – comprises the first ring of influence around the child. If a child has membership in an early childhood education community, the next layer of environment includes teachers, caregivers, and classrooms. Policy decisions at the community, state, and federal level, exert influence on the child and the environments in which the child develops. These are multidimensional contexts full of bidirectional influences, with different types of social processes and levels of resources.

In the present study, my examination was limited to the influence of individual characteristics and environments on the child. Because the data were limited to descriptions of the child and his or her environments, I could not examine bidirectional relationships between people or environments, such as the influence a child might have on his or her parent's behavior. Therefore, a modified conceptual model, in which I simplified the motivating conceptual framework, is presented in Figure 2.

In this model, the child is measured on a changing construct – emergent literacy – on three occasions – at 9 months, 24 months, and preschool. Emergent literacy looks different at each of these occasions – resembling early communicative behaviors earlier and gradually looking more like conventional literacy. The change in the manifestation of the construct is influenced by time (in this case, the child's age) and by specific characteristics of each individual child. The home environment exerts an influence on the child at all ages. For the present study, I focused on the effect of the ECE environment beginning at 2 years. In the figure, these are illustrated by lines from the home

environment to the child at all three occasions and from the ECE environment at 2 years and preschool.

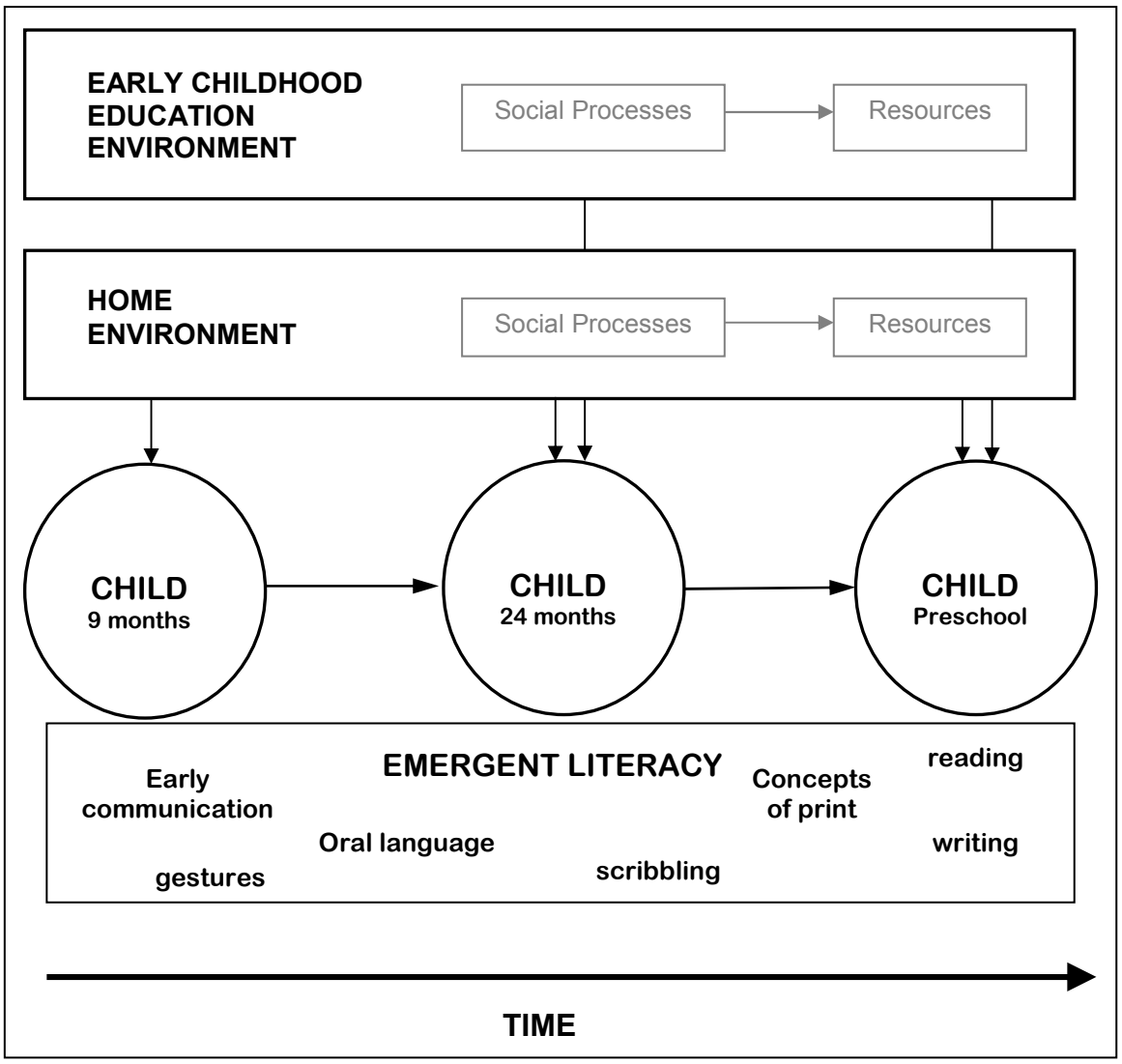

Figure 2. Elements of the Conceptual Model in the Present Study

Significance of the Research

Why should research focus on literacy? Children who read well and read early have been shown to have increased exposure to print and to experience subsequent

growth in other knowledge domains, including science and social studies (Echols, West, Stanovich, & Zehr, 1996; Morrison, Smith, & Dow-Ehrensberger, 1995). In contrast, children who lag behind their peers in reading ability tend to practice reading less often (Allington, 1984), thus missing opportunities to develop more advanced reading strategies (Brown, Palincsar, & Purcell, 1986), and often acquire negative attitudes toward reading (Oka & Paris, 1986). Because of the central role of reading in the acquisition of knowledge, this lag in reading ability further exacerbates overall cognitive development: Poor reading skills can impede learning in other domains (Chall, Jacobs, & Baldwin, 1990), a phenomenon sometimes referred to as the *Matthew effect* (Stanovich, 1986; Bast & Reitsma, 1997, 1998). Cunningham and Stanovich (1997) found that first-grade reading ability was a strong predictor of 11th-grade measures of reading ability, even when controlling for other measures of cognitive ability. Not only do these findings highlight the importance of early literacy skills, but they also suggests that we need to begin our search earlier – even as early as the first year of life – for the critical factors that contribute to literacy competence.

Research Questions

In this study I have addressed questions about the individual and environmental factors related to emergent literacy as it unfolds in the first few years of life. This suggests a deeper problem which has precluded prior studies from examining literacy in these formative years. How can researchers measure a construct that, by definition, changes over time? To further exacerbate the issue, there is no instrument to measure the construct of interest, literacy, when it does not exist – at its ontogenesis. This problem raises methodological issues which are intimately tied to the conceptual issues at hand. In

order to examine the overall question – the effect of early environments on the growth of emergent literacy – I asked four distinct questions. Each research question in this study targeted a specific aspect of the overall question – the construct, its growth, and the contributions of the child, the home, and the early care and education environments.

Research Question 1: How is Emergent Literacy best defined over the course of 9 Months to Preschool?

There is no well agreed upon definition of emergent literacy. One school of thought has conceptualized emergent literacy as a group of relatively independent cognitive abilities, specifically phonological awareness, oral language, and social cognition (Lonigan, Burgess & Anthony, 2000). Others have argued that emergent literacy is a unitary construct that manifests in different ways, depending upon the context (Sénéchal, LeFevre, Smith-Chant, & Colton, 2001). In the present analysis, emergent literacy was conceptualized as a complex of abilities, arising from multiple skills and knowledge, but with an underlying similarity in purpose. Furthermore, emergent literacy was determined to be a changing construct, inherently developmental as it manifests and unfolds over time.

To address this question, principal components analysis (PCA) was used to examine different competencies measured at three times over four years. The components were based upon theoretical understandings of the precursor skills necessary for the emergence of literacy. Measures used in the PCA were taken from direct and indirect assessment of each child, including scores from the Bayley Short Form – Research edition (BSF-R, 2001), MacArthur Communicative Development Inventory (MCDI; Fenson et al., 1994), Peabody Picture Vocabulary Test (PPVT-III; Dunn & Dunn, 1997),

and the Preschool Comprehensive Test of Phonological and Print Processing (Pre-CTOPPP; Lonigan et al., 2002). The specific assessments used to define the components changed at each of the different measurement occasions so that children were assessed for skills appropriate for the age of assessment.

This question was of utmost theoretical salience. According to theory (e.g., Sulzby & Teale, 1996), emergent literacy should be conceptualized as beginning at birth. Thus, it is critical for the theory that we begin to examine the nature of the ontogeny of the skills related to literacy development in the first year of life. Because emergent literacy as a skill may not be best described by a single measure, the components were represented with multiple measures, each of which informed different the overall component of emergent literacy (Sénéchal et al., 2001).

Research Question #2: Do children's emergent literacy skills change over time? If so, in what ways do these skills change or emerge? In order to examine the trajectory of growth in emergent literacy ability, growth curves were estimated for each child over the period of observation using Hierarchical Linear Modeling (HLM) analytic techniques. In addition to the unconditional growth model, child level predictors, such as the child's gender and the primary language spoken in the home, were examined for their effect on the emergence of literacy skills.

Research Question #3: What is the effect of the home environment on the development of children's emergent literacy ability? The home is an important context for development during early childhood. The quality of the home learning environment, beyond the typical proxy measures of parental education and socio-economic status (SES), is crucial for literacy development, along with the benefits associated with

preschool (Melhuish et al., 2008). To gauge the effect of the home environment as it pertains to literacy, affordances in the home were examined in terms of both social interactions and material resources. These were assessed with observations of parent-child interactions and a parental interview that contained items from the Home Observation for Measurement of the Environment (HOME) Inventory (Bradley & Caldwell, 1979). Propensity scores were calculated for each child to represent the home literacy environment (HLE). Social literacy processes with parents were based on the frequency of parent-child shared book reading, and material literacy resources were based on the number of children's books in the home. The propensity scores were added to the conditional growth model to estimate the effect of the HLE to control for the effect of the home literacy environment on children's emergent literacy.

Research Question #4: What is the effect of early care and education environments on the development of children's emergent literacy? Almost as important as the home environment is the early care and education environment in which children spend much of their time. Mashburn and colleagues (2008) found that teachers' interactions with children were the critical factors in effective pre-K programs, more than the structural markers of quality typical of education-oriented legislation such as teacher education. When compared to such structural indicators, sensitive teacher interactions were related to higher scores on measures of cognitive and social abilities. Following this finding, two different approaches to assessing ECE quality were used: one based on structural aspects of the ECE environment and one based on teacher interaction in the classroom environment. These were assessed with interviews with and observations of each child's early care and education provider (ECEP). Structural aspects were assessed

based on the NIEER benchmark criteria. Early care environments were rated using one of two scales: the Infant / Toddler Environment Rating Scale – revised edition (ITERS-R: Harms, Cryer & Clifford, 1990) for center-based care or the Family Day Care Rating Scale (FDCRS; Harms & Clifford, 1989) for home-based care. The teacher sensitivity in the classroom environment criterion was assessed with the Arnett Caregiver Sensitivity Scale (Arnett, 1989).

Two critical issues for early educational policy are *when* to intervene and *how* to intervene: "When" is based on the child's age and "how" is based on the type or quality of the early education program offered. For the present study, I focused on the effect of an intervention – the provision of high-quality ECE – when children were 2 years old. This places it before more proliferated programs, such as Head Start and most state-funded pre-K, making an argument for prevention and intervention earlier than present policies provide. Interventions should follow from the types of programs reported as effective: high-quality early care and education. Propensity scores were created for each child based on the likelihood of exposure to a high-quality early care and education environment. Two different sets of propensity scores were created to examine not only the effect, but also the definition of high-quality ECE. The NIEER benchmarks and the Arnett Caregiver Sensitivity measure were each used to create a propensity score for high-quality early education environment. Using techniques for propensity score stratification, children were grouped into equivalent comparison groups for each set of propensity scores. This grouping facilitated comparison of the effect of high-quality early care and education environments on children's emergent literacy growth.

Implications for Education Policy

The topic of emergent literacy has strong implications for education policy. Even before children commence formal instruction in reading and writing, they display differences that mirror divisions in our society, with children from low-SES and from non-English speaking homes already at a disadvantage (Zill, Collins, West, & Hausken, 1995). Prevention and intervention for children at a disadvantage are the keys to the remediation of these enduring negative effects (Snow, Burns & Griffin, 1998). There are several signs that indicate that a child might be at risk for literacy disabilities (Snow, Burns, & Griffin, 1998). These can be separated into individual risk factors and environmental risk factors.

Individual risk factors for reading difficulties are often characterized in terms of birth defects or developmental disabilities. Preschool children with atypical speech or language development, such as Specific Language Impairment (SLI), often have difficulty learning to read and write upon entry to school. There is a significant overlap in diagnosis of SLI and developmental dyslexia or Specific Reading Disability (SRD), and there are strong links to heritability. Other factors which put children at risk for reading difficulties include physical conditions (e.g., chronic ear infections, otitis media), developmental disorders (e.g., Williams syndrome, autism), or a family history of learning or language disability. Some early warning signs include persistent baby talk, lack of interest or motivation in shared reading, and difficulty in learning new things. Policies have been put in place to encourage early screening for these disabilities and risk factors and to provide services to these children, such as federally-funded special education for preschoolers.

Beyond individual risks are those which arise from the environments in which children spend their first years. The most pervasive and consistent environmental factor related to poor literacy skills is economic poverty (National Assessment of Educational Progress [NAEP], 2005), particularly in urban areas (Donahue, Voelld, Campbell, & Mazzeo, 1998). In most cases it is because children who live in low-SES homes have poor home literacy environments. Home environments in which there are limited literacy resources, such as books and magazines, are predictive of low vocabulary and little knowledge about the nature and uses of print (Bus, van IJzendoorn, & Pellegrini, 1995; Scarborough & Dobrich, 1994). Children's knowledge of concepts of print – such as the direction of reading and the meaning of punctuation marks – when they enter kindergarten is a major factor in determining their literacy level (Nichols, Rupley & Rickleman, 2004).

For generations, children have listened to stories read aloud for enjoyment, for information, and for sharing time with adults. Recent research has indicated that these shared book-reading activities are one of the most important factors in building a foundation for children's enjoyment of and success with reading (Clay, 1991; Gibson, 1989; Teale & Sulzby, 1989). This simple activity, which is common in most middle- and high-SES households, is often absent in lower-SES homes. Supporters of social equity theories have argued that many minority children live in linguistically impoverished environments, and they must wait until formal schooling to overcome this disadvantage (Entwisle, Alexander, & Olson, 1997; Lareau, 1989; Mullis, Campbell, & Farstrup, 1993; Neuman, 1999).

Research also suggests that even when they get to school, disadvantages of children from very low-SES homes are not remediated. Duke (2000) studied the differences in print-related environments and experiences offered to first-grade children in different socioeconomic status school settings. Findings indicated that children in low-SES schools had less print experience, fewer types of print experience, and lower quality print experiences. This lack of experience is predictive of low literacy abilities.

As is the case with many domains of cognitive and social development, there are probably multiple paths to literacy. Some of these paths may be more successful than others; some paths are more likely to lead to competent literacy skills, whereas others do not. We know that certain environmental disadvantages, especially those related to poverty, lead to low literacy skills. In an ideal democratic society, we might set policies which would identify these children and provide a second environment, such as would be provided through an intervention, in which the necessary resources and interactions are made available. Because of limited resources and increasing demand, this ideal does not exist. We must then take the next best step: to spend limited funds where they will have the largest impact and do the most good (Slavin, 2002; Vinovskis, 1999).

The purpose of the present study was to describe the individual patterns of growth in emergent literacy and to examine the effect of literacy-related affordances in the home and early education environments on patterns of growth. Specifically, the trajectory of emergent literacy growth of children in high-quality early care and education environments indicate the effect of investment in specific elements of quality on children's literacy development. Longitudinal analysis is a key component in the examination of developmental patterns and the identification of critical periods during

which children are vulnerable to deviation from the conventional developmental trajectory. What would happen to children's literacy development if we invested in the quality of early care and education environments? The overarching goal of these analyses was to provide evidence on the context of early care and education as a potential intervention to benefit children's emergent literacy and to examine the effect of these environments on different sub-populations for which these interventions might be most beneficial.

Overview of the Study

Several questions drove this study. What is the developmental trajectory of the skills that underlie emergent literacy from 9 months to 4 years? Are there individual characteristics that predict whether children will be at-risk for difficulties in acquiring literacy skills? What is the effect of the home environment on growth in children's emergent literacy? Does a child's experience in a high-quality early care and education environment support the development of that child's emergent literacy? The present study was an investigation of the individual and environmental factors relevant to children's emergent literacy skills as they unfold in time.

In order to address these questions, data from the Early Childhood Longitudinal Study – Birth cohort (ECLS-B), a large complex data set collected by the National Center for Educational Statistics (NCES) were analyzed. The ECLS-B dataset includes measurement of children and their environments at three points across time – 9 months, 2 years, and preschool. In addition, the study had a variety of measures, including direct assessment of children and interviews with parents and teachers, which provides information not only about each individual child but also about their home, child-care,

and preschool environments. The measures include assessment of general cognitive abilities, emergent literacy skills, and environmental resources.

The present study addressed the following objectives: to describe the skills which comprise emergent literacy as they unfold in development; to examine the trajectories of growth and characteristics of children which influence emergent literacy growth; to determine the effect of home environment on emergent literacy growth; and to test the effect of high-quality early care and education environments on emergent literacy growth. These objectives were motivated by an overall interest in teasing apart the mechanisms of change over time, including mitigating factors, such as the role of the environment in development of literacy skills.

CHAPTER 2

REVIEW OF THE LITERATURE

Literacy development does not begin when a child walks through the door on his or her first day of school. It begins early in life, and it is ongoing. Literacy and literacy-related skills occur in the everyday contexts of home and community. They are the result of meaningful and functional experiences in a literate society. The development of these skills is usually social and emerges from interactions children have with adults as they share, collaborate, and negotiate meanings in their world. These experiences are embedded within domain specific areas, such as art, play, and science. Language and literacy are media through which a child can experience purpose and construct meaning.

In this review the theoretical grounding for this study is presented, with particular focus on Bronfenbrenner's (1995) developmental systems theory. Also examined are the links between early language development and emergent literacy, the constellation of skills that comprise emergent literacy, and the role of children's early environments in their literacy development. Finally, the implications for policy in early care and education (ECE) environments for very young children are addressed.

Theoretical Grounding of Emergent Literacy

Emergent literacy consists of the skills, knowledge, and attitudes that are presumed to be the developmental precursors to conventional forms of reading and writing (Sulzby, 1989; Sulzby & Teale, 1991; Teale & Sulzby, 1986), including the

environments and interactions which support these developments (e.g., shared book reading; Lonigan, 1994; Whitehurst et al., 1988). It denotes the idea that the acquisition of literacy is best conceptualized as a developmental continuum, with its origins in the preschool years and ending in conventional literacy.

The term *emergent literacy* was first introduced by Clay (1966) who described the behaviors that 5-year-old children used when reading and writing, even when they could not read or write in a conventional sense. The use of *emergent* suggests that there are continuities in the process of learning to read and to write. Prior research in literacy acquisition had come from a maturationist perspective in which it was assumed that children were not ready to read until a biologically predetermined time (see review in Teale & Sulzby, 1986). Many such "reading readiness" theories began with the endpoint – adult-like reading competence – in mind. Similar to nativist theories of language acquisition (Chomsky, 1957, 1986), prior theories suggested that literacy just happened when a child was ready. Such positions are contrary to a developmental agenda, such as Werner's (1957) orthogenetic principle of development. By interpreting the path of development through the lens of the final form, theories based upon biological maturation make the teleological assumption that what happens through the course of development must necessarily lead to the endpoint and are interpreted in terms of that endpoint (Kessen, 1966). In the mid-1970s, the early research in children's literacy suggested a shift from *literacy* as a static skill toward *emergent literacy* as a continuous and changing competence. This shift was perhaps not as extreme as a Kuhnian paradigm shift (Kuhn, 1960), but a definite and important change in perspective for the field as a whole.

Although some researchers have expanded emergent literacy to include any situation in which an individual negotiates or interacts with the environment through a symbolic system, the present study is focused upon the foundational skills from which emerge the more conventional forms of literacy, such as the reading and writing of alphabetic texts. This conceptualization of literacy moves the theory of how children acquire conventional literacy from the adult perspective, and any teleological assumptions that accompany such a perspective, to a truly developmental perspective.

From this perspective, we can examine the ways in which literacy emerges from the most basic biologically and socially based human activities. In such an approach, there is no clear demarcation between what has been called "pre-reading" and conventional reading, but rather skills emerge, building upon prior competencies and extending into new situations, as children are motivated not by an isolated skill but rather the real and tangible needs from goal-directed activity. This conceptualization of literacy is a shift in perception from literacy as a cognitive skill to literacy as a complex, active process.

Before the 1970s, early literacy research was characterized by research on reading to the near exclusion of writing. Indeed many educators thought that instruction in reading must necessarily precede instruction in writing. The *emergent literacy* movement changed these preconceptions. Instead, the assumption is that reading, writing, and oral language develop concurrently and interdependently from an early age with children's exposure to interactions in the social contexts in which literacy is a component (Teale & Sulzby, 1991).

Emergent literacy concerns all of the different ways that humans communicate – through reading, writing, speaking, and listening – in real life situations. This shift also results in a different way of "seeing" for researchers. At a very young age children begin to imitate behaviors they see modeled by adults and older children. Through the lens of emergent literacy, we see children reading a picture book or writing in scribbles: They are becoming readers and writers, engaging in these activities at their own levels of competence.

Children are continually trying to make sense of information in their world. These attempts to assimilate information occur on a developmental pathway that is characterized both by milestones in common to all children and by individual stories defined by each child. Research in emergent literacy is grounded in constructivist (Piaget, 1962) and interactionist (Vygotsky, 1978) theories. The child is an active learner who constructs knowledge from his or her experiences with the world. These experiences are mediated by others, particularly a child's parent or primary caregiver, who shapes and scaffolds the world into bite-sized bits of meaning.

The characterization of emergent literacy is embodied in the child-as-an-active-learner (Piaget, 1952, 1962; Hiebert & Fisher, 1990; Teale & Sulzby, 1989). As an agent in his or her environment, the child interacts with both the physical and social aspects. People are particularly salient parts of children's environments, and adults are the primary social partners in the lives of very young children. Within these interactions, adults guide children in order to facilitate and to extend their learning (Vygotsky, 1978). It is critical to keep in mind with this perspective that emergent literacy is not taught, but it is learned. It can be improved or stimulated through external forces, but emergent

literacy is a process of learning, and thus is situated within the child as an agent in the environment.

The goal of young children in the world is to uncover meaning, and as such, emergent literacy is focused on meaning. The elaboration of meaning is a constructive (Clay, 1991), functional (Gibson, 1989; Strickland & Morrow, 1989), and interactive (Morrow & Rand, 1991) process. The child constructs an understanding of language and linguistic symbols in tandem with concepts about the environment through active exploration and interaction with the physical and social environment. This use of language allows the child to accomplish goals and to perform activities in everyday situations with naturally occurring demands. These language-mediated activities are often part of a larger social context in which an adult provides feedback and scaffolding to facilitate child-initiated tasks.

Emergent literacy is a process in which a child constructs concepts about the functions of symbols and print. These concepts are based on experiences and meaningful language facilitated within interactions with adults. Emergent literacy "is characterized by the early development of understanding that abstract symbols have meaning and that people use these symbols for the communication of ideas" (Koenig, 1992, p. 279). This emphasizes the distinction between symbol and meaning, between signifier and signified (Saussure, 1983). This semiological function of language allows thought to be symbolized through sounds, gestures, and writing (Langacker, 1998), and it is this understanding of the form-function relationship that is critical for the acquisition of language and literacy skills (Piaget, 1954, 1962; Werner & Kaplan, 1963; Adamson, 1995).

The child's task is to become a competent user of a shared symbolic system. Competence is not a thing, but rather a skill. Hence, language acquisition is skill acquisition (Moerk, 1992, 2000). What children learn are linguistic symbols and communicative patterns. Communicative patterns (or schemes) map onto the basic patterns of language. These include word-formation rules, syntactic constructions, and typical narrative plot structures. These patterns can be thought of as underlying structural invariants which can be abstracted from the acoustic and visual environment of spoken and printed words. Thus, this skill acquisition can be partially described in terms of perceptual learning (Gibson, 1969).

What helps children in this process of pattern abstraction? Children have both internal and external aids to help them with this task. First, children actively process their world – assimilating and accommodating knowledge into cognitive structures (Piaget, 1962). Second, most adults act as fine tuners in their interactions with small children, even in non-didactic contexts (examples include "zone of proximal development," Vygotsky, 1978; "scaffolding," Bruner, 1978, 1983; "optimal level of discrepancy," Kagan, 1970). Feedback is the fine tuning of children's attempts at speaking, reading, and writing using a variety of techniques. This kind of fine-tuned engagement is present in many adult-child interactions. Kaye (1982) reported that variations within mother-child communicative interactions "were introduced subtly over a series of repetitions, as though mothers were holding down the variability so that their infants could tune in to the regularity" (p. 35). In the pairing of children's natural abilities to perceive and to assimilate new patterns and of adults' tendencies to fine-tune children's worlds so that they can work within these abilities, there is born an adaptive context in which the

complex skill of symbolic communication is broken into digestible pieces which can be integrated by a nascent language learner.

Lave and Wenger (1991) stated that "learning and thinking and knowing are relations among people in activity in, with, and arising from the socially and culturally structured world" (p. 51). Attention to the importance of setting has been shaped by the Vygotskian tradition, which posits that the intra-psychological functions have their origins in the social world of shared experiences (Vygotsky, 1962, 1991). Both home and classroom environments are vital to children's development.

A child constructs meaning while engaging with his or her world and the people in it. A fundamental part of this theoretical perspective is the child's world – the environments in which a child lives. Following this, the present study will also draw upon social-ecological theories of human development (Bronfenbrenner, 1979, 1999; Ceci, 1990, 1993). These theories portray human development as occurring within a dynamic environment consisting of nested interactive and interdependent systems that directly and indirectly influence the developmental course. The key dimensions of a developmental system include process, people, context, and time (Bronfenbrenner & Morris, 1998). Within this model, we can look at the interplay of biology and environment through processes:

> Human development takes place through processes of progressively more complex reciprocal interactions between an active, evolving biophysiological human organism and the persons, objects, symbols in its immediate environment. (Bronfenbrenner & Morris, 1998, p. 996)

In a developmental model, time is crucial in understanding people and process. The age at which a child experiences something and the duration of the experience determines the impact of an effect. For example, in Early Head Start, children can be enrolled from birth

through age 3 years. Although more benefit is achieved when children are enrolled at birth, most children are enrolled later around age 2 years, and this shortened time in the program will have a smaller effect on their cognitive and social development than the effect for children who were enrolled at birth.

Bronfenbrenner's developmental systems theory can also be seen in terms of a systems framework (Tseng & Seidman, 2007), which examines the dynamics within a system: social processes between people, the resources available in the environment, and the allocation of those resources. These key aspects of a system – social process, resources, and allocation – represent different targets for intervention and appropriate topics for policy. When developing a policy, it is important to remember that the effects of resources are typically mediated through the social processes that occur in a specific environment.

Two theoretical frameworks for understanding emergent literacy have informed recent research in literacy. The Emergent Literacy framework comes from the work of researchers in psychology and psycholinguistics, exemplified in the work of Sulzby and Whitehurst. The focus of researchers working in this framework is on the child and his or her individual trajectory of literacy development. The Literacy-as-Social-Practice framework is rooted in sociology and sociolinguistics, as found in the work of Hill and Gee. True to the discipline, the focus of research motivated from this framework is on how people create and use literacy in everyday contexts. In a developmental ecological model, both of these frameworks are important. Children's individual development is a focal point, but also of interest are the effects of environments and the interactions of the children within those environments.

Language and Literacy as Socially Mediated

Humans participate in activities through the use of tools, and the use of signs – particularly language – is the preeminent tool (Vygotsky, 1978). The semiological function of language emphasizes the distinction between structure and function, symbol and meaning, signifier and signified (Saussure, 1983). This semiological function allows thought to be symbolized through sounds, gestures, and writing, and it is this understanding of the form-function relationship that is critical for the acquisition of language and literacy (Adamson, 1995; Piaget, 1962; Werner & Kaplan, 1963).

A hallmark of early development is the ability of a child to use these signs in a way that is mediated by the context within which meaning is embedded. Language is the medium through which children can communicate their needs, interests, and wishes to others in their world.

> Firstly, from a constructivist view of the world, all our experience is mediated, nothing is direct. Secondly, by the way they structure reality for us in social interactions, people mediate our experience; and thirdly, texts, whether they are books, films, or advertisements, mediate our experience. (Barton, 1994, p. 68)

The process of learning to read is socially complex and involves parents and children sharing in an imaginative process that integrates factors of language, thought, and feeling (Moerk, 1991). Depending upon where the child's attention is directed, a parent can either guide them or tune into them, and thereby scaffold their entry into literacy (Vygotsky, 1978). As the child's competence increases, the setting becomes a "testing and feedback" (Moerk, 1985, p. 556) interaction led by the parent. The more frequently parents read with their children, the more aware they become of the subtle changes in

their children's language abilities, and thus, become better able to match and to adjust the interactions to the child's level (Ninio & Bruner, 1978; Vygotsky, 1978).

Early Skills in Emergent Literacy

Learning to read is dependent on mastery of a number of basic skills, including perceptual, cognitive, and linguistic processes, especially phonological, orthographic, syntactic, semantic, and comprehension skills (Snow, Burns, & Griffin, 1998). An interest in understanding emergent literacy requires an interest in defining which child behaviors and abilities constitute it and how they change over the course of development. These abilities should follow similar developmental pathways. What is the ontogeny of the various skills and knowledge which comprise emergent literacy? Do these skills exhibit a similar ontogeny or are they separable constructs?

Most researchers agree that emergent literacy is not a unitary construct. Adams (1990) suggested this even before research provided support:

> Skillful reading is not a unitary skill. It is a whole complex system of skills and knowledge…. Let us say that the system that supports our ability to read is like a car. Within this analogy, print is like gas. The engine and the mechanics of the car are the perceptual and [sic] machinery that makes the system go. (p. 3)

The component skills pre-readers need in order to be successful in learning to read include alphabet knowledge, phonological awareness, concepts of print, and experience using writing as a form of communication. How these skills work together is still a matter of theory.

In a confirmatory factor analysis, Lonigan and colleagues (2000) found that a model in which oral language, phonological awareness, and print knowledge were characterized as separate constructs explained children's abilities better than models

which used a single factor to subsume all these skills. In a structural model of emergent literacy, Sénéchal and colleagues (2001) also found that emergent literacy was comprised of distinct and separable constructs for oral language, emergent literacy (procedural and conceptual), and metalinguistic skill. Korat (2005) found a clear distinction between contextual and non-contextual emergent literacy knowledge: With low-SES children lagging behind their middle-SES peers only in their non-contextual knowledge. Research paints a complex picture of different, distinct, yet inter-related skills, each of which undergird the emergence of literacy (Mason & Stewart, 1990; Whitehurst & Lonigan, 1998). The most prominent skills, knowledge, and attitudes which comprise emergent literacy are oral language development (most often measured by vocabulary), interest in literacy, alphabet knowledge, and phonological awareness.

Even at the youngest ages, children are learning something about what it is to be literate. Makin (2006) found that in interactions between mothers and their 8- to 12-month-old infants, mothers used a variety of language and paralinguistic utterances. The main aspect that the children brought to the interaction was a disposition toward the activity of shared reading. What children are learning most is a positive attitude toward reading. This motivation to read and to engage in literacy-related activities is present in the first year of life. Motivation and interest in literacy is part of emergent literacy and is related to competence in conventional literacy.

Alphabet knowledge with an understanding of the alphabetic principle – the mapping of sound to symbol – is the best predictor of reading achievement (Bond & Dykstra, 1967). As long as it is introduced in ways which are natural and developmentally appropriate, this is a skill which can be developed even in children as

young as 2 years (Elliott & Olliff, 2008). But this understanding can only occur in a context of meaning. Without general world knowledge, there is no way for a child to hook the sound or graphic representation to meaning. In order to map sound to symbol, there is a mediation of the meaning; there must be an understanding of the semiological function of print. As Stahl (1992) suggested,

> Letter-sound instruction makes no sense to a child who does not have an overall conception of what reading is about, how print functions, what stories are, and so on, so it must build on a child's concept of the whole process of reading. (p. 21)

Alphabet knowledge, although necessary, is not sufficient for learning to read and write. Code-based interventions in isolation are ineffectual in promoting strong reading skills (Badian, 1995; Muter & Diethelm, 2001; Riley, 1996; Walsh, Price, & Gillingham, 1998).

Phonological awareness – the ability to attend to and to manipulate the sound structures of language – has been repeatedly shown to be a prerequisite for literacy (see Adams, 1990, for a review). We use many of the lyric properties of language in speech directed to children, such as repeated grammatical structures, rhyming schemes, exaggerated intonation, stress, and pitch. At a very young age, infants are attuned to these characteristics of speech and language (Fernald, 1985, 1989). Infants are even able to create these kinds of attractive sounds in their babbling, which often reveals the same patterned repetition found in speech sounds (Fernald et al., 1989). Children use these kinds of lyrical cues, such as stress and pause patterns, to identify new information (Kuhn & Stahl, 2003; Chen, 1998) or to identify the object nouns in simple sentences (Shady & Gerken, 1999). These same skills have also been linked to decoding skills in early reading (Schwanenflugel, Hamilton, Kuhn, Wisenbaker, & Stahl, 2004).

Rhyming ability helps with early reading (Britto, Fuligni & Brooks-Gunn, 2002). The importance of rhyme awareness for reading development in English was first demonstrated by Bradley & Bryant (1983). Since then, numerous studies have found strong associations between rhyming, phonological awareness, and early reading ability (Baker, Fernandez-Fein, Scher, & Williams, 1998; Bryant, Bradley, Maclean, & Crossland, 1989; Bryant, Maclean, Bradley, & Crossland, 1990; Chaney, 1994; Scarborough, 1990; Webster & Plante, 1992). In one study by Walton (1995), "the children with high pre-reading skills demonstrated repeatedly that beginning to read was easier if an orthographic analogy based on rhyming could be used to read a new word than it was if recoding letter sounds was required" (p. 595). Bryant and colleagues (1990) found that nursery rhyme knowledge was related to subsequent sensitivity both to rhymes and to phonemes.

Cross-linguistic differences indicate that children learning languages with more transparent orthographies (e.g., Norwegian, Swedish, and German) make efficient use of rhyme in learning to read and write (Hoien, Lundberg, Stanovich, & Bjaalid, 1995; Lundberg, Olofsson & Wall, 1980; Wimmer, Landerl & Schneider, 1994). Goswami has contrasted children's use of rhyme in English and other languages, including French and Greek (Goswami, Gombert & DeBarrera, 1998; Goswami, Porpodas, & Wheelwright, 1997). Some children use analogy and rhyme to aid the acquisition of grapheme-phoneme correspondences (Muter, Snowling, & Taylor, 1994; Walton, 1995). For instance, a child who knows the word "cat" in sound and print can use this knowledge to match the symbol for "bat." Much like different languages demonstrate different paths to

acquisition, there are also different paths to literacy that mirror the phonological-orthographic mapping.

Poor phonological skills, especially phonological awareness, are the best predictors of later reading difficulties (Adams, 1990; Chall, 1992; Mauer & Kamhi, 1996; Snowling, 1995; Torgesen, Wagner & Rashotte, 1994). This finding is consistent in both the behavioral and the neuropsychological research. Individuals who have been diagnosed with reading difficulties, such as developmental dyslexia, process auditory information differently than normal readers (Hugdahl et al., 1995). Neuroimaging studies have demonstrated that individuals with dyslexia process information during a phonological task, such as rhyming or non-word reading, differently than their typically developing peers (Paulesu et al., 1996; Shaywitz, et al., 1996).

Although the main focus of the present research is on the effect of the environment, it is critical to keep in mind the role of biology in development. Underlying the bioecological model is the principle that genetic transmission of traits (genotype) does not produce finished traits (phenotype), but rather genetic inheritance interacts with environmental experiences in determining outcomes (Cairns, 1991; Gottlieb, 1991; Lemery & Goldsmith, 1999; Rutter et al., 1997). The trajectory from genotype to phenotype

> receives both its impetus and early direction from the genetic endowment inherited from the child's biological parents, but from the very outset it is proximal processes that serve as the mechanisms for the actualization of genetic potential.... The influences of genetics and environment on human development are never wholly separable but an ever-evolving amalgam. (Bronfenbrenner & Ceci, 1994, p. 580)

Nature and nurture are not only inseparable, but they are complementary. This inter-relationship is particularly important in the discussion of reading disabilities.

Reading disabilities are the most common type of disabilities among children (Shaywitz, Fletcher, & Shaywitz, 1995). Children with a history of hearing difficulties, such as those diagnosed with otitis media, are at risk for reading difficulties and related developmental delays (National Research Council, 1998). In addition to hearing-related disabilities, there is significant heritability of reading impairment (DeFries & Alarcon, 1996). Evidence comes from pedigree analysis, family studies, and twin studies, all of which point to high heritability (Tomblin & Buckwalter, 1994; Bishop, 2001), and it suggests that language and literacy impairments appear to be different manifestations of the same underlying genetic deficit (Bishop, 2001).

Research in developmental dyslexia has found that a core perceptual and cognitive deficit may be responsible for the required skills for breaking down syllables (Wagner et al., 1997). McCandliss and Noble (2003) posit a simple cascading model for the developmental progression of dyslexia. Individual differences in brain areas associated with phonological processing, particularly the superior temporal gyrus (STG), influence the specialization of the fusiform gyrus of the visual system, the portion of the brain involved in automatic processing for written word recognition. As deficits in the STG express, they stilt the development of the visual system. In other words, because of a auditory deficit expressed early in development, the later neuronal links to the visual system are not developed and result in a deficit in word recognition.

Children's Early Environments

The most pervasive and consistent environmental factor related to poor literacy skills is economic poverty (NAEP, 2005), particularly in urban (Donahue, Voelld, Campbell, & Mazzeo, 1998) and rural areas (Durham & Smith, 2006). Children who live

in low-SES homes tend to have poor home literacy environments. Home environments in which there are limited literacy resources and interactions, such as books and shared reading, are predictive of low vocabulary and limited knowledge about the nature and uses of print (Bus, van IJzendoorn, & Pellegrini, 1995; Scarborough & Dobrich, 1994; Roberts, Jurgens, & Burchinal, 2005). Even when they get to school, the disadvantages of children from low-SES homes persist. Duke (2000) found that when compared to children attending schools in high-SES areas, children attending schools in low-SES areas have less print experience, fewer types of print experience, and lower quality print experiences (see also Kainz & Vernon-Feagans, 2007).

The Early Home Environment

Home is the first and more important environment in the lives of young children, and of central importance are the parents or primary caregivers. Clay (1972) stated, "when a child enters school… the language he uses mirrors his parents' language; the forms, as they speak with him" (p. 21). The resources and social support available to children vary based on family income, parental education, the primary language spoken in the home, and culture (Leichter, 1984). Differences in the home literacy environment can vary by actual resources, by literacy tools (such as books, newspapers, journals, and computers), by the typical literacy activities (including shared reading and visits to the library), and by the quality of parental literacy mediation. These differences in the home environment are related to differences in young children's literacy development. These environmental differences occur across different cultures, including the United States (Neuman & Celano, 2001; Purcell-Gates, 1998), Israel (Korat & Levin, 2001; Ninio, 1980), and the Netherlands (Bus, Leseman, & Keultjes, 2000).

The physical home environment includes economic and educational resources, such as access to a variety of different print (e.g., grocery lists, books, labels). As Rogoff and colleagues (1993) found in cross-cultural investigations of children's guided participation in culturally-based activities, different settings and physical resources support different activities and interactions. Neumann and Celano (2001) found that differences in family SES had a profound impact on the availability of print resources. Children from low-SES homes had fewer books, and the books they did have were of poor quality. The effect of SES crept out of the home into the community – as was manifest through reduced access to print in public spaces such as libraries, preschools, and local businesses. Differences in classroom settings have also demonstrated an effect on the types of interactions and literacy-related activities that are afforded by the context (Neuman, 1995; Neumann & Roskos, 1997).

Literacy is a social practice that takes many forms, each with different purposes and different contexts (Cairney, 1995; Luke, 1993). Shared book reading is a common activity in many North American homes (Bradley, Corwyn, McAdoo, & Coll, 2001; NCES, 1999). It promotes language and literacy development because it is a natural event, with goals and shared affect, that allows for different aspects of language, such as vocabulary and narrative structure, to be highlighted individually and as a holistic skill. Late in the first year of life, shared book reading interactions are a venue to learn how to handle books and other printed material (Snow & Ninio, 1986; Bus, Van IJzendoorn, & Pelligrini, 1995). Within the context of shared reading, parents introduce their children to different concepts about print, such as word boundaries and page turning (Snow & Goldfield, 1983), and to the many structures of narrative (Snow & Goldfield, 1982).

Parents use books as a way to share novel objects, like giraffes and airplanes, with which many young children have no experience, and in doing so, expand the child's vocabulary (Ninio, 1983; Ninio & Bruner, 1978). In 2005, 98% of preschool children were read to at least once per week; in contrast, 89% of children who lived in homes in which no parent spoke English were read to once per week (Iruka & Carver, 2006).

Shared reading enhances preschool children's emergent literacy skills, including vocabulary (Senechal & LeFevre, 2001), print knowledge (Reese & Cox, 1999), complexity of conversational language (Morrow, 1988), and understanding of narrative structure (Senechal & LeFevre, 2001). Bus, Van IJzendoorn, and Pelligrini (1995) found that this type of interaction explains about 8% of the variance in language and literacy outcomes for middle-class children. The effect is even higher – 12% to 18% of the variance – on the language outcomes of low-income preschoolers (Payne, Whitehurst, & Angell, 1994). There is a cumulative effect of home-related factors on variability in children's literacy performance (Thompson, 1985).

In addition to books, children experience many other sources of environmental print, such as road signs, logos, billboards, and advertisements (Stile & Ortiz, 1999). These fortuitous, naturally-occurring events lead to *incidental pre-literacy experiences* (Mayfield, McCormick, & Cook, 1996). Whereas mothers are more likely to engage their children with literacy through the more conventional shared reading interactions, fathers often take advantage of these more organic experiences as pockets of opportunity to share language and literacy with their children (Ortiz, Stile & Brown, 1999).

There is significant variation across communities in the use of literacy practices, especially in the frequency and manner in which parents introduce children to literacy

(Heath, 1982). Shared book reading is less frequent in low-income families (Whitehurst, Arnold, et al., 1994), and the gap in parent-preschooler reading frequency may be widening along income lines (NCES, 1999). Parents who are poor have been reported to be half as likely to read to their children as parents who are not poor (Bradley et al., 2001).

Ninio and Bruner (1978) found that if shared reading is present in low-income homes, the interaction is similar to that found in middle-income homes. In research on two families from different social classes, the joint book reading interaction was comprised of a joint construction built around pointing to pictures, turning pages, and constant conversation. Mothers gave their children positive feedback and encouraged naming behavior. This study suggests that if this type of interaction is present, the quality of the shared book reading interaction may be stable across SES environments.

Children from homes in which a language other than English is spoken are at risk for poor reading outcomes in American schools (Denton, West, & Watson, 2003; Snow, Burns, & Griffin, 1998), which is attributable to low levels of literacy at entry to kindergarten. Spanish-speaking Head Start children and English-proficient bilingual students often begin kindergarten with language and literacy abilities below age expectations for monolingual children (U.S. Department of Health and Human Services [DHHS], 2003). Some researchers have suggested that this is due to a discontinuity between home and school in terms of environment supports and demands (Reese & Gallimore, 2000). Yarosz and Barnett (2001) reported a low frequency of shared book reading in Hispanic families, which was more pronounced for homes in which English was not the primary language. Immigrant Latino parents rarely read to or with their

children (Goldenberg, Reese, & Gallimore, 1992; Reese, et al., 1995), although much time is spent in story-telling.

There are contrary findings for the literacy development of Spanish-English bilingual children. In a study of children in Head Start, growth in either Spanish or English language development during the preschool years resulted in positive reading outcomes in kindergarten (Hammer, Lawrence, & Miccio, 2007). For bilingual 4-year-olds, Tabors and colleagues (2003) found positive associations between vocabulary, word identification, and concepts of print. For most of the children, abilities in one language were related to their abilities in the other. This finding is consistent with research on bilingual language acquisition – language acquisition is initially delayed, but soon catches up and is similar across languages.

Preschool and Early Care and Education Experiences

Another important environment for young children is the setting for their early care and education. The value of early educational experiences is widely accepted as fact, particularly from the inter-related perspectives of basic cognitive and social development, brain development, early intervention, child care, and economic analysis (Brooks-Gunn, Fuligni, & Berlin, 2003; Heckman, 2006; Karoly, Kilburn, & Cannon, 2005; Ludwig & Phillips, 2007; National Research Council and Institute of Medicine, 2000).

Children from all backgrounds participate in non-parental care situations, either for socialization with other children or for practical reasons because of maternal or paternal employment. Between 1970 and 2000, the proportion of married mothers in the labor force who have preschool-aged children doubled from 30% to 63% (U.S. Bureau of the Census, 1999), with the most dramatic increase in mothers with infants. By the early

1990s, the employment of mothers with infants was at 52% by the sixth month and 60% by 12 months after birth (Smith, Downs, & O'Connell, 2001). In the U.S., 58% of mothers with children under the age of 3 years were employed in 2006 (U.S. Department of Labor, 2007). These statistics suggest that most children will experience non-parental care and education at some time between birth and entry to formal schooling. The quality of early care and education is important not only for children from disadvantaged backgrounds, but for all children. Thus, it is important to look at the early care and education experiences of children outside the home generally.

Child care has historically been a term applied to programs in which the primary goal was the health and safety of children. In contrast, early education has been applied to programs in which the focus was on academic skills and school readiness. With the recent emphasis on quality and accountability, this distinction has become blurred, and most early care and education environments serve both goals. The National Research Council (2002) suggested that for children to be ready for school, this comprehensive approach is necessary:

> [A]dequate care involves providing quality cognitive stimulation, rich language environments, and the facilitation of social, emotional, and motor development. Likewise, adequate education for young children can occur only in the context of good physical care and of warm affective relationships. (p. 2)

In reference to these kinds of environments, the more current term of early care and education (ECE) are used in the present study. ECE comes in many forms, from federally-funded programs such as Head Start and Early Head Start, to model programs like the Carolina Abecedarian Project, and the recent trend of state-funded pre-K (both universal and targeted).

ECE can produce large effects on intelligence and persistent effects on achievement, grade retention, special education, and socialization (Barnett & Masse, 2007; Temple & Reynolds, 2007). There are particularly sizeable effects for its impact on grade retention and special education. In a review of model and public preschool programs, Barnett (1995) found that preschool participation was associated with 31% reduction in grade retention, 50% reduction in special education placement, and 32% reduction in high-school dropout. These effects are large enough and persistent enough to have a strong positive influence on the lives of children from disadvantaged backgrounds (see also Barnett & Masse, 2007). Additional benefits include a reduction in the need for future remedial services, increased educational attainment and labor productivity, and improved health.

Decisions that families make about child care are based on different criteria, such as cost and maternal employment, and are influenced by other factors, such as geography and family structure (Singer et al., 1998). Quality of care accounts for approximately 5% of children's developmental outcomes (after adjusting for family and home environment). Child care quality was more strongly associated with outcomes for children from low-income families than for middle-income children in many, but not all, studies (Burchinal, Peisner-Feinberg, Bryant, & Clifford, 2000; Peisner-Feinberg & Burchinal, 1997). High quality ECE is associated with a variety of positive outcomes for young children. They perform better on measures of social, language, and cognitive development, when compared with other children who were not enrolled in an ECE program.

Evidence from both observational and experimental studies of the effect of child care indicate that high quality child care can have a positive effect on the cognitive and

social outcomes of disadvantaged children (Caughy, DiPetro, & Strobino, 1994). In more intensive programs, such as the Carolina Abecedarian Project, the long-term effects were observed into adulthood – higher IQ, higher educational level, higher employment rates, lower rates of crime (Campbell, Ramey, Pungello, Sparling, & Miller-Johnson, 2002; Schweinhart, Weikart, & Larner, 1986; Yoshikawa, 1995). Quality of child care is associated with cognitive and language skills, even after controlling for SES, maternal employment, or family structure. Child care quality has been positively related to cognitive and linguistic development at ages 2, 3, and 4 ½ years (NICHD ECCRN, 2000, 2002). Observational studies report that children who attend child care centers with higher quality ratings have better cognitive outcomes than children who attend centers with lower ratings (Burchinal, Roberts, Nabors, & Bryant, 1996; McCartney, 1984; Peisner-Feinberg & Burchinal, 1997). Child care quality predicted cognitive outcomes at 54 months, with effect sizes of .04 to .08 for both infant and preschool aged children (NICHD ECCRN & Duncan, 2003).

Two prominent models for early education policy are Head Start and state-funded pre-kindergarten programs. Most states currently offer some type of pre-K program, and two states, Oklahoma and Georgia, offer the program to most of their 4-year-olds (Barnett et al., 2007). Children who attended a state-funded pre-K program scored higher than their Head Start counterparts on all cognitive outcomes assessed (Henry, Gordon & Rickman, 2006), a finding which supports an increasingly popular argument for devolving control of Head Start to the states. This finding must be qualified, because the characteristics of state-funded pre-K programs vary.

Rather than being solely an education program, Head Start is a comprehensive program which provides health, nutrition, and social services (Vinovskis, 2005; Zigler, 1970). In the United States, the number of children served by Head Start increased from 720,000 in 1995 to 850,000 in 2000 (ACF, USDHHS, 2007). Even during the 1980s, when many social programs experienced budget cuts, Head Start continued to receive federal funds. In 1995, a new federally-funded program of community interventions, Early Head Start, was developed to address the needs of children from birth to 3 years. Like Head Start, Early Head Start is a comprehensive program in which children receive health, social, and educational services.

Research on Early Head Start programs indicates that they produce positive impacts on children's cognitive and language development. Children who were enrolled in Early Head Start programs performed significantly better than a comparison group of children on standardized assessments of cognitive ability. Even so, children in Early Head Start continued to lag behind national norms for the same assessment (Love et al., 2005). Early Head Start also demonstrated a similar effect on language development, with children in the program scoring higher on a measure of receptive vocabulary than control children. Raikes and colleagues (2006) found that mothers who participated in Early Head Start programs engaged in more literacy-related events with their child, including shared book reading. At 14 months, the likelihood of a mother engaging in daily shared reading increased if the child was first-born or a female. At 24 and 36 months, the odds of daily shared reading increased if the maternal education was beyond high school or if the family was a participant in Early Head Start. This increased

frequency translated into an increase in child language and literacy ability at entry to kindergarten.

Implications for Early Education Policy

Even before children begin formal instruction in reading and writing, they display differences that mirror divisions in our society, with children from low-SES and from non-English speaking homes at a disadvantage (Duncan & Brooks-Gunn, 1997; Duncan, Brooks-Gunn, & Klebanov, 1994; McLloyd, 1998; Zill, Collins, West, & Hausken, 1995). Prevention and intervention for children at a disadvantage are critical in the remediation of these enduring negative effects (Snow, Burns & Griffin, 1998). Early childhood intervention programs are based on the premise that it is possible to alter cognitive and linguistic outcomes in young children (Bronfenbrenner, 1979; Brooks-Gunn, 2004). As indicated above, there exists compelling research on early care and education that suggests that such programs, when they are high in quality and provide environments which are caring, simulating, and stable, can have strong and sustained effects that can alter the developmental trajectories of children at-risk in the direction of positive outcomes.

Pre-kindergarten classrooms are often not the first out-of-home care experiences for children, especially for children at risk for literacy delays. Missing from the research are interventions that take place between infancy and preschool – the toddler years in which children's language development is exploding (Bloom, 1973; Nelson, 1973). Ramey and colleagues (2000) indicate that the effects of early education on high-risk children are positive, especially regarding literacy outcomes. Evidence from long-term programs, such as the Chicago Child-Parent centers (Temple & Reynolds, 2007) and the

Abecedarian project (Barnett & Masse, 2007), as well as recent research on Early Head Start (Love et al., 2005) have indicated that investment in education during these early years is cost effective. These findings are particularly important in a political climate in which funds for early care and education are diminishing (Miller, 2006; U.S. OMB, 2008).

Rog (2001) stated that the failure "to give children literacy experiences until they are of school-age can severely limit the reading and writing levels they ultimately attain" (p. 10). In impoverished environments, these critical literacy experiences are most often created through interventions. In the present study, the focus was on classroom-based programs in early care and education environments (Connor, Morrison, & Slominski, 2006; Justice & Pullen, 2003). To assess the quality of the ECE environment, two criteria were used: structural quality of the environment and quality of caregiver classroom interaction. The benchmarks set by the National Institute of Early Education Research (NIEER) were used as a marker for structural quality (Barnett et al., 2007). Because the focus of the NIEER is on preschool for 3- and 4-year-olds and the focus of the present study is the quality of ECE at 2 years, the NIEER benchmarks were augmented with criteria from a policy statement from the American Academy of Pediatrics (Committee on Early Childhood, Adoption, and Dependent Care, 2005), based on recommendations from a panel of pediatricians and early childhood experts that issued a statement on the quality of early care and education for children from birth to 5 years. The recommendations for maximum class size and staff-to-child ratio for ECE centers that serve 2-year-old children were used. The Arnett Caregiver Sensitivity Scale (Arnett, 1989) was used as a marker for the quality of caregiver interaction.

Beyond the issue of quality, the critical issues of funding, quality, and stability of Head Start and pre-kindergarten remain. Programs which are mature and well-developed tend to have strong positive effects; in contrast, programs which are younger and likely not to meet standards tend to have small or transient effects on children's cognitive and social outcomes. Ratings of higher social and cognitive competencies in children are associated with high quality instructional interactions (Mashburn et al., 2008), which are often related to structural markers of quality such as teacher training. These kinds of requirements, as those measured by NIEER quality benchmarks, are often expensive. Any early education policy must consider what is necessary to build a high-quality ECE environment and what such mandates will cost.

One program alone – or even one social domain alone – cannot be expected to provide the solution to a problem as complex as the effects of poverty and other disadvantages on children and their families. Heckman (2000) stated that,

> in evaluating a human capital investment strategy, it is crucial to consider the entire policy portfolio of interventions together – training programs, school-based policies, school reform, and early interventions – rather than focusing on one type of policy in isolation from the others. (p. 50)

Investment in early care and education has been shown to have a higher net benefit and benefit-cost ratio than many other interventions for education and health services (Barnett, 1995; Barnett & Masse, 2007). One of the goals of the present research is to investigate the role of ECE beyond the influence of the individual child and his or her home environment on emergent literacy growth. Most current programs, specifically Head Start and the state-funded pre-K, serve 4-year-old children. Is it sufficient to serve children of 4 years or even 3 years, or must we consider programs and policies that support the care and education of our youngest children? In the present investigation the

effect of high-quality ECE at 2 years on emergent literacy growth was examined, suggesting that earlier may be better. Due to the high rates of return, a larger allocation of public investment in high-quality early child care and education is merited.

Estimating Causal Effects with Observational Data

Policymakers have emphasized an increase in the need for evidence-based interventions for education (National Research Council, 2002). This call was particularly notable in the reauthorization of the Elementary and Secondary Education Act – the *No Child Left Behind* Act of 2001 (Eisenhart & Towne, 2003). Experimental research designs, such as the randomized control trial, are considered to be a gold standard for evidence-based research. A common concern among education researchers is that these designs often result in fragmented research that is difficult to replicate (Kaestle, 1993; Sroufe, 1997; Labaree, 2004). In addition, these types of research designs are also untenable in applied disciplines such as education. An alternative is to use techniques, such as propensity score modeling, that can be used to approximate randomized trials. The use of propensity score analysis to create equivalent groups for comparison with observational data has been demonstrated as an effective analytic technique in policy research (Schneider, et al., 2007).

A problem of causal inference is that if a person is in one condition, that person cannot go back in time and also be in the other (often referred to as the *counterfactual* case). In randomized control trials, this problem is solved by matching participants from the treatment group to participants in the control group. In observational studies, however, it is often infeasible or unethical to assign participants randomly to different groups. For observational studies, this randomized assignment to groups can be

approximated using propensity score analysis to match or to sub-classify participants across naturally occurring conditions (Rosenbaum & Rubin, 1983a; Rubin, 1997). Thus, propensity score analysis with matching or stratification is a way to deal with the ubiquitous problem of selection bias in observational studies (Cochran, 1968; Holland, 1986; Schneider, Carnoy, Kilpatrick, Schmidt, & Shavelson, 2007). Because of its usefulness in estimating causal effects when groups cannot be assigned, propensity scores can be effective in answering questions involving issues of policy.

In observational studies, propensity scores are used to estimate the effect of a treatment or intervention by comparing the outcomes for people who were not assigned to interventions at random. If background characteristics influence the likelihood that someone will receive a treatment or if they influence the outcome, then direct comparison of naturally occurring groups will produce biased results. The propensity score is a device for balancing numerous covariates. The propensity score is used to sub-classify the observations into strata (Rosenbaum & Rubin, 1984). People in the treatment and control groups who share background characteristics are grouped by sub-classifying on the propensity score (Rosenbaum & Rubin, 1983a). These sub-classifications – strata – are based on discriminant matching as a method for controlling bias in observational studies using the propensity score. In multivariate normal distributions that have common covariance across treatment groups, the propensity score is a monotone function of the discriminant score.

Propensity scores are often used to adjust for differences across treatment groups. Traditional methods of adjustment include matching, stratification, and regression adjustment. As typically practiced, these methods are limited because they can only

adjust for a few covariates. A propensity score provides a scalar summary of all covariate information. Once the propensity score is estimated, the score can be applied through these same methods. Propensity score methods of adjustment produce estimates that are less biased, more robust, and more precise than estimates produced with traditional methods (Gu & Rosenbaum, 1993, but also see Kurth et al. 2005).

> The point estimate of the treatment effect from an analysis of covariance adjustment for multivariate X is equal to the estimate obtained from a univariate adjustment for the sample linear discriminant based on X, whenever the same sample covariance matrix is used for both the covariance adjustment and the discriminant analysis. (Rubin, 1979, p. 320)

Furthermore, several studies have found that covariance adjustment combined with matching on covariates provides more reliable estimates than either technique alone (Rubin, 1973, 1979; Rubin & Thomas, 2000).

Children live in multiple environments, and they engage these environments to different degrees in the first 5 years of life. Propensity scores were used in the present study to balance children according to these different environments and to estimate the effects of these environments on growth in children's emergent literacy.

The Present Investigation

This study was motivated by two questions. First, how does emergent literacy develop in the first years of life? Second, does experience in a high-quality early care and education environment enhance the development of emergent literacy? In order to address these questions, two additional questions were asked: How should emergent literacy be defined as a construct which changes over the first years of life, and what is the effect of the home environment, as distinguished from the effect of ECE, on children's emergent literacy growth?

To address these questions, data from the Early Childhood Longitudinal Study – Birth cohort (ECLS-B), a nationally representative dataset from the National Center of Education Statistics (NCES), were used. The growth in emergent literacy was modeled using hierarchical linear modeling (HLM) techniques, with observations nested within children. The construct of emergent literacy, modeled at level 1, was defined using principal component analysis that combined various measures from the survey into components which represented emergent literacy. The environments were described using propensity score analysis. To partial out the effects of the home environment from the early care and education environment, a logistic regression model was used to create a propensity score, which was used as a predictor at level 2 to adjust for the contribution of the home environment. Differences in the ECE environment were determined by using propensity score analysis to stratify cases and to match groups based on exposure to the intervention of a high quality ECE. The effect of a high-quality ECE environment on children's emergent literacy was then modeled by adding strata as level 2 predictors.

CHAPTER 3

METHOD

The method used in the present study, including the techniques employed to answer the four research questions, is illustrated in Figure 3. First, emergent literacy was defined using principal components analysis (PCA). The measures used to inform the components at each time of measurement – 9 months, 2 years, and preschool – varied in order to produce components from developmentally appropriate assessments. A component score was calculated for each of the three measurement occasions. These scores were used as the outcome in the HLM growth model at level 1, with each child's age at assessment as the level 1 predictor. After the unconditional growth model was estimated, the effects of the child characteristics, the home environment, and the early care and education environment on the growth of emergent literacy were estimated.

Participants and the Analytic Sample

The Early Childhood Longitudinal Study – Birth cohort (ECLS-B: Snow et al., 2007; see also Moore et al., 1999) is a federally-sponsored, multiple-method, multiple-respondent study of the cognitive, social, and health development of children from birth through kindergarten. The study includes data about children born in the United States during the year 2001; data were collected from the children as well as their parents and early childcare and education providers (Bethel, Green, Kalton, & Nord, 2005). The ECLS-B researchers used a multistage probability sample design to select a nationally

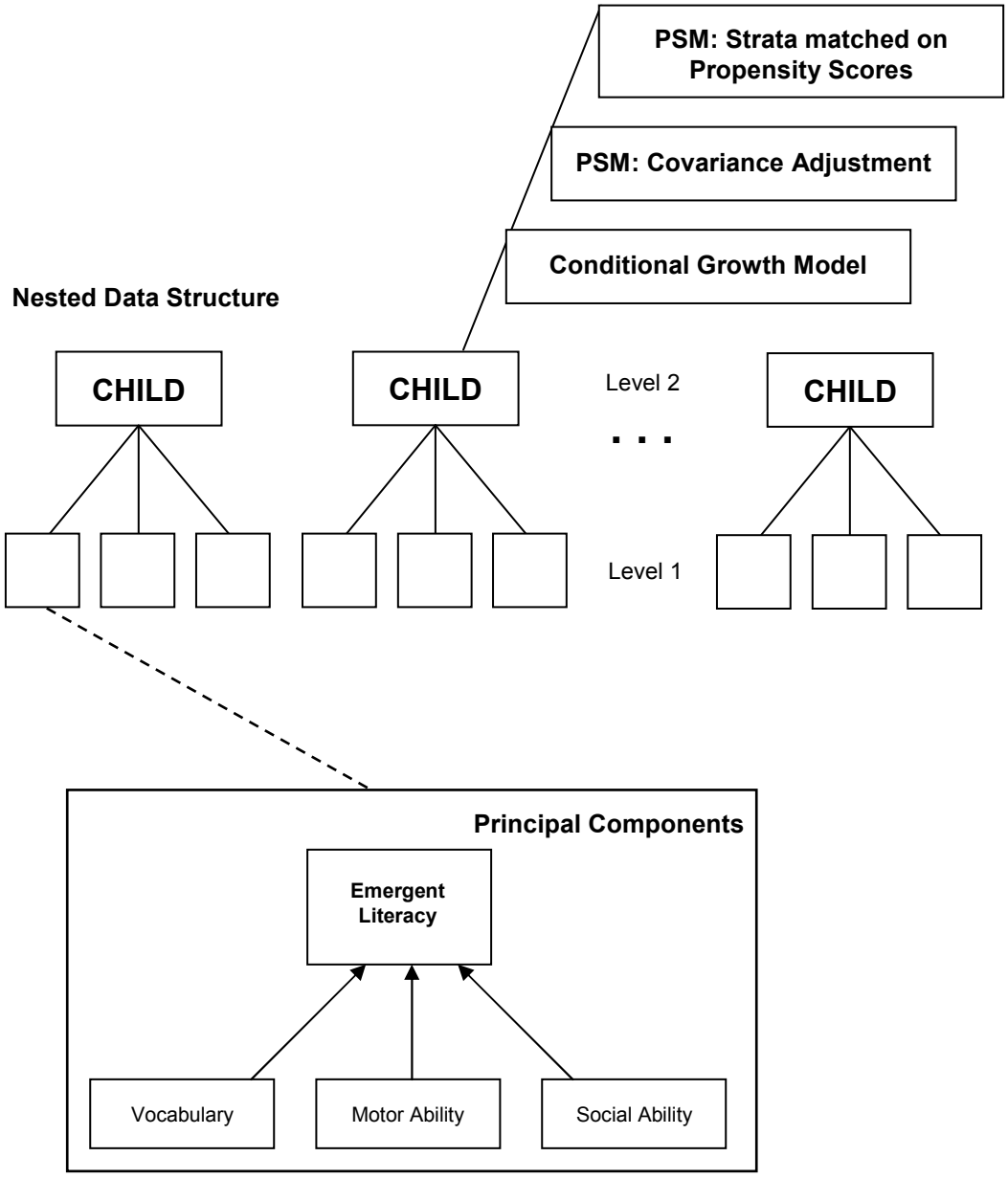

Figure 3. Methodology Model

representative sample of children born in 2001. Certain groups of children were over-sampled: children who had ethnic background of American Indian, Alaskan Native, or Asian-Pacific Islander, children who were low birth weight, and children who were twins. Sample weights were used in all of the analyses presented here to adjust for this over-sampling. The response rate for children who were assessed at all three measurement occasions was 63.1%. The sample weights also adjust for differences due to response rates and non-response bias.

The analytic sample was drawn from the restricted-access ECLS-B 9-Month to Preschool longitudinal file (NCES, 2008). The sample included children who were single births, of normal birth weight, and experienced typical development (for example, children with hearing impairment were not included), with no atypical development (such as Down's syndrome) detected at any of the available assessments. In addition, only children who had data available at all three measurement occasions were included in the analytic sample. Specific exclusion criteria included multiple birth status (e.g., twins), low birth weight (less than 2500 grams), prematurity (< 37 weeks gestation), diagnoses of syndromes, and visual or hearing impairment. Also relevant to the research questions for the present study were the mothers, fathers, and early care providers of these children, as well as the physical home and early care and education environments. In the first 4 years of the study, the children were assessed three times: at 9 months; 2 years; and preschool (approximately 4 years). The present study used all three waves of data collection.

The effective sample size for the growth model was approximately 5,700 children measured over the course of the three waves of data collection. Because the ECLS-B is a restricted-access dataset, all statistics related to actual frequencies (including raw

frequencies and degrees of freedom based on frequencies) are reported rounded to the nearest 50. This restriction on report is a requirement of the restricted access license with the National Center for Education Statistics (NCES, 2008), and it is for the protection of privacy for the children and their families who participated in this study. All weighted descriptive statistics and coefficients are reported in exact numbers.

Many large-scale secondary datasets used in education research, such as NHES and ECLS, use complex survey sample designs. Complex sample surveys often use multistage sampling schemes that involve unequal selection probabilities at one or more levels of sampling. An additional problem arises from the clustered design which can result in biased variances and standard errors. When multi-level models are estimated using complex survey data, the probability of unequal selection at any stage of sampling can lead to bias in parameters or standard errors (Pfefferman, Skinner, Holmes, Goldstein, & Rasbash, 1998). When weights are present at only one level, as is the case with the present growth model in which the sample weights were applied at level 2, the problem is more straightforward. In a simulation study, Asparouhov (2005) found that the "level 2 weight variable has the role of a single-level weight variable and the estimation can be done by the single level PML [pseudo-maximum likelihood estimation] technique" (p. 442). Thus, the analyses here were treated in a similar manner as a multivariate single-level model with weights (Asparouhov, 2006).

The two main concerns when using complex survey data are over-sampling and cluster sampling. Sampling weights were used in these analyses to adjust estimates for the over-sampling of certain populations for the study (Hahs-Vaugh, 2005; Hahs-Vaughn & Onwuegbuzie, 2006); the primary sampling units (PSU) and strata were used in a

model-based design to adjust for clustering. Because the focus of the analyses is on the child's ability across time, the appropriate sample weight (W3C0) was applied at the level of the child (level 2). This weight is calibrated to include only the observations for children who have assessment data available at all three time points (9 months, 2 years, and preschool), and it also adjusts for non-response so that analytic results can be interpreted in terms of the nationally representative sampling frame of children born in 2001. To adjust for the effect of clustering from the complex sampling design, a multistage probability sample, primary sampling unit (W3CPSU) and strata variables (W3CSTR) were used in the calculation of all descriptive statistics.

Instrumentation and Data Collection Procedure

The ECLS-B was designed to assess children and their environments in a variety of ways, including direct and indirect measures of child ability and health, observations of interactions between children and their parents, interviews of parents on care-giving behaviors and the home environment, and interviews of the early care and education providers (ECEP) on the child's classroom experiences. For the ECLS-B data collection, a trained researcher used a variety of standardized assessments to assess each child's cognitive, social-emotional, and physical development. The researcher also used a computer-assisted personal interview (CAPI) procedure to interview each child's primary care provider and ECEP. Additional data were collected using self-administered questionnaires (SAQ) to resident and non-resident fathers and to directors of ECE programs.

Demographic characteristics were obtained through a variety of methods, including the child's birth certificate and parental self-report. NCES analysts constructed

composite variables for the ECLS-B data, including variables for socio-economic status (SES), highest parent education, and child's literacy ability at preschool. Details on the construction of these variables are available in the ECLS-B Psychometric Report and User's Manual (Andreassen & Fletcher, 2005; Snow et al., 2007). It is important to keep in mind that the primary language spoken in the home, especially when informed by the race/ethnicity of the parent or child, is not only an indicator of the type of linguistic input, but also of the level of acculturation. Cultures have different norms regarding literacy-related activities, such as shared book reading and story-telling, which have an influence on children's emergent literacy abilities.

The child's emergent literacy skill level was based on the assessments of the child, which varied based on developmentally appropriate assessments at each of the three measurement occasions. At the first measurement occasion (9 months), the child was assessed with the Bayley Short Form – Research edition (BSF-R) and the Nursing Child Assessment Teaching Scale (NCATS: Barnard et al., 1989; Sumner & Spietz, 1994). The BSF-R is a shortened version of the Bayley Scales of Infant Development, a measure of mental and motor development for children from 1 to 42 months. The NCATS is an instrument for measuring the interaction between parent and child from birth to 36 months.

At the second measurement occasion (2 years), the child was assessed with the BSF-R and the MacArthur Communicative Development Inventory (MCDI: Fenson et al., 1994). The MCDI is a parental report assessment of children's vocabulary development. The MCDI was administered as part of the parent interview.

At the third measurement occasion (preschool), the child was assessed with the Preschool Comprehensive Test of Phonological and Print Processing (Pre-CTOPPP: Lonigan et al., 2002), a fine motor skill assessment, and the Test of Early Mathematics Ability – 2 (TEMA-2: Ginsburg & Baroody, 1990). The test for literacy ability included tests of phonological awareness, letter-sound knowledge, letter recognition, print convention, and word recognition. Language ability was assessed using subtests from the PreLAS (Duncan & DeAvila, 1998) – Simon Says and Art Show – and the Peabody Picture Vocabulary Test (PPVT: Dunn & Dunn, 1997). The fine motor task was a psychomotor activity which required the child to copy basic geometric forms, such as circles and squares. Finally, an assessment of mathematics was included because at this age it also serves as an indicator of both language ability and general knowledge.

The home environment, including both the social practices of the family and the physical resources of the home, was assessed through the parent CAPI. Interview questions included items from the Home Observation for the Measurement of the Environment (HOME) Inventory (Bradley & Caldwell, 1979, 1981). The HOME assesses the quality and quantity of stimulation available to the child in the environment, including access to objects, events, and interactions with people.

Finally, the ECE environment, including classroom practices, classroom resources, and overall center facilities, was measured for children who were in an early care or education program at 2 years. The environment was assessed through an interview with the ECEP, observations of the ECE environment, and a questionnaire completed by the center director. The ECE observation included the Arnett Caregiver Sensitivity Scale (Arnett, 1989) and either the Infant / Toddler Environment Rating Scale – revised edition

(ITERS-R: Harms, Cryer & Clifford, 1990) for center-based care or the Family Day Care Rating Scale (FDCRS; Harms & Clifford, 1989) for home-based care. These assessments provided information on both the physical and interpersonal aspects of the ECE environment. General center information, such as class size and teacher education, was obtained through the questionnaire from the center director.

Two different approaches were used to assess ECE quality as defined in the present study: (1) one based on structural aspects of the environment and (2) one based on the caregiver interaction within the classroom environment. Structural aspects were assessed based on the NIEER benchmark criteria. Part of this was determined using either the ITERS or FDCRS. The ITERS-R and FDCRS provide global ratings of child care quality based on structural features of the center or home and the primary caregiver's interaction with the child. They have a similar format, although the content of each scale is adapted to match the specific type of environment it was designed to assess. Each of the items on the scale is rated on a 7-point scale: 1 (inadequate), 3 (minimal), 5 (good), and 7 (excellent). Other benchmarks were determined from the CATI and Center Director SAQ. Although NIEER currently report on 10 benchmarks, one of the benchmarks – monitoring of programs with site visits – was excluded from the present analysis because there were no consistent initiatives to monitor the quality or mandates for early care environments for 2-year-olds. The ECE programs in the present study met an average of 4.5 benchmarks (*SE* = .05) out of 9 possible.

The classroom instructional environment was based on the Arnett Caregiver Sensitivity Scale (Arnett, 1989). The Arnett scale is comprised of 26 items to rate caregiver interaction on characteristics such as relationships and prosocial interaction. A

child's caregiver was rated for each item of the Arnett on a 4-point scale to indicate the extent to which the statement describes the caregiver. The Arnett was administered by a trained observer who spent at least 2 hours in the child care setting. When coded from 0 (low) to 3 (high), caregivers with an averaged item score of 2.5 or higher were classified as providing a high-quality ECE environment for the present study. The average score for all ECEP on the Arnett was 2.4 (*SE* = .01).

Coding time in the growth model

Children in the ECLS-B were not assessed at exactly the same age. That is, although the aims of the project and data collection were to gather information when the child was aged 9 months, 24 months, and at the beginning of preschool (approximately 48 months), logistical constraints resulted in children and their environments being observed at ages varying around these targets. The differences in ability change quickly, particularly within the first 5 years of life, so it is critical that this variability in age be incorporated into the analysis. Thus, the time variable was defined as the child's age at assessment. In growth modeling, HLM allows for the time aspect to be variably spaced, to allow for measurements to occur at different intervals with respect to the child's age.

Although the scaling of time might seem arbitrary, it has strong implications for the interpretation of the growth model parameters (Biesanz, Deeb-Sossa, Papadakis, Bollen, & Curran, 2004). Methodologists have emphasized the need to parameterize growth curve models in a way that will enable interpretation in addressing the specific question of import for the analysis (Biesanz et al., 2004; Raudenbush, 2001; Raudenbush & Bryk, 2002). Although coding of time may change, the underlying latent trajectories remain the same. The fitting of the model to interpret either the initial or the final time

points does not change the underlying meaning of the growth patterns. For the present study, time for the main analysis will be coded for the initial status by subtracting each child's age by 7 months, the youngest age of any child in the study at the first observation.

Missing data

Given the nature of longitudinal data collection, there are missing data. Some of this missingness, often due to attrition, was not a problem because only children with data from all three measurement occasions were included in the sample. Sample weights are also calibrated to correct for this type of person-level non-response bias. Because of the large number of assessments in the ECLS-B, some children or parents did not complete all assessments (e.g., administration was too long, respondents were fatigued). Thus, item-level missingness was present. If data are missing not at random (MNAR), a condition in which the probability of missing values of a variable is related to the variable itself, the missing values can result in biased estimates (Peugh & Enders, 2004; Raudenbush & Bryk, 2002). For example, if a child with a language delay did not complete a language assessment, the missing datum is directly related to the variable of interest. Regardless of the mechanism for missingness, missing data at level 2 are a problem because HLM handles cases that have missing values with listwise deletion; thus, it does not include cases in an analysis if any of the predictor variables are missing at level 2. Without attention to the missing data, any child who had missing data on a person-level variable would have been excluded for the analysis.

To retain the maximum number of cases for the analysis, a hot-decking algorithm was used to impute data that were missing in the NCES raw data file for child-level

predictors and environmental characteristics at level 2. Hot-decking originally got its name from the deck of cards used in the processing of data files. In hot-deck imputation the hot – or current – data file is used as the source for potential imputed values. Parametric multiple imputation methods (Rubin, 1987) accommodate missing data depending upon the outcome; the nonparametric counterpart – hot-deck multiple imputation – replaces missing values for non-respondents with values from actual respondents in the same data file who are similar on specific characteristics (Reilly, 1993). Hot-decking procedures preserve the distribution of the estimates, especially when compared to mean imputation methods (i.e., when the mean of a variable is used to fill-in the missing value). Thus, hot-deck imputation addresses the problem of understating uncertainty that occurs with other methods of imputation (Schafer & Graham, 2002). Hot-decking is one of the methods of imputation used by NCES (2003). After data were imputed, the weighted means and frequencies were compared. None of the variables yielded a significant difference between the pre- and post-imputed datasets.

Statistical Analyses

The goal of this study was to model influences from multiple levels of the child's ecology, with particular emphasis on the early child care and education environment, on the growth in children's emergent literacy. To address the objectives of the study, a two-level growth model was used, with observations nested within children, using one propensity score model to capture the range of the home environment and a second propensity score model to match groups on the early child care and education environment.

Research Question 1: How is emergent literacy best defined from 9 months to preschool?

The outcome variable in this study was emergent literacy. This construct is, by definition and design, in a state of flux. That is, the skills and abilities which contribute to the overall construct of *emergent literacy* change as a child develops. Because this construct has not been formally addressed in the empirical literature with children this young, this research question involves an exploratory aspect. Research with preschool-aged children has suggested that emergent literacy may not be a unitary construct, but rather is comprised of several distinct but inter-related factors (Lonigan et al., 2000). Principal components analysis (PCA) is a data reduction technique that reduces the number of observed variables to a smaller number of components that account for most of the variance. Based on emergent literacy theory, I expected to extract components that were comprised of children's general cognitive ability, their vocabulary (receptive and expressive), their social skills, and their motor abilities. These skills and abilities comprise specific aspects of the higher-level construct of emergent literacy. Although it is of theoretical interest to examine the contributions of these individual abilities, the main focus of this study is the growth of emergent literacy as a unified construct. PCA was used to retain the individual characteristics of the different abilities that contribute to emergent literacy, a complex constellation of skills and knowledge, as they combine in a unitary construct – a component – which was used in other analyses.

Factor analytic methods include both principle components analysis and factor analysis. Components determine structure (the relationship between latent variables and observed variables) based on total variance (shared, unique, and error variance), whereas factors are based on shared variance only. This distinction is a critical consideration in the choice to use a principle components approach or principle axis factoring (Velicer &

Jackson, 1990; Ogasawara, 2000). Because emergent literacy is defined in the present study as a "constellation of skills, abilities, and knowledge," it was determined that a component would be the best way to represent both the shared and unique variance of the different skills and knowledge involved.

A principal component is a linear combination of weighted observed variables such that the sum of the squared distances to the component axis is minimized. For each measurement occasion, a principal component based on developmentally appropriate assessments was extracted. Principal component scores were calculated from the eigenvectors, the weights in a linear transformation.

The correlations between indicator variables will be examined for associations not only within each measurement occasion, but also across measurements. Pellegrini and Galde (1993) argued that something missing from the literature in emergent literacy is attention to the validity of measures: "We need measures of early literacy which are consistent with theory (i.e., which have construct validity) and which relate to later aspects of literacy (i.e., which have predictive validity)" (p. 164). Although the present study is not a validity study for scale development, the issues of construct validity and consistency across time are important. Predictors at 9 months and at 2 years were examined for their association with indicators of emergent literacy at Preschool.

It is good practice to cross-validate a component solution, particularly in exploratory ventures as in the present study. A resampling method, the jackknife, was used. The jackknife makes intensive use of the data in order to reduce bias in parameter estimates and standard errors. Jackknife estimates are calculated by reusing the sample multiple times, each time calculating parameters while leaving observations out one at a

time. The average component loadings from the jackknife were used. The analysis was conducted using SAS PROC FACTOR; the analysis was repeated with SPSS data reduction command with the same outcome. Based on the component loadings, component scores were calculated for emergent literacy for each child at each measurement occasion.

Research Question 2: What is the trajectory of growth in emergent literacy ability from 9 months to preschool and are these different trajectories influenced by child characteristics?

Hierarchical linear modeling (HLM) was used to assess the initial status and the patterns of growth in children's emergent literacy skills (Rabe-Hesketh & Skrondal, 2006; Raudenbush & Bryk, 2002). The use of HLM techniques enables researchers to estimate both individual and group growth curves, in order to describe patterns of change over time and to examine the factors associated with those patterns. In the context of growth modeling, the repeated measures are represented at level 1, and participants at level 2, such that observations are nested within people (Bryk & Raudenbush, 1987). HLM allows for specification of within- (intra-individual at level 1) and between-person (inter-individual at level 2) variation simultaneously. Level 1 is used to explore differences in patterns in growth as a function of time or age with the slope or rate of change and the differences in initial status with the intercepts. Level 2 is used to explain variability between individuals through person-level explanatory variables, such as education and poverty. HLM also accommodates inconsistent timing in data collection (i.e., unequal time intervals between measurement points). Because the difference of only

a few months of development in the early years of a child's life is dramatic, this is particularly important for the present research.

A two-level model for each child was estimated using restricted maximum-likelihood estimation (REML), with HLM version 6 (Raudenbush, Bryk, Cheong, Congdon, & du Toit, 2005). The level-1 model estimated emergent literacy at each time, as measured by child's age at assessment, and the level-2 model estimated group parameters of growth based on predictors of child, home, and ECE characteristics. Individual trajectories were estimated for each child (Singer & Willett, 2002), using the child's age at level 1 and characteristics of the child and his or her social and physical environment, such as child's gender, at level 2. This yielded separate slopes and intercepts for each child. Grouped growth curves were estimated from the individual curves to look at overall patterns of development.

Although theoretically the pattern of growth expected was linear, both linear and nonlinear growth models were examined during preliminary investigation to determine whether the addition of a nonlinear term would yield a better explanation. Many early abilities can be described with a quadratic growth element. Because there are only three measurement occasions, however, the number of parameters for the estimation of a growth curve in which a quadratic term was included would have required that the term be fixed, which means it would not be allowed to vary randomly across children. The exploratory nature of examining growth of this construct during this time in development also led to an emphasis on linear growth in the present analysis. Finally, both statistical (i.e., homogeneity of variance at level 1) and visual inspection of the growth curves supported this decision. In addition to patterns of nonlinear growth, exposure to child

care was examined as a predictor at level 1. As a time-varying covariate, it did not add information to the analysis which was not already provided from its inclusion as a level-2 predictor, and its use at level 1 obfuscated the interpretation. The model estimated was a linear growth model in which child's age at assessment was the only predictor at level 1. All other predictors examined were entered at level 2.

In growth modeling, an intercept and slope are estimated for each person and used as the outcome for level 2. Thus, the level-1 model included the child's age and a time-specific error term,

$$Y_{ti} = \pi_{0i} + \pi_{1i}(ChildAge - 7)_{ti} + e_{ti} , \quad (1)$$

where child *i*'s observed factor score for emergent literacy at time *t*, Y_{ti}, is a function of the child's initial status, π_{0i}, the slope of emergent literacy growth due to age, and a time-specific residual, e_{ti}. The level-2 unconditional model allowed the outcomes at level 1 (π_{0i}, π_{1i}) to vary, but did not posit any additional explanatory variables,

$$\begin{aligned} \pi_{0i} &= \beta_{00} + r_{0i} \\ \pi_{1i} &= \beta_{10} + r_{1i} , \end{aligned} \quad (2)$$

where child *i*'s initial status, π_{0i}, is a function of the average initial status, β_{00}, and a person-specific residual, r_{0i}, and child *i*'s growth rate, π_{1i}, is a function of the average growth rate associated with child's age, β_{10}, and a person specific residual, r_{1i}.

Before modeling, all assumptions necessary for the use of HLM were checked with descriptive statistics and visual inspection of graphics. All assumptions were met. For models of continuous dependent variables at level 1 (Y_{ti}), it is assumed that the errors at level 1 are normal random variables with a mean of 0 and a variance of σ^2. For level-2

parameters, π_{0i} and π_{1i}, it is assumed that the errors are distributed as multivariate normal with means of β_{00} and β_{10}, respectively, and variances of τ_{00} and τ_{11}, respectively.

After the unconditional growth model was estimated, child and household characteristics were added to the model as explanatory variables to examine the effect of individual characteristics on emergent literacy growth. In this conditional model, five child-level variables were added to level 2: the child's gender, child's race (African-American, Hispanic, and Asian), the primary language spoken in the home (either English or non-English), the household poverty status (based on the 100 percent poverty threshold), and the exposure of the child to early care and education environments. Exposure to ECE was calculated based on the hours each child spent in non-parental care each week and the age at which they began non-parental care. For children who were not in the care of a person other than a parent, their exposure score was 0. Because this variable was skewed, the log transformation was used in the analyses.

Child and household characteristics were added to explain the variation at the child-level (group-level differences),

$$\begin{aligned}\pi_{ti} = \ & \beta_{s1}(ChildGender) + \beta_{s2}(Poverty) \\ & + \beta_{s3}(Primary\ Language) + \beta_{s4}(AfrAmer) \\ & + \beta_{s5}(Hispanic) + \beta_{s6}(Asian) \\ & + \beta_{s6}(ECE\ Exposure) + r_{si}\end{aligned} \tag{3}$$

for the intercept term and the slope for growth associated with child's age. Child *i*'s initial status, π_{0i}, is a function of the conditional average initial status, β_{00}, which is conditioned on the values of the explanatory variables, as a linear function of the slopes for each predictor, β_{01} through β_{07}, and a person-specific residual, r_{0i}. Child *i*'s growth rate, π_{1i}, is a function of the conditional average growth rate, β_{10}, conditioned on the

values of the explanatory variables as a function of the slopes for each predictor, β_{11} through β_{17}, and a person specific residual, r_{1i}. The parameters for the predictors in the growth rate equation, π_{1i}, are interpreted as the acceleration of growth in emergent literacy (Y_{ti}). In addition to the variances from the unconditional model, the covariance of π_{0i} and π_{1i} is τ_{01} (and, redundantly, τ_{10}). Thus, assumptions for the model are summarized as:

$$e_{ti} \sim N(0, \sigma^2)$$
$$\begin{pmatrix} r_{0i} \\ r_{1i} \end{pmatrix} \sim N\left[\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \tau_{00} & \tau_{10} \\ \tau_{01} & \tau_{11} \end{pmatrix}\right] \quad (4)$$

where e_{ti} is the error at level 1 and r_{0i} and r_{1i} are the errors at level 2

Similar to the work of Callaghan and Rankin (2002), a two-stage approach was used to model change within individual children and to model between-child parameters based on background characteristics. This approach afforded an examination of systematic variation in growth as a function of individual characteristics for each child, as well as a description of overall patterns of growth as a function of characteristics for groups of children (for instance, differences in growth between boys and girls).

Research Question 3: What is the effect of the home environment on the development of children's emergent literacy ability?

The home environment exerts a strong influence on children, particularly in terms of their language development and emergent literacy ability. In the present study, it was important to know the effect of the home environment on the growth in emergent literacy in order that it could be examined apart from the influence of the early care and education environment. The influence of the home environment on children's emergent literacy was

estimated by using a propensity score as a covariate adjustment at level 2 in the conditional growth model.

A propensity score is "the conditional probability of assignment to a particular treatment given a vector of observed covariates" (Rosenbaum & Rubin, 1984, p. 516),

$$E(x_i) = p(z = 1|x_i) , \tag{5}$$

given a unit with a vector of observed covariates, **x**, and a treatment or intervention, z. A propensity score reduces a collection of variables, such as covariates or background characteristics, into a single composite score. Thus, the propensity score is a scalar function of the covariates, and as such it serves as an extension of discriminant analysis as a monotone function of the discriminant score (Rubin, 1997). Because the propensity score replaces multiple covariates, just one score can be applied as a predictor rather than multiple covariates, simplifying the model to be estimated.

A propensity score is estimated using logistic regression. The *logit* function is the inverse of the sigmoid or logistic function. In logistic regression the logit is a special case of a link function in the general linear model. A link function provides the relationship between the linear predictors of a model and the mean of the distribution function. The logit link function takes the outcome and returns it to binary form (0 or 1). The propensity scores in the present analysis were estimated by maximum likelihood using a logit model, following the logistic function:

$$\eta_{i\varphi} = \ln\left(\frac{q_i}{1-q_i}\right) = \beta_0 + \beta_1 x_i , \tag{6}$$

such that the propensity score, q, is a number between 0 and 1 that depends on the vector of observed covariates, $\mathbf{x}_i$. The logit of the unknown probability (i.e., propensity), q, is

modeled as a linear function of the vector $\mathbf{x}_i$. The estimated propensity score, which is the probability of a person being assigned to the intervention group ($z = 1$) given a vector of covariates, $\mathbf{x}_i$, is defined by

$$pr(z = 1|x_i) = \frac{e^{logit(\hat{q})}}{1 + e^{logit(\hat{q})}} \quad (7)$$

The variables needed to estimate a propensity score include the treatment variable, z, and the covariates, $\mathbf{x}$. For the estimation of the home literacy environment propensity scores, the probability that a child is in a treatment group was determined based on whether he or she lived in a rich home literacy environment. For the present study, a rich home literacy environment was defined as having both of two characteristics related to social processes and material resources: daily shared reading interaction and at least 10 children's books in the home (Sanders, Zacur, Haecker, & Klass, 2004). Although there are measures of these two variables at all three measurement occasions, I focused on these resources at time 2, when the child was 2 years of age. Thus, if a 2-year-old child had a parent read to her at least once each day and had at least 10 children's books in her home, she was considered to be in a rich home literacy environment ($z = 1$). Children who lived in homes that did not meet both of these two criteria were considered to be in the control group ($z = 0$).

When deciding which predictors to include in a propensity score model, the general guideline is that, as long as the predictors are measured prior to the treatment variable, more is better: "Unless a variable can be excluded because there is consensus that it is unrelated to outcome or is not a proper covariate, it is advisable to include it in the propensity score model even if it is not statistically significant" (Rubin & Thomas,

1996, p. 253). The covariates, $\mathbf{x}_i$, included various background characteristics of the family, such as parental education and number of siblings.

The treatment variable, the level of the home literacy environment, was modeled as an outcome of the covariates, **x**, with SAS version 9.1 PROC SURVEYLOGISTIC for the estimation of the propensity score model. This analysis yielded parameters for a model from which propensity scores were calculated. The propensity score for home literacy environment was the conditional probability of receiving the intervention of increased access and interaction given the observed covariates (Rosenbaum & Rubin, 1983b) – the likelihood of being reared in a high-quality home literacy environment.

With complex sample data like the ECLS-B, it is necessary to consider when it is appropriate to incorporate the sample weight into the model. Zanutto and colleagues (Zanutto, Lu, & Hornik, 2005) suggested that

> estimated propensity scores are used only to form subclasses with similar backgrounds covariates in the sample data and not to make inferences about the population-level propensity score model, it is not necessary to use survey-weighted estimation for the propensity score model. (p. 69-70)

The logistic model was used to determine the equation for the propensity scores that were used as a predictor in a subsequent analysis. Even though the logistic model was not used to make inferences, the question of when to incorporate the elements of the complex design was still relevant. The logistic regression model was estimated both with and without the sample weights and sampling units (PSU and strata). Although the actual propensity scores varied slightly, the strata into which the observations were classified were the same across both models. The model based on the complex design was used in the final calculation and estimation of the environmental effects.

In order to examine the effect of the home environment and to adjust for its effect in the analysis of the ECE environment, the propensity score was used as a covariate adjustment at level 2 in the growth model of children's emergent literacy. The propensity score was included to adjust the estimate of the treatment effect. In the equation to estimate the effect of the home environment on children's emergent literacy growth, the logit of the propensity score from the model of home environment was used. The logit transformation is defined by

$$logit(\hat{q}) = ln\left(\frac{\hat{q}}{1-\hat{q}}\right) = \beta_0 + \beta_1 x_i \ , \tag{8}$$

The original variable, in this case, the estimated propensity score for home environment, $\hat{q}$, was bounded by 0 and 1. After the logit transformation, it was mapped to the real line as a continuous variable ($-\infty \leq \text{logit}(\hat{q}) \leq +\infty$), which allowed the use of REML for model estimation (Noh & Lee, 2007). The logit of the estimated propensity score, $\hat{q}$, was used in the growth model, entered at level 2. The level-1 equations remained the same as in the first two models.

$$\begin{aligned}\pi_{si} = \ & \beta_{s0} + \beta_{s1}(Child\ Gender)_i + \beta_{s2}(Poverty)_i \\ & + \beta_{s3}(PrimaryLanguage)_i + \beta_{s4}(AfrAmer)_i \\ & + \beta_{s5}(Hispanic)_i + \beta_{s6}(Asian)_i + \beta_{s7}(ECE)_i \\ & + \beta_{s8}(logit(q))_i + r_{si}\end{aligned} \tag{9}$$

Research Question 4: What is the effect of early child care environments on the development of children's emergent literacy ability?

Using Rubin's (1978) causal model, the effect of a high-quality early care and education environment on a child was defined as the difference between the growth in

emergent literacy the child would display if in a high-quality environment and the growth if in a low-quality environment. Thus, the average treatment effect on children's emergent literacy growth was estimated as the difference between the average effect of children in high-quality ECE and the average effect of children not in high-quality ECE across strata.

To conduct the propensity score analysis and stratification, I followed the recommendations articulated in Hahs-Vaughn and Onwuegbuzie (2006): (1) define the variables to be used; (2) examine preliminary differences across groups; (3) model the intervention variable as a function of the covariates; (4) create strata based on the propensity scores; and (5) check the balance of the covariates across strata groups.

First, the propensity score was defined by

$$E(X_i) = p(Z = 1|X_i), \quad (10)$$

where each child, *i*, had observed covariates, $\mathbf{X}_i$, and an intervention assignment, *Z*. The pattern of covariates, $\mathbf{X}_i$, was used to predict which treatment a person was most likely to receive. If children who have the same propensity score are matched, then the children in the intervention and control groups will have similar distributions on **X**. Each child *i* might have varying levels across the covariates, but the means and proportions for the covariates are the same across the groups.

The quality of the ECE environment was defined in two different ways: program infrastructure and caregiver interaction. The intervention variable for the ECE environment for structural quality was based on the number of NIEER quality benchmarks a center met. NIEER currently reports on 10 benchmarks: early learning standards, teacher education, teacher specialized training, assistant teacher education,

teacher in-service, class size, caregiver-child ratio, screening and referral services, meals, and quality monitoring (NIEER, 2007). These benchmarks, however, are set for preschool environments. Although there are no proscribed guidelines for early care and education environments for younger children, for the purpose of evaluating ECE environments for 2-year-olds, the NIEER guidelines were modified with the recommendations from the American Academy of Pediatrics (AAP) for quality ECE environments from birth to Kindergarten (Committee on Early Childhood, Adoption, and Dependent Care, 2005). At the time of data collection, not all states had a monitoring or accreditation process for evaluating ECE programs, so this benchmark was eliminated. A composite score was created using 9 of the 10 NIEER benchmarks, with modifications to the benchmarks for class size and child-caregiver ratio based on AAP recommendations. The ECE programs in the present study met an average of 4.5 benchmarks (*SE* = .05) out of 9 possible. In a recent sample of pre-K programs, Mashburn and colleagues (2008) found that an average of 5.8 benchmarks (*SD* = 1.50) were met using the same 9-item NIEER scale. Because these are based on minimum requirements and the benchmarks were originally developed for older children, a more conservative estimate of high-quality ECE was taken here. Thus, any child who attended an early care and education center that met 6 of the 9 benchmarks was considered as having attended a program with a high-quality ECE environment. For the purpose of the propensity score, these children were assigned to the *intervention* group ($Z = 1$); all other children who attended an ECE program that met fewer than 6 benchmarks were in the *comparison* group ($Z = 0$).

The intervention variable for the ECE environment for the nature of caregiver emotional and instructional interaction was based on the caregiver score on the Arnett

Caregiver Sensitivity Scale. For the purpose of estimating the propensity model, a child who attended a program in which the provider had an Arnett score of 2.5 or higher was in the *intervention* group ($Z = 1$); children who attended a program in which the provider had score lower than 2.5 were in the *comparison* group ($Z = 0$).

Children who were not in child care at 2 years were not used to estimate the propensity score model. After the regression coefficients were estimated, the resulting equation was used to calculate the propensity score for all children – both those who attended an ECE program and those who did not – to facilitate matching. This makes clearer the distinction between high-quality and low-quality ECE, rather than confusing the policy or intervention variable with children who did not participate in an ECE at all. It also allowed for a comparison of children who would have attended a high-quality ECE program but did not, because they were not in non-parental care. Because the primary unit of analysis and the focus of the sampling frame for the ECLS-B is the child, the propensity score was modeled to create scores that describe the likelihood that a child attended a high-quality ECE program. Thus, the covariates in the model were based not on the ECE program, but on characteristics of the child and the child's household, including income, region, and urbanicity.

Second, after the propensity score was defined, the preliminary differences between groups were assessed. Before the propensity score was estimated, each child was assigned either to the intervention or to the comparison group. Each of the covariates was compared across the groups using inferential statistics, such as a t-test to compare means or a chi-square to compare frequencies. If an imbalance existed, a decision was made whether to retain the covariate in the propensity analysis based on theoretical reasons.

Both the structural and interaction-based models had the same predictors for the estimation of the propensity model.

Third, each child's assignment to the intervention or comparison group was modeled as the outcome of the covariates with logistic regression,

$$\eta_{i\varphi} = logit(\hat{Q}) = \ln\left(\frac{Q_i}{1-Q_i}\right) = \beta_0 + \beta_1 X_i \ , \quad (11)$$

such that the estimated propensity score, $\hat{Q}$, is a function of the observed covariates, X_i. The estimated propensity score was defined by

$$pr(Z = 1|X_i) = \frac{e^{logit(Q)}}{1+ e^{logit(Q)}} \quad (12)$$

where a child, *i*, is in a high-quality ECE environment ($Z = 1$) with a vector of covariates, X_i.

Fourth, after each child was assigned a propensity score ($\hat{Q}$), the sample was sorted and divided into five equal strata based on the propensity score (Cochran, 1968). There should ideally be the same number of children in the intervention as not in the intervention within each stratum, but this type of balance across groups seldom holds in applied research. In cases of extreme imbalance, researchers decide whether to collapse across strata. Although there was some imbalance across groups within strata in the present analyses, it was not extreme.

Fifth, once the children were stratified based on the propensity score of the ECE environment, the groups were compared to test for balance within strata – a sensitivity analysis to check the model for the effect or bias due to the absence of unobserved covariates (Rosenbaum & Rubin, 1983b). A propensity score can adjust for observed covariates, but cannot account for unobserved or unmeasured covariates which can lead to hidden bias. Sensitivity analysis was used to check whether the propensity scores were

sufficient to control for differences across the groups. For cases in which the bias is too high, it is interpreted to mean that the assignment to intervention groups and the outcome are influenced by unobserved covariates, and thus propensity score analysis should not be used to adjust the analysis. Propensity scores also need to have some overlap between the treatment groups. If most participants who have a high propensity score received the treatment and those who have a low propensity score did not receive the treatment, then propensity score analysis will not work. In order to match or stratify, an analyst must have people in both groups (intervention and comparison) along the continuum of propensity scores. Because of this requirement, propensity scores work best with larger samples, like the ECLS-B. The distributional balance of observed covariates (created by sub-classifying on propensity scores) is an expected balance. The larger the sample size, the more minor these imbalances. In the present analysis, there were no systematic differences in the intervention variable across strata.

A model-based approach was used to estimate the average effect of the intervention of a high-quality ECE environment across the strata on the growth of emergent literacy. In the conditional model at level 2, propensity score stratification categories were combined with covariance adjustment for the logit of the propensity score in order to remove any remaining within-strata bias. This created the level 2 equations,

$$\pi_{si} = \beta_{s0} + \delta_z Z_i + \beta_{s1}(logit(Q))_i + \sum_{R=1}^{4} \beta_{s(R+1)}(stratum(Q))_i + \beta_{s6}(logit(q))_i + \beta_{s7}(ECE)_i + r_{si} \quad (13)$$

where stratum_Q_i, with R = 1 to 4, was a series of dummy variables indicating four of the five ECE-level propensity strata, logit_Q was the child *i*'s estimated logit of propensity to attend a high-quality ECE center, and logit_q was child *i*'s estimated logit of propensity to live in a high-quality home literacy environment. The final model included child characteristics, the home environment, and the strata based on the propensity of a child to receive an intervention of a high-quality early care and education environment at age 2 years. Poverty and race were removed from the level-2 equation because they were included in the propensity score model for ECE environment. Differences across groups for all the strata were taken as evidence that children who are provided with a high-quality ECE environment experience benefits to their emergent literacy development that their peers in lower-quality ECE do not. When groups across all strata are found not to differ, this suggests that differences are probably due to selection bias and not attributable to the intervention. Finally, if treatment group differences vary across strata, it is usually interpreted to mean that selection characteristics interact with the groups. A selection by treatment interaction requires a careful examination of differences between the strata, perhaps suggesting that the effect of the intervention has a differential impact, which has implications for generalization of the results.

RESULTS

The ECLS-B was designed such that it can be used as a representative sample of children born in the United States during 2001. Descriptive statistics for characteristics of the children are in Table 1. ECLS-B is designed to be a representative sample. This means that children were sampled and subsequently weighted in a way that replicates the population of children born in 2001. There were approximately the same number of boys (50.9%) and girls (49.1%) in the sample. Most of the children were white (53.6%), followed by Hispanic (25.4%) and African-American (13.6%). The target ages for the three assessments were 9 months, 2 years, and preschool; the mean ages at time of assessment were 10.4 months, 24.4 months, and 52.5 months, for times 1, 2, and 3, respectively. Half (50.7%) of the children were not in any non-parental care at the time of the second measurement.

Children's environments, both in and out of the home, were critical elements in the design of the present study. Statistics for the children's caregivers and households are in Table 2. The racial and ethnic background of mothers and fathers mirrored that of the children in the sample: most parents were white, followed by Hispanic and African-American. Most of the mothers (83.0%) and fathers (86.6%) had at least a high school education. Most of the fathers (87.0%) worked full-time, but this was not the case for the mothers (34.9%).

English was the primary home language for most children (82.4%). Among those households where it was not the primary language, English was still often spoken in the

home (78.0%). Many children (73.0%) lived in an urban or metropolitan area. Based on those who were classified as living below the poverty threshold, 11.3% were persistently below poverty throughout the study.

Table 1. *Descriptive Statistics for Child Characteristics*

	N	Wt. %	Mean	St. Err.	Range
Child Characteristics					
Gender					
Male	2900	50.9%			
Female	2800	49.1%			
Race					
White	2300	53.6%			
African-American	750	13.6%			
Hispanic	1150	25.4%			
Asian	700	2.7%			
Other	750	4.7%			
Age (in months)					
Time 1			10.45	0.05	6.9 - 22.2
Time 2			24.40	0.03	20.1 - 38.2
Time 3			52.51	0.08	44.0 - 65.3
Early Childcare and Education					
Primary Care Arrangement (Time 2)					
No Non-parental Care	2850	50.7%			
Relative Care	1150	18.4%			
Non-relative Care	800	14.6%			
Center-based Care	950	16.2%			
Age began ECE (in months)			13.70	0.27	0.0 - 60.0

Table 2. *Descriptive Statistics for Parent / Caregiver and Household Characteristics*

	Mother		Father	
	N	Wt. %	*N*	Wt. %
Primary Caregiver Characteristics				
Race				
White	2550	57.1%	2350	51.1%
African-American	800	13.7%	400	6.6%
Hispanic	1000	22.9%	800	18.9%
Asian	850	3.2%	750	2.8%
Other	500	3.1%	1400	20.6%
Education (at Time 2)				
Less than High School	900	17.1%	700	13.4%
High School or equivalent	1650	31.5%	1200	22.3%
More than High School	3150	51.5%	3800	64.3%
Employment (at Time 2)				
Work 35 hours or more per week	2100	34.9%	3900	87.0%
Work less than 35 hours per week	1050	20.0%	250	5.9%
Not in the labor force	2550	35.1%	400	7.0%
Household Characteristics				
Primary Home Language				
English	4550	82.4%		
Non-English language	1150	17.6%		
~ English is also spoken in the home	1050	78.0%		
Poverty Status				
Above Poverty	5050	88.7%		
Below Poverty Threshold	650	11.3%		
Region				
Northeast	800	16.7%		
Midwest	1350	22.3%		
South	1950	36.6%		
West	1600	24.4%		
Urbanicity				
Urban / Metropolitan	4050	73.0%		
Suburban	750	12.1%		
Rural	900	14.9%		

For the children who had some form of non-parental care (n = 2900), the descriptive statistics for their early care and education environments are in Table 3. Of the early care and education environments that were assessed at the second measurement occasion, most of the programs med recommendations for class size (91.1%) and child-caregiver ratio (84.2%). The benchmarks met by the fewest number of programs were teacher education (8.7%) and specialized training in early education (15.8%).

Table 3. *Descriptive Statistics for Early Childcare and Education Environments*

	N	Wt. %	Mean	St. Err.	Range
Early Care and Education Characteristics					
Quality of Overall Environment					
ITERS Overall Score			4.31	0.06	1.8 - 6.6
FDCRS Overall Score			3.44	0.05	1.2 - 6.5
ECEP Arnett average (out of 3)			2.37	0.01	0.3 - 3.0
Average Group Size			5.59	0.35	8 - 78
Child-Caregiver Ratio			3.48	0.08	.3 - 12.9
NIEER Benchmarks					
Teacher has BA or higher	250	8.7%			
Teacher has ECE training or CDA	800	15.8%			
Center uses Learning Standards	400	15.8%			
Class size 10 or fewer	2450	91.1%			
Child-Caregiver Ratio 1:5	2250	84.2%			
Program serves meals	1750	65.5%			
Program provides health screening	1850	68.1%			
Program offers family services	600	21.7%			
ECEP has 15+ hours of in-service	1050	40.4%			

Emergent Literacy: Principal Components Analysis

Principal component analysis (PCA) was used to define the construct *emergent literacy* at each of the three measurement occasions. One component was retained to describe emergent literacy at each of the three measurement occasions. Because the construct is emergent in nature, the assessments used to measure the different aspects of children's emergent literacy change across time. For example, emergent literacy at 2 years was assessed with a general measure of mental and motor ability (BSF-R), a shortened version of a parental report of child's vocabulary (MCDI), and by parental report of child's book related behavior. In contrast, the assessment at 9 months did not include a parental report of child's vocabulary, because most children are either not talking or have limited vocabularies.

Components were extracted using SAS PROC FACTOR. The component matrix and score matrix used to calculate the component scores at each time are in Table 4. The table also includes the descriptive statistics for both the observed variables and the component scores. The variance explained by the emergent literacy component scores decreases over time. This may be an indication that although emergent literacy is often discussed as a single construct, the nature of the construct changes as a child develops. That is, for the youngest children emergent literacy looks similar across different tasks, but as children grow older and become more proficient with language these skills become more differentiated and distinct. This is also indicated in the associations between the components and the individual observed variables, in Table 5. There are stronger associations between the component at 2 years and preschool than at 9 months and preschool. Among the observed variables, the lowest associations are between the

cognitively based language skills at preschool and the physical exploration of literacy materials (defined as the age at which the child began to turn the pages of a book).

Table 4. *Principal Components Analysis for Emergent Literacy at all Measurement Occasions*

N = 5700	Eigenvalues	% Variance	Mean	Std. Error	Range
Emergent Literacy Component					
Emergent Literacy at 9-months	1.73	57.6%	0.0388	0.0289	-3.0780 - 4.4594
Emergent Literacy at 2-years	1.73	43.3%	0.0254	0.0226	-3.4479 - 5.0843
Emergent Literacy at Preschool	1.58	39.4%	-0.0380	0.0210	-3.6500 - 3.8480
					Indicator
	Component Matrix	Component Scores	Mean	Std. Error	Range
Indicators at 9-months					
BSF-R Mental T-Score	0.917	0.531	50.50	0.25	0.79 - 99.16
BSF-R Motor T-Score	0.904	0.523	50.38	0.24	6.99 - 83.86
NCATS Total Score	0.264	0.153	50.17	0.10	23.00 - 70.00
Indicators at 2-years					
BSF-R Mental T-Score	0.846	0.489	50.41	0.23	15.79 - 88.81
BSF-R Motor T-Score	0.657	0.379	50.31	0.26	2.91 - 97.36
Parental Report of Vocabulary	0.731	0.422	33.51	0.24	0.00 - 54.00
Age Child Turned Pages of Book	-0.221	-0.128	13.68	0.09	3.00 - 28.00
Indicators at Preschool					
Literacy Theta	0.759	0.482	0.74	0.01	0.00 - 3.16
Language Theta	0.537	0.340	0.70	0.01	0.00 - 2.34
Math Theta	0.767	0.487	0.74	0.02	0.00 - 3.09
Copying Forms task	0.352	0.223	3.38	0.03	0.00 - 7.00

Table 5. *Correlations of Emergent Literacy Components and Observed Variables*

	N = 5700	C1	C2								
	Emergent Literacy Components										
C1	Emergent Literacy at 9-months	-									
C2	Emergent Literacy at 2-years	0.21	-								
C3	Emergent Literacy at Preschool	0.12	0.32	-							
		1	2	3	4	5	6	7	8	9	10
	Indicators at 9-months										
1	BSF-R Mental T-Score	-									
2	BSF-R Motor T-Score	0.71	-								
3	NCATS Total Score	0.15	0.06	-							
	Indicators at 2-years										
4	BSF-R Mental T-Score	0.18	0.11	0.19	-						
5	BSF-R Motor T-Score	0.11	0.12	0.09	0.41	-					
6	Parental Report of Vocabulary	0.15	0.11	0.09	0.48	0.20	-				
7	Age Child Turned Pages of Book	-0.05	-0.04	0.02	-0.06	-0.03	-0.10	-			
	Indicators at Preschool										
8	Literacy Theta	0.05	0.04	0.06	0.15	0.04	0.11	-0.02	-		
9	Language Theta	0.03	0.01	0.07	0.20	0.05	0.13	0.00	0.16	-	
10	Math Theta	0.02	0.01	0.03	0.15	0.05	0.09	-0.04	0.33	0.18	-
11	Copying Forms task	0.08	0.05	0.08	0.20	0.08	0.13	-0.01	0.16	0.12	0.18

Propensity Score Analyses for Early Environments

The answers to the third and fourth questions, regarding the effect that different types of environments have on children's emergent literacy development, involve the balancing of two groups for each environment on known pretreatment covariates. The groups were balanced based on propensity score models. Propensity scores were modeled based on three different intervention or "environmental quality" variables: home literacy environment, high-quality early care and education environment based on program infrastructure, and high-quality early care and education environment based on the quality of caregiver interaction. The distributions and descriptive statistics for the variables from which they were derived are in Table 6.

Table 6. *Variables for Home Literacy Environment and High-Quality ECE Environment*

	N	Wt. %	Mean	St. Err.	Range
Home Literacy Environment					
High-Quality Environment = Yes	2550	45.1%			
High-Quality Environment = No	3200	54.9%			
Read books with child (days/week)			5.37	0.05	0 - 7
# of Children's Books in Home			48.66.	1.30	0 - 200
ECE Environment					
Program infrastructure					
High-Quality ECE Environment = Yes	950	35.1%			
High-Quality ECE Environment = No	1750	64.9%			
Number of Benchmarks (out of 9)			4.47	0.05	1 - 9
Quality of ECEP Interactions					
High-Quality ECE Environment = Yes	800	43.4%			
High-Quality ECE Environment = No	1050	56.6%			
Arnett Caregiver Sensitivity Score			61.32	0.35	8 - 78

Table 7. *Coefficients and Descriptive Statistics for Indicators of a High Quality Home Literacy Environment*

	Propensity Coefficient	High Quality HLE Environment = Yes		High Quality HLE Environment = No	
		Wt. Mean	Std. Error	Wt. Mean	Std. Error
Mother's age at child's birth	-0.004	28.48	0.15	26.15	0.13
Parental English Fluency	0.084	2.56	0.02	2.25	0.02
Parental Depression (CES-D)	0.087	1.50	0.01	1.55	0.01
Number of Children in Household	-0.137	2.03	0.03	1.28	0.02
Household Income (2-yr) - in $1000	0.005	62.05	0.94	38.47	0.66
Household Food Security (2-yr)	-0.014	2.83	0.04	2.94	0.04
Family eats dinner together (days/week)	0.030	6.10	0.04	5.89	0.04
Times Household has moved	0.006	0.37	0.02	0.46	0.02
Number of Books Read by Parent	0.010	20.68	0.62	11.44	0.36
Read Books to Child (9-months)	0.221	5.35	0.05	4.06	0.05
Tell Stories to Child (9-months)	0.029	4.78	0.06	4.08	0.05
Sing Songs with Child (9-months)	0.088	6.41	0.04	5.96	0.04
		N	Wt. %	N	Wt. %
Parent's Education: High School or higher	0.191	1400	42.6%	2650	34.4%
Household has Investments (9-mo)	0.330	1500	27.0%	900	14.3%
Household has Investments (2-yr)	0.410	1500	26.7%	900	13.6%
Child has Health Insurance (9-mo)	0.351	2500	44.0%	3050	51.7%
Caregivers Married or Coupled	0.176	2350	42.2%	2750	47.2%
Mother's race: African-American	-1.142	150	2.9%	600	10.8%
Mother's race: Hispanic	-1.101	250	4.7%	800	18.2%
Mother's race: Asian	-0.846	400	1.4%	500	1.9%
Parent has Library Card	0.660	1900	32.9%	1750	29.3%
Parent takes Child to Story Hour	0.402	500	8.3%	250	3.5%

Note: High-Quality HLE Environment - Yes n = 2550, No n = 3200; Intercept for model = -3.422

For the home literacy environment, 20 covariates were included in the propensity score model. These covariates were household and caregiver characteristics, such as parental education and shared reading at 9 months. These variables were entered into a logistic regression model, the outcome of which was the logit of the propensity score for home literacy environment (Table 7). The sample of children was divided into five strata

on the basis of the logit of the propensity score. The balance of the propensity scores across the strata by the home literacy environment is in Table 8. As commonly seen in propensity score analysis, the middle strata are more evenly distributed in number, but the numbers in stratum 1 (the lowest) and stratum 5 (the highest) are sufficiently large for examining the influence of a high quality home literacy environment. Of more concern is that there are significant differences across groups in the propensity scores themselves. In each of the strata the intervention group is significantly different from the comparison, with the higher propensity scores associated with the high-quality home literacy environment across all five strata. This imbalance, however, is of less concern, because the main focus of the home literacy environment is as a control in the growth model.

Table 8. *Propensity Scores for Home Literacy Environment (HLE) by Strata*

	Hi-Quality Environment = Yes			Hi-Quality Environment = No			
Strata	N	Mean	SD	N	Mean	SD	p-value
Stratum 1	150	0.1173	0.0399	1000	0.1031	0.0425	<0.001
Stratum 2	300	0.2649	0.0492	850	0.2522	0.0495	<0.001
Stratum 3	500	0.4476	0.0529	650	0.4293	0.0539	<0.001
Stratum 4	650	0.6274	0.0532	500	0.6146	0.0535	<0.001
Stratum 5	950	0.8202	0.0642	200	0.7945	0.0528	<0.001

The effect of the home literacy environment on the outcome variable of interest was also examined. There were differences in the emergent literacy score at preschool between the home literacy groups (Table 9). Children who lived in a home in which they were read to daily and had access to more than 10 children's books had a higher emergent literacy then children who did not, $t(5700) = 18.04$, $p < .001$. The range of scores for each

group had sufficient overlap that both groups were represented across the five strata. There is a significant difference between the intervention and comparison groups for 4 of the 5 strata in emergent literacy ability at preschool. In each case, the children in a high-quality home literacy environment had higher emergent literacy component scores.

Table 9. *Emergent Literacy at Preschool by HLE Strata*

	Hi-Quality Environment = Yes			Hi-Quality Environment = No			
Strata	N	Mean	SD	N	Mean	SD	p-value
Stratum 1	150	-0.3570	0.0759	1000	-0.4480	0.0310	0.303
Stratum 2	300	-0.0790	0.0596	850	-0.2310	0.0318	0.019
Stratum 3	500	0.1073	0.0416	650	-0.1200	0.0381	<0.001
Stratum 4	650	0.3249	0.0360	500	0.0582	0.0406	<0.001
Stratum 5	950	0.4948	0.0313	200	0.1651	0.0638	<0.001
Overall	2550	0.212	0.019	3200	-0.243	0.011	< 0.001

For the ECE environment, 9 covariates were included in the propensity score model. These covariates were characteristics of the household, such as region and urbanicity, that predicted a child would receive care from a high-quality early care and education program. Logistic regression was used to model the policy variable, the number of NIEER benchmarks achieved by the ECE program (out of 9), which was used as an indicator of a high-quality ECE environment. The model was estimated with data from only the children in the sample who participated in non-parental care at 2 years (n = 2700). The coefficients for the model are in Table 10.

These cases were sorted and grouped into five strata based on the logit of the propensity score for ECE based on the NIEER benchmarks. The balance of the propensity scores was checked across all strata, as shown in Table 11. Using the equation

from the logistic model, a propensity score for attending a high-quality ECE program was calculated for children who had not attended early care at 2 years. These cases were also ranked and stratified for further analysis.

Table 10. *Coefficients for High Quality Early Care and Education Environment by Structural (NIEER) and Process (Arnett) Indicators*

	Program Infrastructure (NIEER)	Caregiver Sensitivity (Arnett)
	Coefficient	Coefficient
Intercept	-1.113	-1.446
Read book with Child (2 yrs)	0.104	0.084
SES level	0.281	0.177
Neighborhood Safety Rating	0.090	0.202
Food Insecurity	-0.208	-0.112
Region: Midwest	-0.068	-0.146
Region: South	-0.180	0.216
Region: West	-0.122	0.047
Urban	0.064	-0.063
Rural	0.009	0.104
Mother Employed	0.131	-0.009
Father Employed	-0.577	-0.089
Two Parents / Guardians	0.016	0.055

Although the lowest strata had an imbalance across groups, indicating that children from low-SES homes are less likely to attend a high-quality ECE program, the overall sample size produced groups (high-quality vs. low-quality) that were sufficiently large across all five strata to proceed with the analysis of the effect of an ECE policy on the development of children's emergent literacy.

Emergent literacy at preschool was also examined across groups in each stratum. There was no difference between the groups in any of the strata for emergent literacy (see Table 12).

Table 11. *Propensity Scores for High Quality Early Care and Education Environment by Strata (based on NIEER benchmarks)*

	Hi-Quality Environment = Yes			Hi-Quality Environment = No			
Strata	N	Mean	SD	N	Mean	SD	p-value
Stratum 1	150	0.2556	0.0257	350	0.2487	0.0269	0.011
Stratum 2	150	0.3062	0.0121	350	0.3078	0.0111	0.168
Stratum 3	200	0.3473	0.0105	300	0.3452	0.0105	0.023
Stratum 4	200	0.3842	0.0118	350	0.3842	0.0114	0.963
Stratum 5	300	0.4586	0.0422	350	0.4582	0.0359	0.176

Table 12. *Emergent Literacy at Preschool by ECE-NIEER Strata*

	Hi-Quality Environment = Yes			Hi-Quality Environment = No			
Strata	N	Mean	SD	N	Mean	SD	p-value
Stratum 1	150	-0.286	0.944	350	-0.243	0.967	0.660
Stratum 2	150	-0.298	0.904	350	-0.193	0.991	0.269
Stratum 3	200	0.060	0.093	300	0.005	0.889	0.499
Stratum 4	200	0.185	0.887	350	0.182	0.893	0.970
Stratum 5	300	0.463	1.005	350	0.414	1.025	0.552
Overall	950	0.062	0.031	1750	-0.009	0.023	0.071

Following Mashburn and colleagues (2008), in addition to the structural markers of quality, another approach was used to assess the quality of ECE programs – caregiver sensitivity and interaction. A high-quality ECE program was defined as those in which

the early care and education provider (ECEP) scored a 2.5 or higher (out of 3) for the averaged score of the Arnett Caregiver Sensitivity Index (Arnett, 1989). Following the same procedures as outlined above, the policy group (high-quality ECE = 1) was modeled with logistic regression using the same covariates as were used in the propensity model for the high-quality ECE program as defined by NIEER benchmarks. By adding this approach, the present study could examine differences that may arise from how the construct of "quality" is defined: structural benchmarks versus caregiver interaction in the classroom. The propensity scores were balanced across all five strata (Table 13). Additionally, there were no differences between groups across strata for emergent literacy at preschool, as seen in Table 14, but there was a difference in the component scores overall.

Table 13. *Propensity Scores for High Quality Early Care and Education Environment by Strata (based on Arnett Caregiver Sensitivity)*

	Hi-Quality Environment = Yes			Hi-Quality Environment = No			
Strata	N	Mean	SD	N	Mean	SD	p-value
Stratum 1	100	0.3316	0.0331	250	0.3286	0.0333	0.419
Stratum 2	150	0.3929	0.0143	250	0.3940	0.0140	0.498
Stratum 3	150	0.4359	0.0115	200	0.4360	0.0119	0.941
Stratum 4	150	0.4728	0.0111	200	0.4736	0.0112	0.465
Stratum 5	200	0.5300	0.0254	200	0.5295	0.0268	0.846

Table 14. *Emergent Literacy at Preschool by ECE-Arnett Strata*

	Hi-Quality Environment = Yes			Hi-Quality Environment = No			
Strata	N	Mean	SD	N	Mean	SD	p-value
Stratum 1	100	-0.2430	0.9835	250	-0.0294	0.9686	0.647
Stratum 2	150	0.0546	0.8359	250	-0.0740	0.9367	0.187
Stratum 3	150	0.0298	0.9988	200	0.0807	0.8979	0.602
Stratum 4	150	0.2438	1.0181	200	0.2200	0.9622	0.822
Stratum 5	200	0.3133	0.9479	200	0.3042	0.9924	0.927
Overall	800	0.109	0.033	1050	-0.014	0.028	0.005

Growth Trajectories in Emergent Literacy

To examine the growth of children's emergent literacy over the first several years of life, a two-level hierarchical linear model was estimated using restricted maximum likelihood estimation (REML). Although individual growth curves were estimated for each individual child, the main focus of the current analysis was the grouped growth curves. Sample weights were applied to the level of the child, level 2, for all growth models. Because a weight was applied at only one level, HLM assumes the weight is inversely proportional to the marginal probability that child *i* has been selected for the sample. The weight is normalized such that the mean is 1.0.

First, the unconditional growth model was estimated, with the only predictor in the model being the level-1 predictor Age. The intra-class coefficient for the unconditional means model was .21, which indicated that there is variability of interest at level 2. This is usually not surprising in growth models because level 2 is the level of the person. The addition of child's age at level 1 revealed a conditional variance, where 9% of the variance in emergent literacy is explained by a child's age. A representation of

overall growth is in Figure 4. The bold line is the average growth, which indicates a general positive linear trend. Also presented are instances of individual trajectories and the range of emergent literacy ability at the three measurement occasions.

Child characteristics and growth trajectories in emergent literacy

A two-level conditional growth model was estimated. The model included the intercept and the growth slope at level 1 and explanatory variables at level 2. For the first growth model, child characteristics were used to explain differences in initial status and growth in emergent literacy. In the full model, poverty status, home language, child race, child gender, and exposure to early care and education contexts were entered for both the intercept and the slope. The log-transformed ECE exposure variable was grand-mean centered. Fixed and random effects were estimated and are presented in Table 15.

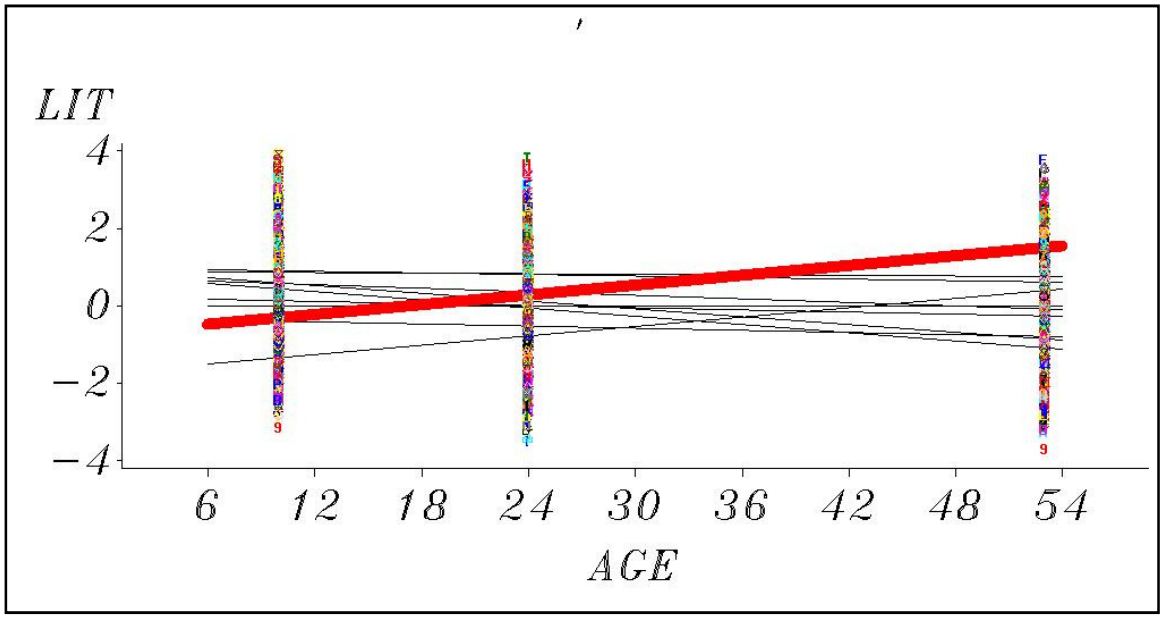

Figure 4. Overall growth in emergent literacy

In the final model, primary language spoken in the home, child gender, and exposure to ECE were kept in the level 2 equation for the intercept (π_0); poverty and child race were kept in the level 2 equation for the slope (π_1). The results suggest that a child who is

Table 15. *Fixed and Random Effects for Growth in Emergent Literacy by Child Characteristics*

	Full Model			Final Model		
Fixed Effects	Coefficient	St. Err.	p-value	Coefficient	St. Err.	p-value
For intercept (π 0i)						
Intercept (β 00)	-0.023	0.026	0.374	-0.048	0.020	0.015
Poverty (β 01)	-0.084	0.053	0.113			
Non-English Home Language (β 02)	-0.216	0.052	< 0.001	-0.221	0.032	< 0.001
Child Race - Black (β 03)	0.029	0.046	0.519			
Child Race - Hispanic (β 04)	-0.046	0.047	0.324			
Child Race - Asian (β 05)	-0.011	0.063	0.864			
Child Gender - male (β 06)	0.158	0.031	< 0.001	0.175	0.022	< 0.001
ECE Exposure (β 07)				0.013	0.003	< 0.001
For slope Age (π 1i)						
Intercept (β 10)	0.003	0.001	< 0.001	0.004	0.001	< 0.001
Poverty (β 11)	-0.006	0.002	< 0.001	-0.007	0.001	< 0.001
Non-English Home Language (β 12)	0.001	0.002	0.699			
Child Race - Black (β 13)	-0.010	0.001	< 0.001	-0.009	0.001	< 0.001
Child Race - Hispanic (β 14)	-0.005	0.001	0.001	-0.006	0.001	< 0.001
Child Race - Asian (β 15)	0.004	0.002	0.013	0.005	0.001	< 0.001
Child Gender - male (β 16)	0.001	0.001	0.450			
ECE Exposure (β 17)						
Random Effects		Variance	p-value		Variance	p-value
Intercept, r0		0.1866	< 0.001		0.1843	< 0.001
Age slope, r1		0.0001	0.052		0.0001	0.050
Level 1, e		0.7787			0.7788	
Deviance	47561.8			47505.3		

reared in a home in which English is not the primary language begins at a lower level of emergent literacy skill. The growth in the emergent literacy for a child who is living in a household that is below the poverty level occurs at a slower rate than a child in a

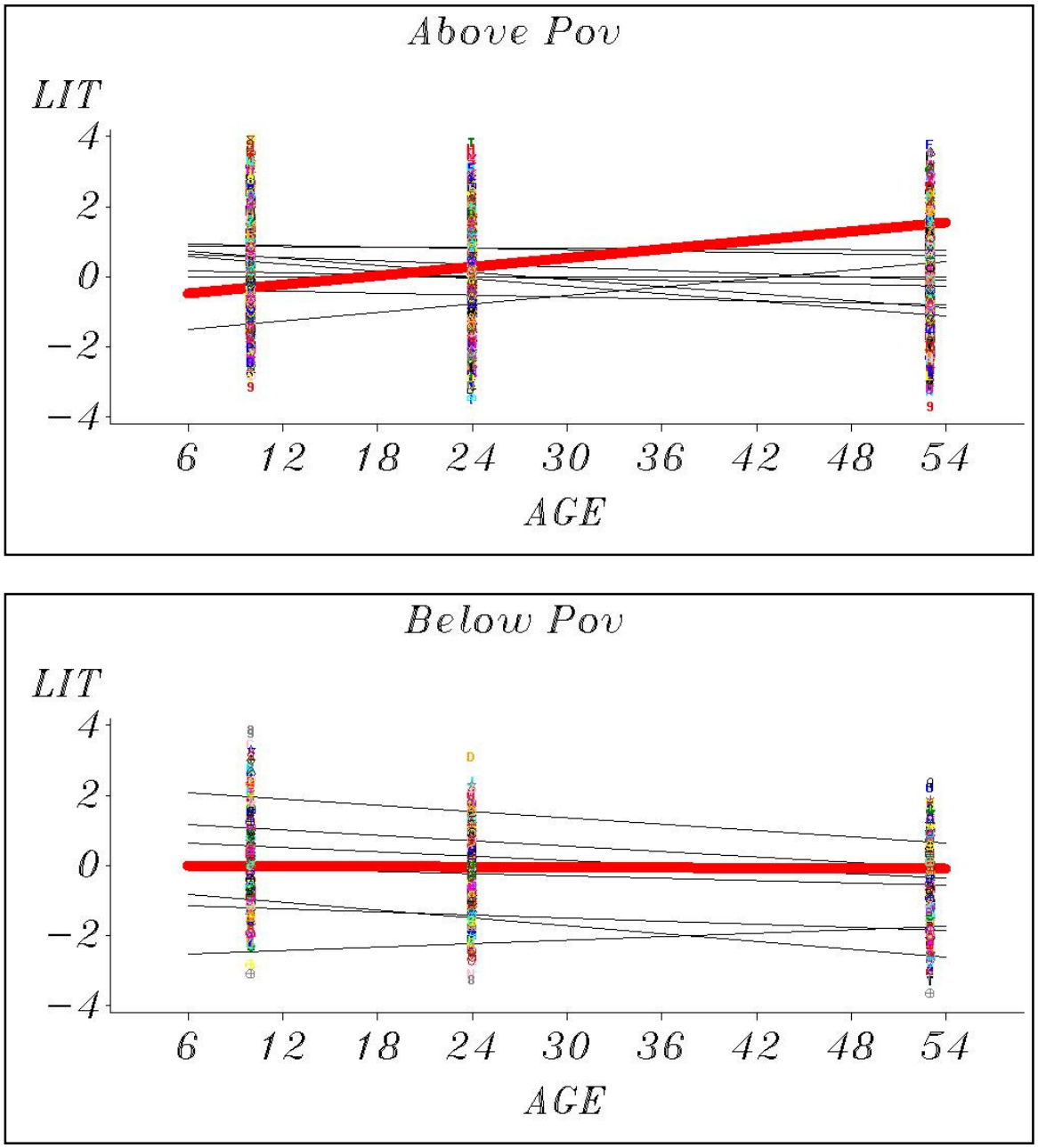

Figure 5. Growth trajectories for emergent literacy by poverty status

household above the poverty threshold. The difference in the relationship between children who are living either above or below the poverty level is depicted in Figure 5. The figure also shows that the overall pattern of growth for children living below poverty is flat, there is greater variability in the individuals in this group when compared to children living at or above poverty.

Effect of home literacy environment on growth of emergent literacy

The base growth models used to estimate effects of environments were the same as the final model for child characteristics (see Table 15). The model used to test effects of a high-quality home literacy environment was specified as follows, with the level-1 model the same throughout all models (see Equation 1),

$$\begin{aligned}\pi_{0i} = {} & \beta_{00} + \beta_{01}(PrimaryLanguage) + \beta_{02}(ChildSex) \\ & + \beta_{03}(ECE\ Exposure) + \beta_{04}(HomeLitEnv) \\ & + \beta_{05}(stratum\ q2) + \beta_{06}(stratum\ q3) \\ & + \beta_{07}(stratum\ q4) + \beta_{08}(stratum\ q5) \\ & + \beta_{09}(logit(q)) + r_{0i} \\ \pi_{1i} = {} & \beta_{10} + \beta_{11}(Poverty) + \beta_{12}(AfrAmer) + \beta_{13}(Hispanic) \\ & + \beta_{14}(Asian) + \beta_{15}(HomeLitEnv) \\ & + \beta_{16}(stratum\ q2) + \beta_{17}(stratum\ q3) \\ & + \beta_{18}(stratum\ q4) + \beta_{19}(stratum\ q5) \\ & + \beta_{110}(logit(q)) + r_{1i}\end{aligned} \tag{14}$$

where β_{16} - β_{19} is the quintile gap in the growth rate (e.g., the difference in the growth rate of emergent literacy between children in quintile 5 and the reference group, quintile 1). The error terms are r_{0i} and r_{1i}, where $r_{0i} \sim N(0, \tau_{00})$ and $r_{1i} \sim N(0, \tau_{11})$, representing the variance of the intercept and of the rate of change, respectively.

Table 16. *Fixed and Random Effects for the Effect of High Quality Home Literacy Environment on Emergent Literacy Growth*

	Full Model			Final Model		
Fixed Effects	Coefficient	St. Err.	p-value	Coefficient	St. Err.	p-value
For intercept (π 0i)						
Intercept (β 00)	-0.095	0.082	0.248	-0.071	0.019	0.001
Home Language (β 01)	-0.110	0.034	0.002	-0.070	0.031	0.026
Child Gender - male (β 02)	0.158	0.021	< 0.001	0.162	0.022	< 0.001
ECE Exposure (β 03)	0.014	0.003	< 0.001	0.014	0.003	< 0.001
Policy - Home Literacy Env (β 04)	0.105	0.036	0.004			
HLE Stratum 2 (β 05)	-0.002	0.064	0.973			
HLE Stratum 3 (β 06)	0.061	0.091	0.502			
HLE Stratum 4 (β 07)	-0.079	0.115	0.491			
HLE Stratum 5 (β 08)	-0.043	0.153	0.781			
Logit of Home Literacy Env. (β 09)	0.045	0.037	0.228	0.060	0.011	< 0.001
For slope Age (π 1i)						
Intercept (β 10)	-0.003	0.003	0.265	-0.005	0.001	< 0.001
Poverty (β 11)	-0.003	0.001	0.005	-0.004	0.001	0.001
Child Race - Black (β 12)	-0.001	0.001	0.226			
Child Race - Hispanic (β 13)	0.001	0.001	0.162			
Child Race - Asian (β 14)	0.008	0.001	< 0.001			
Policy - Home Literacy Env (β 15)	0.002	0.001	0.045	0.005	0.001	< 0.001
HLE Stratum 2 (β 16)	0.001	0.002	0.604	0.002	0.001	0.024
HLE Stratum 3 (β 17)	0.000	0.003	0.917	0.003	0.001	0.004
HLE Stratum 4 (β 18)	0.004	0.003	0.227	0.006	0.001	< 0.001
HLE Stratum 5 (β 19)	0.006	0.005	0.158	0.010	0.001	< 0.001
Logit of Home Literacy Env. (β 110)	0.002	0.001	0.168			

Random Effects		Variance	p-value		Variance	p-value
Intercept, r0		0.1873	< 0.001		0.1880	< 0.001
Age slope, r1		0.0001	0.108		0.0001	0.070
Level 1, e		0.7708			0.7731	
Deviance	47181.8			47169.7		

The model estimates for the full and final models for the effects of home literacy environment are shown in Table 16. Even when controlling for child characteristics and an additional adjustment for the logit of the propensity score (*logit_q*, the logit of a child's propensity to be reared in a high-quality home literacy environment), there was an effect of the home environment on both the initial status and the growth rate for emergent literacy.

Effect of early care and education environments on growth of emergent literacy

Because there are different ways to measure the quality of early care and education environments, two measures of ECE quality were assessed: indicators of infrastructure and indicators for caregiver interaction. These were modeled separately to examine the effect of a high-quality ECE environment. Both of the initial equations (full model) were the same,

$$\begin{aligned}\pi_{0i} = {} & \beta_{00} + \beta_{01}\big(logit(q)\big) + \beta_{02}(Child\ InECE) \\ & + \beta_{03}(HiQualityECE) + \beta_{04}(stratumQ2) \\ & + \beta_{05}(stratumQ3) + \beta_{06}(stratumQ4) \\ & + \beta_{07}(stratumQ5) + \beta_{08}(logit(Q)) + r_{0i}\end{aligned} \tag{15}$$

$$\begin{aligned}\pi_{1i} = {} & \beta_{10} + \beta_{11}\big(logit(q)\big) + \beta_{12}(Child\ InECE) \\ & + \beta_{13}(HiQualityECE) + \beta_{14}(stratumQ2) \\ & + \beta_{15}(stratumQ3) + \beta_{16}(stratumQ4) \\ & + \beta_{17}(stratumQ5) + \beta_{18}(logit(Q)) + r_{1i}\end{aligned}$$

Where β_{00} is the average initial status for emergent literacy, β_{10} is the average growth rate for emergent literacy, and $\beta_{04} - \beta_{07}$ and β_{14}- β_{17} are the quintile gaps for initial status and growth, respectively. For example, β_{17} represents the difference in the growth slope for emergent literacy between children in the first (reference) quintile and the fifth (highest)

quintile. The models also include the logit of the home literacy environment. As demonstrated above, the quality of the home environment has an effect on children's emergent literacy, and the purpose of the model stipulated in Equation 15 is to assess the effect of high-quality ECE environments above and beyond that of the home environment.

The model included an additional variable to indicate whether or not a child attended non-parental care: 50.7% of children were not in an ECE program at Time 2, the time for which the intervention variable was modeled. This variable helped to assess the counterfactual case – what would have happened *if* a child who did not attend ECE had attended one of high-quality. The comparison of the overall patterns of growth in emergent literacy between children who did and did not attend an ECE program is graphically represented in Figure 6. Household characteristics that had been included in growth models for research questions 1 and 2, such as SES, were used as covariates to estimate the ECE propensity scores. Thus, the growth models to assess the effects of the ECE environment included the ECE strata and exposure to child care; the inclusion of household-level variables would have been redundant.

The first model of the effect of high-quality ECE is based on the structural aspects of quality, from the NIEER benchmarks. The fixed and random effects for both the full and final models are in Table 17. In the final model, the effect of a high-quality ECE environment is mixed. There is a difference in the growth rates for children who attended an ECE program, with a slight increase in slope for children in a program compared to those who were not. Each of the coefficients for ECE strata is negative, indicating a decrease in the slope of the growth rate, which suggests that for these children emergent

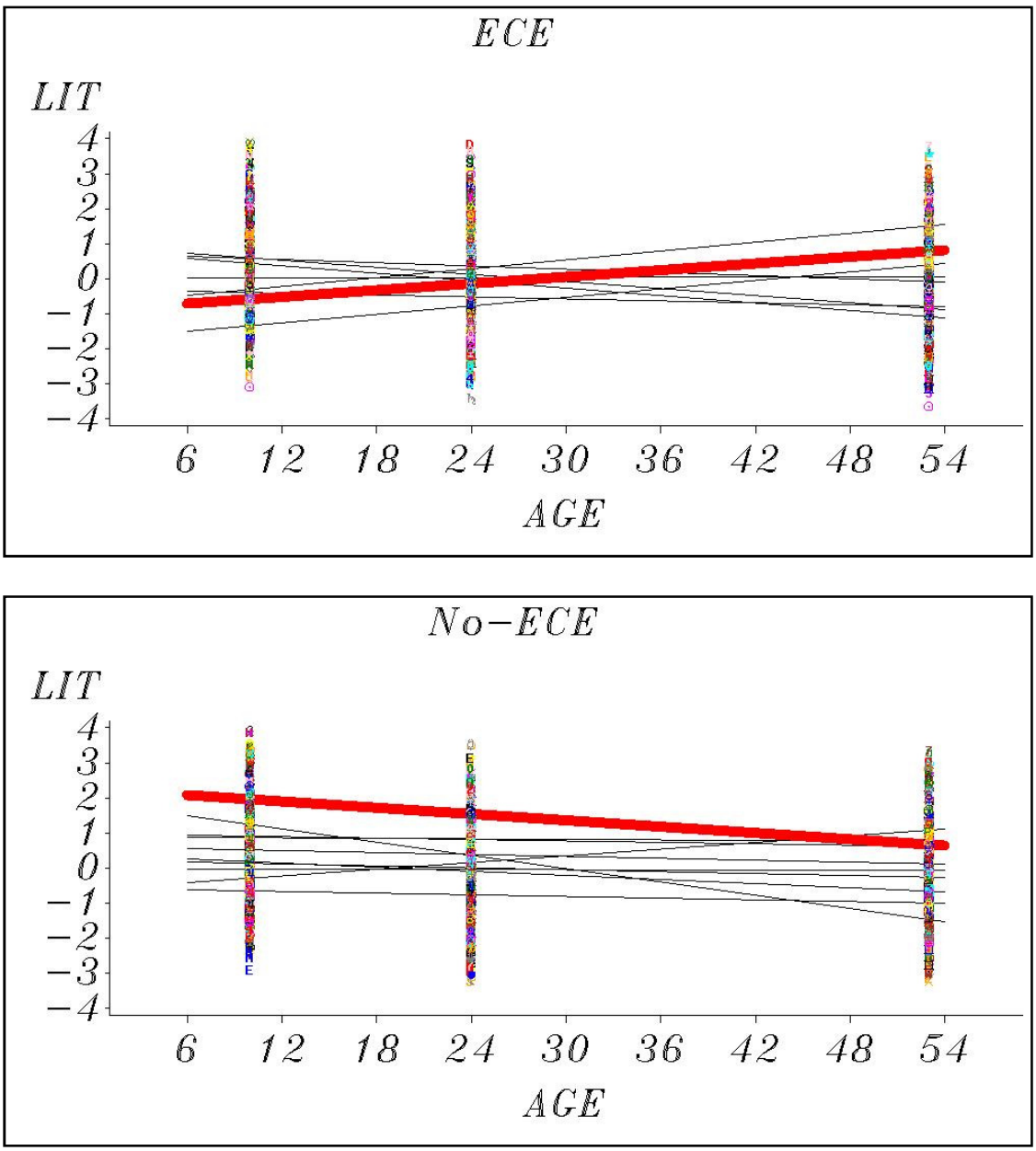

Figure 6. Growth trajectories in emergent literacy by child care and education status

literacy is slowed (i.e., a less steep slope). Only the two highest strata, however, indicated a difference from the reference group (stratum 1). There is also no overall effect of high-quality ECE (β_{03} and β_{13}). This suggests that there may be a selection by treatment effect

for the influence of high-quality ECE on emergent literacy. Children in the lower strata are more likely to live in the South or West, have some issues with food insecurity, and live in a single-parent household. The combination of these results – the lower strata are not significant and the description of these lower strata – suggests that the effect of ECE environment (based upon NIEER criteria) does not have an effect on children from single-parent households with food insecurity. Further investigation is necessary to tease apart whether and how these factors could be remediated through early care environments.

The second model of high-quality ECE is based on quality in the classroom environment due to caregiver interaction, the sensitivity of the caregiver with the children as assessed with the Arnett Caregiver Sensitivity Index. High propensity scores are associated with the likelihood that a child would attend an ECE program in which the caregiver was highly interactive and sensitive to the child's needs. The fixed and random effects for both the full and final models are in Table 18. The home environment still exerts an influence on both the initial status and the growth rate. In this model, the effect of a child's participation in a high-quality ECE program positive and statistically significant for all strata. This result suggests that children in ECE programs with highly sensitive caregivers experience a higher rate of growth in emergent literacy than children not in such programs. Children in any ECE program have a lower rate of growth than children not in such programs (β_{12}), indicated by a negative coefficient for the slope. Children in ECE, however, begin at a higher initial status for emergent literacy (β_{02}) than their counterparts not in early care.

Table 17. *Fixed and Random Effects for the Effect of High Quality ECE Environment on Emergent Literacy Growth (NIEER benchmarks)*

	Full Model			Final Model		
Fixed Effects	Coefficient	St. Err.	p-value	Coefficien	St. Err.	p-value
For intercept (π 0i)						
Intercept (β 00)	-0.075	0.119	0.527	-0.071	0.019	< 0.001
Home Language (β 01)	-0.054	0.049	0.269	-0.077	0.031	0.013
Child Gender - male (β 02)	0.165	0.031	< 0.001	0.166	0.022	< 0.001
ECE Exposure (β 03)	0.015	0.006	0.013	0.012	0.003	< 0.001
Logit of Home Literacy Env. (β 04)	0.039	0.018	0.028	0.054	0.011	< 0.001
ECE Environment - NIEER (β 05)	0.044	0.047	0.352			
ECE - NIEER Stratum 2 (β 06)	-0.004	0.092	0.967			
ECE - NIEER Stratum 3 (β 07)	0.043	0.121	0.721			
ECE - NIEER Stratum 4 (β 08)	0.048	0.153	0.754			
ECE - NIEER Stratum 5 (β 09)	0.110	0.210	0.600			
Logit of ECE Environ - NIEER (β 010)	0.080	0.215	0.708			
For slope Age (π 1i)						
Intercept (β 10)	0.005	0.004	0.132	0.000	0.001	0.620
Poverty (β 11)	-0.006	0.002	0.001	-0.004	0.001	0.001
Logit of Home Literacy Env. (β 12)	0.003	0.001	< 0.001	0.003	0.000	< 0.001
ECE Environment - NIEER (β 13)	-0.002	0.001	0.257	-0.001	0.001	0.431
ECE - NIEER Stratum 2 (β 14)	-0.005	0.003	0.087	-0.001	0.001	0.149
ECE - NIEER Stratum 3 (β 15)	-0.003	0.004	0.452	0.001	0.001	0.292
ECE - NIEER Stratum 4 (β 16)	-0.004	0.005	0.357	0.003	0.001	0.004
ECE - NIEER Stratum 5 (β 17)	-0.006	0.006	0.367	0.005	0.001	< 0.001
Logit of ECE Environ - NIEER (β 18)	0.008	0.006	0.199			
Random Effects		Variance	p-value		Variance	p-value
Intercept, r0		0.2185	< 0.001		0.1894	< 0.001
Age slope, r1		0.0001	0.194		0.0001	0.090
Level 1, e		0.7610			0.7721	
Deviance	23559.0			47183.1		

Table 18. *Fixed and Random Effects for the Effect of High Quality ECE Environment on Emergent Literacy Growth (Arnett Caregiver Sensitivity Index)*

	Full Model			Final Model		
Fixed Effects	Coefficient	St. Err.	p-value	Coefficient	St. Err.	p-value
For intercept (π 0i)						
Intercept (β 00)	-0.034	0.074	0.647	-0.073	0.019	< 0.001
Home Language (β 01)	-0.070	0.031	0.025	-0.071	0.031	0.022
Child Gender - male (β 02)	0.164	0.021	< 0.001	0.167	0.021	< 0.001
ECE Exposure (β 03)	0.013	0.003	< 0.001	0.013	0.003	< 0.001
Logit of Home Literacy Env. (β 04)	0.034	0.012	0.004	0.055	0.011	< 0.001
ECE Environment - CG Sensitivity (β 05)	0.004	0.044	0.932			
ECE - CG Sensitivity Stratum 2 (β 06)	-0.115	0.064	0.069			
ECE - CG Sensitivity Stratum 3 (β 07)	-0.049	0.083	0.554			
ECE - CG Sensitivity Stratum 4 (β 08)	0.023	0.103	0.822			
ECE - CG Sensitivity Stratum 5 (β 09)	-0.044	0.133	0.742			
Logit of ECE Environ - CG Sens (β 010)	0.241	0.150	0.109			
For slope Age (π 1i)						
Intercept (β 10)	-0.002	0.002	0.530	-0.002	0.001	0.045
Poverty (β 11)	-0.003	0.001	0.005	-0.003	0.001	0.004
Logit of Home Literacy Env. (β 12)	0.003	0.000	< 0.001	0.003	0.000	< 0.001
ECE Environment - CG Sensitivity (β 13)	0.000	0.001	0.027			
ECE - CG Sensitivity Stratum 2 (β 14)	0.004	0.002	0.338	0.003	0.001	0.010
ECE - CG Sensitivity Stratum 3 (β 15)	0.003	0.003	0.712	0.003	0.001	0.015
ECE - CG Sensitivity Stratum 4 (β 16)	0.001	0.003	0.400	0.003	0.001	0.003
ECE - CG Sensitivity Stratum 5 (β 17)	0.004	0.004	0.555	0.005	0.001	< 0.001
Logit of ECE Environ - CG Sens (β 18)	-0.003	0.005	0.789			
Random Effects		Variance	p-value		Variance	p-value
Intercept, r0		0.1822	< 0.001		0.1865	< 0.001
Age slope, r1		0.0001	0.087		0.0001	0.070
Level 1, e		0.7734			0.7744	
Deviance	47205.3			47203.2		

In contrast to the prior model of ECE quality based on NIEER benchmarks, all of the strata based on the caregiver sensitivity are significantly different from the reference

stratum (the lowest stratum), and the coefficients associated with these are all positive. This increase in the growth rate is above that of the positive influence from a high-quality home literacy environment.

DISCUSSION

Overall, children who live in households below the poverty level throughout the first years of life show a slower rate of growth in emergent literacy than those from households at or above the poverty level. Children in homes where the primary language spoken is not English begin at a lower level of emergent literacy than children from homes in which English is the primary language. The overall effect of a high-quality home literacy environment is to increase the rate of growth in emergent literacy. Thus, children who experience daily shared reading with a parent or guardian and live in homes with at least 10 children's books available to them have a faster rate of growth in their emergent literacy skills. The effects of two aspects of quality in early care and education environments were assessed for their impact on emergent literacy growth: features of program infrastructure, such as teacher education, and the nature of caregivers' emotional and instructional interactions with children. Results indicate that the effect of an early care and education environment depends upon how the quality of the environment is defined. When quality was determined by structural criteria, such as teacher education, only certain children benefit in terms of their emergent literacy growth. Children from households in which there is only one parent and there are issues related to food security do not experience a benefit from a structurally-defined high-quality ECE environment. In contrast, when quality was determined by caregiver sensitivity, there was a positive effect of a high-quality ECE environment for all children.

The present study is the first to examine the development of emergent literacy as a unified construct across the first four years of life. Emergent literacy, conceptualized as a constellation of skills and abilities, demonstrated an increasing pattern of growth as children developed from age 9 months to preschool, suggesting that most children become more sophisticated regarding their facility with language and with print as they approach the age of entry into formal schooling. The quality of the home environment regarding literacy practices and resources had a strong influence on children's emergent literacy, exerting an influence not only on the initial status but also the rate of growth of children's abilities. The effect of a high-quality early care and education environment was somewhat mixed. Some children were influenced by ECE programs when quality was assessed by structural aspects, such as class size or caregiver education. When quality was assessed using a process approach, such as caregiver sensitivity, there were consistent increases in the growth rate for emergent literacy across all children, including a difference between children who did and did not attend an ECE program. These results suggest that the quality of early care and education environments are more strongly tied to caregiver interaction and sensitivity than to the specific types of benchmarks often found in policy mandates. In addition, these findings also suggest that, like language development, the development of emergent literacy appears to be grounded in a social process.

Relationship of ECE Environment to Emergent Literacy

Children learn to read and write in the context of their everyday lives. Thus, the interaction with their environments, both at home and in early care and education programs, is directly related to the development of their emergent literacy abilities. These

skills are learned in environments in which print is available through resources such as books and is shared with others in interactions such as shared book reading. Resources and interactions are both necessary for children to learn to read, as is supported by the research presented here.

As the mantra goes, reading starts at home. A high-quality home literacy environment must provide children with both access to books written at their level of ability and an adult who will share these books with them. These findings are in line with previous research on interventions in which parents are provided with children's books and instructions on how to share the books with their children (High et al., 1998).

An additional aspect of the home environment, and one which bears on the interpretation of the present study, is the role of the primary home language. It is important to keep in mind that the assessments were presented in English and do not necessarily transfer to overall emergent literacy. Home language represents not only whether the primary language to which the child is exposed is English but also serves as a proxy indicator for acculturation. Although most of the households spoke at least some English, even if it was not the primary language in the home, the overall culture often puts certain practices into place. For example, shared book reading between parents and children is uncommon in Hispanic households, but there is a strong tradition of story-telling (Goldenberg, Reese, & Gallimore, 1992; Reese, et al., 1995). Language-rich interactions, such as story-telling and singing songs, have been shown to influence language development which in turn supports emergent literacy.

For some children, the home environment cannot fully provide for their emergent literacy needs. This is particularly salient in low-SES homes. For example, homes in

which there is a high level of food insecurity often do not have many children's books. In concrete terms, when given a choice between providing either food or books, most parents understandably provide their children with food. In some cases, these deficits in the home literacy environment can be remediated if children are able to attend high-quality early care and education programs. Many studies (e.g., Burchinal et al., 2000; Clarke-Stewart et al., 2002) indicate that high-quality ECE supports positive social and cognitive development of young children. As the present results indicate, how that quality is assessed has an influence on whether an effect of the ECE environment is detected.

These findings are consistent with expectations that arise from a bioecological model of development (Bronfenbrenner & Morris, 2006): The pathways through which the exosystem impact a child's development are not direct, but rather environments exert an effect through proximal processes. In other words, the mechanisms through which a high-quality ECE environment has a positive effect on children's emergent literacy are through the sensitive instructional interactions of the child with the caregiver in the ECE classroom. Thus, the features of an ECE program's design and infrastructure are ecological conditions that establish the space within which high-quality emotional and instructional interactions occur.

What is more important for children's emergent literacy development? According to the results of the present study, the interactions in a classroom environment with a sensitive caregiver are more important than the types of programmatic design and infrastructure that are often the target of policy. If the caregiver is responsive to children, then there is a strong effect on children's emergent literacy skills. This structure-process system is consistent with findings for first-grade (Hamre & Pianta, 2005) and pre-K

classrooms (Mashburn, et al., 2008). The results presented in this study extend the research conducted with preschoolers to younger children.

Program infrastructure, as measured by the modified NIEER benchmarks, does have a moderate effect on children's emergent literacy growth. Its effect, however, does not apply to all children. Only children from more advantaged backgrounds show a positive effect from a high-quality ECE environment when the quality is measured by structural attributes of the center or program. These findings do not mean that structural assessments of quality are without use. It is most likely that these two approaches to assessing quality are related: structural features of ECE programs, such as teacher training in early childhood education, are predictive of process quality (Phillipsen, Burchinal, Howes, & Cryer, 1997). Some aspects of program infrastructure set the stage for the high-quality interactions. For example, smaller class sizes and reduced child-to-caregiver ratios provide the environmental resources that allow for the type of sensitive interactions that are related to children's development of language and literacy skills.

Beyond the potentially moderated and indirect effects of the structure-based markers of quality, there are reasons to believe that the types of program features usually regulated or mandated are worthwhile. Several of the NIEER benchmarks are related to aspects of comprehensive early childhood programs, such as meal provision, health screening and referrals, and family support. Although these may not directly influence the development of emergent literacy, they are important components for the promotion of healthy child development. This is particularly important for children from economically disadvantaged backgrounds who otherwise may not have access to these types of services.

Interventions are best defined in terms of things that can be changed or altered. How can we effect the home literacy environment of young children? What should be the focus for improving ECE programs? Propensity score modeling, particularly as it was used in the present analysis, illustrates a distinction between things that cannot be changed and things that can. For example, it is difficult to change maternal education level, household income, or the geographic region where someone lives. In contrast, programs can be developed to influence access to resources, such as the number of children's books in the home. Policies can influence the types of training required for ECE caregivers and for screening or referral programs for young children. In the present study there was a positive effect on the growth of emergent literacy skills for children who attended a high quality ECE program, even after controlling for child and household characteristics. This suggests that interventions of a specific type – based on sensitive caregiver interactions – are beneficial to all children and would be a good target for further intervention research. This type of research also allows for an examination of the different types of children for whom interventions may or may not work best, such as the selection by treatment effect found in the analysis of ECE quality defined by the program infrastructure.

Emergent literacy is an important skill, and it is a critical skill for success in school. For children who do not have the benefits of a high quality home literacy environment, their emergent literacy can be positively influenced by an ECE environment in which caregivers interact with them in a sensitive and attuned manner. The interplay between the home and ECE environments on children's emergent literacy is a rich source for future research. In particular, the mechanisms through which these environments

support and improve children's literacy development could highlight valuable targets for intervention.

Limitations

One of the major limitations of the present research is the conceptualization and quantification of emergent literacy. There has been little research on the assessment of emergent literacy in children younger than 2 years and none that has examined the construct across multiple ages. This absence of research is likely due to the complexity of the construct of interest. Emergent literacy is, by definition, changing as a child develops. What emergent literacy looks like at 9 months is very different from its manifestation at preschool. In this first attempt, the use of components to assemble a unified construct is perhaps crude, but it addresses the fundamental problem: How do we conceptualize an emergent construct? If researchers are going to continue to talk about emergent literacy as something which evolves along a continuum, we must address this complexity. If emergent literacy begins in the first year of life, we must begin to examine it in the first year. This limitation of the present study provides a jumping off point for researchers to engage this construct in a truly developmental manner – from birth through the emergence of conventional literacy.

A second limitation is the use of secondary data analysis to address the questions of the effect of the home and ECE environments. Because of this, the questions that could be asked were limited. ECLS-B was developed to be a representative picture of children's development over the first 5 years of life. This dataset is valuable as a place to begin investigations of a general nature, but specific questions or interventions cannot be addressed. The use of propensity score analysis to create equivalent groups with non-

experimental data has been demonstrated as an effective analytic technique in policy research, where experimental manipulation is untenable or unethical. Using the information from the present study, researchers can form more precise questions regarding the specific nature of the effects of early education on children's emergent literacy and gather data pertinent to these questions.

Implications for Education and Policy

Over half of the infants and toddlers in the United States are in regular, non-parental child care (Kreader, Ferguson, & Lawrence, 2005). This makes the quality of that care a priority concern not only for parents and educators, but also for policymakers. The current political climate, motivated by legislation such as *No Child Left Behind*, has pushed for an increase in quality assurance requirements based on infrastructure. These are reflected in the structural benchmarks used by NIEER, which have been used to monitor the state of preschool programs across the nation. The present research suggests that adherence to such structural benchmarks may obscure the real effects – and the source of those effects.

Mandates for maximum ECE class sizes and requirements that teachers have a college degree may not be sufficient to ensure that children learn the skills and abilities necessary for literacy. When combined with similar findings, the results of the present investigation confirm that for young children learning occurs through interactions with others. When taken to the next step for policy development, this suggests that the focus should be not on infrastructure but on improving interactions between children and their caregivers in the classroom. One avenue toward such improvement is professional development with teacher in-service training.

The NIEER benchmarks include whether teachers have had at least 15 hours of in-service training each year. The type of training teachers receive is critical in order for the benefit to translate into practice in the classroom. Traditional versions of professional development, such as direct training in workshops, are often ineffectual because the learning is passive and the topics are irrelevant or disconnected from the classroom (Birman, et al., 2000), which often renders the training ineffective (Smylie, 1989). Just as the children in their care need high-quality educational experiences, early care and education providers need high-quality in-service development. The most effective type of in-service training is intensive and sustained, usually embedded within the classroom context and involving mentoring from experienced teachers (Darling-Hammond & McLaughlin, 1995). Policies which support this specific type of professional development for early care and education providers are the type of policies likely to have an impact not only on the program infrastructure, but on the interactions within classrooms.

Most states do not currently have proscribed standards for the quality of early care and education analogous to those developed by NIEER. Although these structural features are not directly related to the quality of an ECE program, they are predictive of classroom quality in early education contexts. For example, it is easier for a caregiver to be sensitive to the children in his charge when the child-to-caregiver ratio affords more individual attention to each child. One place to begin is the development of preliminary guidelines that can serve as benchmarks for ECE quality. These guidelines should be tempered with evaluations of the classroom quality, with particular attention to caregiver interactions.

In addition to the quality of ECE programs, many children for whom quality ECE would have a profound effect do not participate in such programs. Most children in low-SES homes do not have non-parental care (Joesch & Hiedemann, 2002; NICHD ECCRN, 1997). Childcare subsidies can help low-income families provide for the care and education of their young children. Such subsidies gained higher visibility with the passage of the Work Opportunity Reconciliation Act and the establishment of the Child Care and Development Fund (CCDF). These funding opportunities foster both enrollment of the child in ECE programs and maternal employment, both of which are related to higher child cognitive outcomes. A next step for research is to examine the children and their families who participated in the CCDF and similar programs, like Temporary Assistance for Needy Families (TANF), in order to assess the economic impact of these programs on children's early emergent literacy development.

To the extent that the criteria for deciding where to invest resources is based on children's language and literacy development, policies and practices should reflect the resources and process that have a positive effect on the development of these abilities. Research, including the contribution of the present study, recommends the support of programs that increase the ability of ECE caregivers to provide sensitive instructional interaction with the children in their care. Other environmental factors, both resource- and process-based, should be examined for their influence on children's emergent literacy development.

References

Adams, M. J. (1991). *Beginning to read: Thinking and learning about print.* Cambridge, MA: MIT Press.

Adamson, L. B. (1995). *Communication development during infancy.* Madison, WI: Brown & Benchmark.

Administration on Children and Families, U.S. Department of Health and Human Services. (2007). *Head Start Program fact sheet, Fiscal year 2007.* www.acf.hhs.gov/programs/hsb/research

Andreassen, C., & Fletcher, P. (2005). *Early Childhood Longitudinal Study, Birth Cohort (ECLS-B), Methodology report for the nine-month data collection (2001-02), Vol. 1: Psychometric characteristics* (NCES 2005-100). U.S. Department of Education, Washington, DC: National Center for Education Statistics.

Arnett, J. (1989). Caregivers in day-care centers: Does training matter? *Journal of Applied Developmental Psychology, 10,* 441-552.

Asparouhov, T. (2005). Sampling weights in latent variable modeling. *Structural Equation Modeling, 12,* 411-434.

Asparouhov, T. (2006). General multi-level modeling with sampling weights. *Communications in Statistics – Theory and Methods, 35,* 439-460.

Badian, N. (1995). Predicting reading ability over the long term: The changing role of letter naming, phonological awareness, and orthographic processing. *Annals of Dyslexia, 45,* 29-96.

Baker, L, Scher, D., & Mackler, K. (1997). Home and family influences on motivations for reading. *Educational Psychologist, 32,* 69-82.

Barnard, K., Hammond, M., Booth, C., Bee., H., Mitchell, S., & Spieker, S. (1989). Measurement and meaning of parent-child interaction. In F. J. Morrison, C. Lord, & D. P. Keating (Eds.), *Applied developmental psychology* (Vol. 3, pp. 40-79). New York: Academic Press.

Barnett, W. S. (1995). Long-term effects of early childhood programs on cognitive and school outcomes. *The Future of Children, 5,* 25-50.

Barnett, W. S., Hustedt, J. T., Friedman, A. H., Stevenson Boyd, J., & Ainsworth, P. (2007). *The State of Preschool 2007.* New Brunswick, NJ: National Institute for Early Education Research, Rutgers University.

Barnett, W. S., & Masse, L. N. (2007). Comparative benefit-cost analysis of the Abecedarian program and its policy implications. *Economics of Education Review, 26,* 113-125.

Barton, D. (1994). *Literacy: An introduction to the ecology of written language.* Oxford: Blackwell.

Bast, J., & Reitsma, P. (1997). Matthew effects in reading: A comparison of latent growth-curve models and complex models with structured means. *Multivariate Behavioral Research, 32,* 135-167.

Bast, J., & Reitsma, P. (1998). Analyzing the development of individual differences in terms of Matthew effects in reading: Results from a Dutch longitudinal study. *Developmental Psychology, 34,* 1373-1399.

Bayder, N., Brooks-Gunn, J., & Furstenberg, F. F. (1993). Early warning signs of functional illiteracy: Predictors in childhood and adolescence. *Child Development, 64,* 815-829.

Bayley Short Form – Research Edition. (2001). Adapted from N. Bayley, *Bayley Scales of Infant Development: Second Edition (BSID-II).* San Antonio, TX: The Psychological Corporation, a Harcourt Assessment Company.

Beeber, L. S., Chazan-Cohen, R., Squires, J., Harden, B. J., Boris, N. W., Heller, S. S., et al. (2007). The early promotion and intervention research consortium (E-PIRC): Five approaches to improving infant/toddler mental health in Early Head Start. *Infant Mental Health Journal, 28,* 130-150.

Benasich, A. A., Brooks-Gunn, J., & Clewell, B. C. (1992). How do mothers benefit from early intervention programs? *Journal of Applied Developmental Psychology, 13,* 311-362.

Bethel, J., Green, J. L., Kalton, G., & Nord, C. (2005). *Early Childhood Longitudinal Study, Birth Cohort (ECLS-B), Methodology Report for the nine-month data collection (2001-02), Vol. 2: Sampling* (NCES 2005-113). U.S. Department of Education, Washington, DC: National Center for Education Statistics.

Biesanz, J. C., Deeb-Sossa, N., Papadakis, A. A., Bollen, K. A., & Curran, P. J. (2004). The role of coding time in estimating and interpreting growth curve model. *Psychological Methods, 9,* 30-52

Bird, V. (2004). *Literacy and social inclusion: The policy challenge.* London: National Literacy Trust.

Birman, B. F., Desimone, L., Porter, A. C., & Garet, M. S. (2000). Designing professional development that works. *Educational Leadership, 57*(8), 1-23.

Bishop, D. V. M. (2001). Genetic influences on language impairment and literacy problems in children: Same or different? *Journal of Child Psychology and Psychiatry, 42,* 189-198.

Bloom, L. M. (1973). *One word at a time: The use of single word utterances before syntax.* The Hague: Mouton.

Bond, Z. S., & Dykstra, R. (1967). The cooperative research program in first-grade reading instruction. *Reading Research Quarterly, 2,* 5-14.

Bowey, J. A. (1995). Socioeconomic status differences in preschool phonological sensitivity and first-grade reading achievement. *Journal of Educational Psychology, 87,* 476-487.

Bradley, R. H., & Caldwell, B. M. (1979). Home Observation for Measurement of the Environment: a revision of the preschool scale. *American Journal of Mental Deficiency, 84,* 235-244.

Bradley, R. H., & Caldwell, B. M. (1981). The HOME Inventory: A validation of the preschool scale for black children. *Child Development, 52,* 708-710.

Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and by design.* Cambridge, MA: Harvard University Press.

Bronfenbrenner, U. (1986). The ecology of the family as a context for human development. *Developmental Psychology, 22,* 723-742.

Bronfenbrenner, U. (1995). Developmental ecology through space and time: A future perspective. In P. Moen, G. Elder, Jr., & K. Luscher (Eds.), *Examining lives in*

context: Perspectives on the ecology of human development (pp. 619-648). Washington, DC: American Psychological Association.

Bronfenbrenner, U. (1999). Environments in developmental perspective: Theoretical and operational models. In S. L. Friedman & T. D. Wachs (Eds.), *Measuring environment across the life span: Emerging methods and concepts* (pp. 3-28). Washington, DC: American Psychological Association Press.

Bronfenbrenner, U., & Ceci, S. J. (1994). Nature-nurture reconceptualized in developmental perspective: A bioecological model. *Psychological Review, 101,* 568-586.

Bronfenbrenner, U., & Morris, P. A. (1998). The ecology of developmental processes. In R. M. Lerner (Ed.), *Handbook of child psychology* (5th ed., Vol. 1, pp. 993-1028). New York: Wiley.

Bronfenbrenner, U., & Morris, P. A. (2006). The bioecological model of human development. In R. M. Lerner (Ed.), *Handbook of child development: Vol. 1. Theoretical models of human development* (6th ed., pp. 793-828). Hoboken, NJ: Wiley.

Brooks-Gunn, J. (2004). Intervention and policy as change agents for young children. In P. L. Chase-Lansdale, K. Kiernan, & R. J. Friedman (Eds.), *Human development across lives and generations: The potential for change* (pp. 293-340). New York: Cambridge University Press.

Brooks-Gunn, J., & Duncan, G. J. (1997). The effects of poverty on children. *The Future of Children, 7,* 55-71.

Brooks-Gunn, J., Fuligni, A. S., & Berlin, L. J. (2003). *Early child development in the 21st century.* New York: Teachers College Press.

Brooks-Gunn, J., Klebanov, P. K., Liaw, F. R., & Spiker, D. (1993). Enhancing the development of low-birthweight, premature infants: Changes in cognition and behavior over the first three years. *Child Development, 64,* 736-753.

Bruner, J. S. (1960). *The process of education.* Cambridge, MA: Harvard University Press.

Bruner, J. S. (1978). On prelinguistic prerequisites of speech. In R. N. Campbell & P. T. Smith (Eds.), *Recent advances in the psychology of language* (pp. 199-214). New York: Plenum Press.

Bruner, J. S. (1983). *Child's talk: Learning to use language.* New York: Norton.

Bryk, A. S., & Raudenbush, S. W. (1987). Application of hierarchical linear models to assessing change. *Psychological Bulletin, 101,* 147-158.

Burchinal, M. R., Peisner-Feinberg, E., Bryant, D. M., & Clifford, R. (2000). Children's social and cognitive development and child care quality: Testing for differential associations related to poverty, gender, or ethnicity. *Journal of Applied Developmental Sciences, 4,* 149-165.

Burchinal, M., Roberts, J., Nabors, L., & Bryant, D. (1996). Quality of center child care and infant cognitive and language development. *Child Development, 67,* 606-620.

Burgess, S. R., Hecht, S. A., & Lonigan, C. J. (2002). Relations of the home literacy environment (HLE) to the development of reading-related abilities: A one-year longitudinal study. *Reading Research Quarterly, 37,* 408-426.

Bus, A. G., & Van IJzendoorn, M. H. (1988). Mother-child interactions, attachment, and emergent literacy: A cross-sectional study. *Child Development, 59,* 1262-1272.

Bus, A. G., Van Ijzendoorn, M. H., & Pellegrini, A. D. (1995). Joint book reading makes for success in learning: A meta-analysis on intergenerational transmission. *Review of Educational Research, 65,* 1-21.

Cairney, T. H. (1995). *Pathways to literacy.* London: Cassell.

Cairns, R. B. (1991). Multiple metaphors for a singular idea. *Developmental Psychology, 27,* 23-26.

Callaghan, T. C., & Rankin, M. P. (2002). Emergence of graphic symbol functioning and the question of domain specificity: A longitudinal training study. *Child Development, 73,* 359-376.

Campbell, F. A., Pungello, E. P., Miller-Johnson, S., Burchinal, M. R., & Ramey, C. (2001). The development of cognitive and academic abilities: Growth curves from an early intervention educational experiment. *Developmental Psychology, 37,* 231-242.

Campbell, F. A., & Ramey, C. T. (1994). Effects of early intervention on intellectual and academic achievement: A follow-up study of children from low-income families. *Child Development, 65,* 684-698.

Campbell, F. A., Ramey, C. T., Pungello, E. P., Sparling, J., & Miller-Johnson, S. (2002). Early childhood education: Young adult outcomes from the Abecedarian project. *Applied Developmental Science, 6,* 42-57.

Caughy, M. O., DePetro, J. A., & Strobino, D. M. (1994). Day-care participation as a protective factor in the cognitive development of low-income children. *Child Development, 65,* 457-471.

Ceci, S. J. (1993). Some contextual trends in intellectual development. *Developmental Review, 13,* 1-32.

Chall, J. (1992). The new reading debates: Evidence from science, art, and ideology. *Teachers College Record, 94,* 334-347.

Christian, K., Morrison, F. J., & Bryant, F. B. (1998). Predicting kindergarten academic skills: Interactions among child care, maternal education, and family literacy environments. *Early Childhood Research Quarterly, 13,* 501-521.

Chomsky, N. (1957). *Syntactic Structures.* The Hague: Morton.

Chomsky, N. (1986). *Knowledge of language.* Berlin: Prager.

Clarke-Stewart, K. A., Vandell, D. L., Burchinal, M., O'Brien, M., & McCartney, K. (2002). Do regulable features of child-care homes affect children's development? *Early Childhood Research Quarterly, 17,* 52-86.

Clay, M. (1966). *Emergent reading behavior.* Unpublished doctoral dissertation, University of Aukland, New Zealand.

Clay, M. (1967). The reading behavior of 5-year-old children: A research report. *New Zealand Journal of Educational Studies, 2,* 11-31.

Clay, M. (1972). *Reading. The patterning of complex behavior.* Auckland, New Zealand: Heinemann Educational Books.

Clay, M. (1991). *Becoming literate: The construction of inner control.* Portsmouth, NH: Heinemann Educational Books.

Cochran, W. G. (1968). The effectiveness of adjustment by subclassification in removing bias in observational studies. *Biometrics, 24,* 295-313.

Committee on Early Childhood, Adoption, and Dependent Care (2005). Quality early education and child care from birth to kindergarten. *Pediatrics, 115,* 187-191.

Connor, C. M., Morrison, F. J., & Slominski, L. (2006). Preschool instruction and children's emergent literacy growth. *Journal of Educational Psychology, 98,* 665-689.

Crone, D. A., & Whitehurst, G. J. (1999). Age and schooling effects on emergent literacy and early reading skills. *Journal of Educational Psychology, 91,* 604-614.

Cunningham, A. E., & Stanovich, K. E. (1997). Early reading acquisition and its relationship to reading experience and ability 10 years later. *Developmental Psychology, 33,* 934-945.

D'Agostino, R. B. (1998). Propensity score methods for bias reduction in the comparison of a treatment to a non-randomized control group. *Statistics in Medicine, 17,* 2265-2281.

D'Agostino, R. B., & Rubin, D. B. (2000). Estimating and using propensity scores with partially missing data. *Journal of the American Statistical Association, 95,* 749-759.

Darling-Hammond, L., & McLaughlin, M. W. (1995). Policies that support professional development in an era of reform. *Phi Delta Kappa, 76,* 597-604.

Davidson, M. C., Thomas, K. M., & Casey, B. J. (2003). Imaging the developing brain with MRI. *Mental Retardation and Developmental Disabilities Research Reviews, 9,* 161-167.

DeFries, J. C., & Alarcon, M. (1996). Genetics of specific reading disorders. *Mental Retardation and Developmental Disabilities Research Reviews, 2,* 39-47.

Dehejia, R. H., & Wahba, S. (2002). Propensity score matching methods for nonexperimental causal studies. *The Review of Economics and Statistics, 84,* 151-161.

Dickinson, D. K., De Temple, J. M., Hirschler, J. A., & Smith, M. W. (1992). Book reading with preschoolers: Co-construction of text at home and at school. *Early Childhood Research Quarterly, 7,* 323-346.

Dickinson, D. K., & McCabe, A. (2001). Bringing it all together: The multiple origins, skills, and environmental supports of early literacy. *Learning Disabilities Research & Practice, 16,* 186-202.

Dickinson, D. K., McCabe, A., Anastasopoulos, L., Peisner-Feinberg, E., & Poe, M. (2003). The comprehensive language approach to early literacy: The interrelationships among vocabulary, phonological sensitivity, and print knowledge among preschool-aged children. *Journal of Educational Psychology, 95,* 465-481.

Donahue, P., Voelld, K., Campbell, J., & Mazzeo, J. (1998). *National Assessment of Educational Progress 1998 reading report card for the nation and states.* Washington, DC: U.S. Government Printing Office.

Duke, N. K. (2000). For the rich it's richer: Print experiences and environments offered to children in very low- and very high-socioeconomic status first-grade classrooms. *American Educational Research Journal, 37,* 441-478.

Duncan, G. J., & Brooks-Gunn, J. (1997). Income effects across the life span: Integration and interpretation. In G. J. Duncan & J. Brooks-Gunn (Eds.), *Consequences of growing up poor* (pp. 596-610). New York: Russell Sage Foundation.

Duncan, G. J., Brooks-Gunn, J., & Klebanov, P. K. (1994). Economic deprivation and early childhood development. *Child Development, 65,* 296-318.

Duncan, S. W., & DeAvila, E. A. (1998). *PreLAS (Preschool Language Assessment Scales).* Monterey, CA: CTB/McGraw-Hill.

Dunn, L. M., & Dunn, L. M. (1997). *Peabody Picture Vocabulary Test – Third Edition (PPVT-III).* Upper Saddle River, NJ: Pearson Publishing.

Durham, R. E., & Smith, P. J. (2006). Nonmetropolitan status and kindergarteners' early literacy skills: Is there a rural disadvantage? *Rural Sociology, 71,* 625-661.

Eisenhart, M., & Towne, L. (2003). Contestation and change in national policy on scientifically based research. *Educational Researcher, 34*(4), 31-38.

Elliott, E. M., & Olliff, C. B. (2008). Developmentally appropriate emergent literacy activities for young children: Adapting the Early Literacy and Learning Model. *Early Childhood Education Journal, 35,* 551-556.

Enders, C. K., & Tofighi, D. (2007). Centering predictor variables in cross-sectional multilevel models: A new look at an old issue. *Psychological Methods, 12,* 121-138.

Entwisle, D., Alexander, K., & Olson, L. S. (1997). *Children, schools, and inequality.* Boulder, CO: Westview.

Evangelou, M., Brooks, G., & Smith, S. (2007). The Birth to School study: Evidence on the effectiveness of PEEP, an early intervention for children at risk of educational underachievement. *Oxford Review of Education, 33,* 581-609.

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).

Fletcher, K. L., & Reese, E. (2005). Picture book reading with young children: A conceptual framework. *Developmental Review, 25,* 64-103.

Foster, M. A., Lambert, R., Abbott-Shim, M., & McCarty, F. (2005). A model of home learning environment and social risk factors in relation to children's emergent literacy and social outcomes. *Early Childhood Research Quarterly, 20,* 13-36.

Gee, J. P. (1990). *Sociolinguistics and literacies: Ideology in discourses.* London: Farmer.

Gesell, A. (1940). *The first five years of life.* New York: Harper & Row.

Gibson, E. J. (1969). *Principles of perceptual learning and development.* New York: Appleton-Century-Crofts.

Gibson, E. J., & Pick, A. D. (2000). *An ecological approach to perceptual learning and development.* Cambridge: Oxford University Press.

Gibson, J. J. (1979). *The ecological approach to visual perception.* Mahwah, NJ: Erlbaum.

Gibson, L. (1989). *Literacy development in the early years: Through children's eyes.* New York: Teacher's College Press.

Gilger, J., Pennington, B., & DeFries, J. (1991). Risk for reading disability as a function of family history in three family studies. *Reading and Writing: An Interdisciplinary Journal, 3,* 205-217.

Gilliam, W. S., & Zigler, E. F. (2001). A critical meta-analysis of all impact evaluations of all state-funded preschool from 1977 to 1998: Implications for policy, service delivery, and program evaluation. *Early Childhood Research Quarterly, 15,* 441-473.

Ginsburg, H. P., & Baroody, A. J. (1990). *Test of Early Mathematics Ability, Second edition: Examiner's manual.* Austin, TX: PRO-ED, Inc.

Goldenberg, C., Reese, L., & Gallimore, R. (1992). Effects of literacy materials from school on Latino children's home experiences and early reading achievement. *American Journal of Education, 100,* 497-536.

Gorsuch, R. L. (1997). Exploratory factor analysis: Its role in item analysis. *Journal of Personality Assessment, 68,* 532-560.

Gottlieb, G. (1991). Experiential canalization of behavioral development: Theory. *Developmental Psychology, 27,* 4-13.

Green, P. J., Hoogstra, L. A., Ingels, S. J., Greene, H. N., & Marnell, P. K. (1997). *Formulating a design for the ECLS: Review of Longitudinal Studies* (Working Paper No. 97-24). U.S. Department of Education, Washington, DC: National Center for Education Statistics.

Gu, X. S., & Rosenbaum, P. R. (1993). Comparison of multivariate matching methods: Structure, distances, and algorithms. *Journal of Computational and Graphical Statistics, 2,* 405-420.

Hahs-Vaughn, D. L. (2005). A primer for using and understanding weights with national datasets. *Journal of Experimental Education, 73,* 221-248.

Hahs-Vaughn, D. L,. & Onwuegbuzie, A. J. (2006). Estimating and using propensity score analysis with complex samples. *Journal of Experimental Education, 75,* 31-65.

Hamre, B. K., & Pianta, R. C. (2005). Can instructional and emotional support in the first grade classroom make a difference for children at risk of school failure? *Child Development, 76,* 949-967.

Harms, T., Clifford, R. M., & Cryer, D. (1998). *Early Childhood Environment Rating Scale – Revised Edition (ECERS-R).* New York: Teachers College Press.

Heckman, J. (2000). Policies to foster human capital. *Research in Economics, 54,* 3-56.

Heckman, J. J. (2006). Skill formation and the economics of investing in disadvantaged children. *Science, 312,* 1900-1902.

Henry, G. T., Gordon, C. S., & Rickman, D. K. (2006). Early education policy alternatives: Comparing quality and outcomes of Head Start and state prekindergarten. *Educational Evaluation and Policy Analysis, 28,* 77-99.

Hiebert, E. H., & Fisher, C. W. (1990). Whole language: Three themes for the future. *Educational Leadership, 47,* 62-64.

High, P. C., Hopmann, M., LaGasse, L., & Linn, H. (1998). Evaluation of a clinic-based program to promote book sharing and bedtime routines among low-income urban families with young children. *Archives of Pediatrics and Adolescent Medicine, 152,* 459-465.

High, P. C., LaGasse, L., Becker, S., Ahlgren, I., & Gardner, A. (2000). Literacy promotion in primary care pediatrics: Can we make a difference. *Pediatrics, 105,* 927-934.

Holland, P. W. (1986). Statistics and causal inference. *Journal of the American Statistical Association, 81,* 945-961.

Hugdahl, K., Helland, T., Faerevaag, M. K., Lyssand, & Asbjornsen, A. (1995). Absence of ear advantage on the consonant-vowel dichotic listening test in adolescent and adult dyslexics: Specific auditory-phonetic dysfunction. *Journal of Clinical and Experimental Neuropsychology, 17,* 833-840.

Humphreys, L. J. (1991). Limited vision in the social sciences. *American Journal of Psychology, 104,* 333-353.

Huttenlocher, J., Haight, W., Bryk, A., Seltzer, M., & Lyons, T. (1991). Early vocabulary growth: Relation to language input and gender. *Developmental Psychology, 27,* 236-248.

Joesch, J. M., & Hiedemann, B. G. (2002). The demand for nonrelative child care among families with infants and toddlers: A double hurdle approach. *Journal of Population Economics, 15,* 495-526.

Justice, L. M., & Pullen, P. C. (2003). Promising interventions for promoting emergent literacy skills: Three evidence-based approaches. *Topics in Early Childhood Special Education, 23,* 99-113.

Kaestle, C. F. (1993). The awful reputation of educational research. *Educational Researcher, 22,* 23-31.

Kagan, J. (1970). The determinants of attention in the infant. *American Scientist, 58,* 298-306.

Kainz, K., & Vernon-Feagans, L. (2007). The ecology of early reading development for children in poverty. *The Elementary School Journal, 107,* 407-427.

Kaplan, D. (2002). Methodological advances in the analysis of individual growth with relevance to education policy. *Peabody Journal of Education, 77*(4), 189-215.

Karoly, L. A., Kilburn, M. R., & Cannon, J. S. (2005). *Early childhood interventions: Proven results, future promise.* Santa Monica, CA: Rand Corporation.

Kaye, K. (1982). *The mental and social life of babies.* Chicago: University of Chicago Press.

Kessen, W. (1966). Questions for a theory of cognitive development. In H. W. Stevenson, Concept of Development, *Monographs of the Society for Research in Child Development, 31,* (55-70, Serial No. 107).

Knitzer, J. (2007). Putting knowledge into policy: Toward an infant-toddler policy agenda. *Infant Mental Health Journal, 28,* 237-245.

Koenig, A. J. (1992). A framework for understanding the literacy of individuals with visual impairment. *Journal of Visual Impairment & Blindness, 86,* 277-284.

Korat, O. (2005). Contextual and non-contextual knowledge in emergent literacy development: A comparison between children from low SES and middle SES communities. *Early Childhood Research Quarterly, 20,* 220-238.

Korat, O., & Levin, I. (2001). Maternal beliefs and child development: Comparison of text writing between two social groups. *Journal of Applied Developmental Psychology, 22,* 397-420.

Korn, E. L., & Graubard, B. I. (1999). *Analysis of health surveys.* New York: Wiley.

Kreader, J. L., Ferguson, D., & Lawrence, S. (2005). *Infant and toddler child care arrangements.* New York: Columbia University, National Center for Children in Poverty.

Kurth, T., Walker, A. M., Glynn, R. J., Chan, K. A., Gaziano, J. M., Berger, K., et al. (2005). Results of multivariable logistic regression, propensity matching, propensity adjustment, and propensity-based weighting under conditions of nonuniform effect. *American Journal of Epidemiology, 163,* 262-270.

Labaree, D. F. (2004). *The Trouble with Ed Schools.* New Haven, CT: Yale University Press.

Langacker, R. (1998). Conceptualization, symbolization, and grammar. In M. Tomasello (Ed.), *The new psychology of language* (pp. 1-39). Mahwah, NJ: Lawrence Erlbaum Associates.

Lareau, A. (1989). *Home advantage: Social class and parental intervention in elementary education.* New York: Falmer Press.

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation.* New York: Cambridge University Press.

Lee, E. S., & Forthofer, R. N. (2006). *Analyzing complex survey data* (2nd ed.). Thousand Oaks, CA: Sage.

Leichter, H. J. (1984). Families as environments for literacy. In H. Goelman, A. A. Oberg, & F. Smith (Eds.), *Awakening to literacy* (pp. 38-50). Bedford Square, London: Heinemann Educational Books.

Lemery, K. S., & Goldsmith, H. H. (1999). Genetically informative designs for the study of behavioral development. *International Journal of Behavioral Development, 23,* 293-317.

Lonigan, C. J., Burgess, S. R., & Anthony, J. L. (2000). Development of emergent literacy and early reading skills in preschool children: Evidence from a latent-variable longitudinal study. *Developmental Psychology, 36,* 596-613.

Love, J. M., Chazan-Cohen, R., & Raikes, H. (2007). Forty years of research knowledge and use: From Head Start to Early Head Start and beyond. In J. L. Aber, S. J. Bishop-Josef, S. M. Jones, K. T. McLearn, & D. A. Phillips (Eds.), *Child development and social policy* (pp. 79-95). Washington, DC: American Psychological Association.

Love, J. M., Kisker, E. E., Ross, C., Raikes, H., Constantine, J., Boller, K., Brooks-Gunn, J., et al. (2005). The effectiveness of Early Head Start for 3-year-old children and their parents: Lessons for policy and programs. *Developmental Psychology, 41,* 885-901.

Ludwig, J., & Phillips, D. (2007). The benefits and costs of Head Start. *Social Policy Report: Society for Research in Child Development, 21*(3).

Luke, A. (1993). Stories of social regulation: The micropolitics of classroom narrative. In B. Green (Ed.), *The insistence of the letter: Literacy studies and curriculum theorising.* London: Falmer.

Makin, L. (2006). Literacy 8-12 months: What are babies learning? *Early Years, 26,* 267-277.

Mashburn, A. J., Pianta, R. C., Hamre, B. K., Downer, J. T., Barbarin, O. A., Bryant, D., et al. (2008). Measures of classroom quality in prekindergarten and children's development of academic, language, and social skills. *Child Development, 79,* 732-749.

Mauer, D. M., & Kamhi, A. G. (1996). Factors that influence phoneme-grapheme correspondence learning. *Journal of Learning Disabilities, 29,* 259-270.

May, D. C., & Kundert, D. K. (1997). School readiness practices and children at-risk: Examining the issues. *Psychology in the Schools, 34,* 73-84.

McCandliss, B. D., & Noble, K. G. (2003). The development of reading impairment: A cognitive neuroscience model. *Mental Retardation and Developmental Disabilities Research Reviews, 9,* 196-205.

McCartney, K. (1984). Effect of quality of day care environment on children's language development. *Developmental Psychology, 20,* 244-260.

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

Melhuish, E. C., Phan, M. B., Sylva, K., Sammons, P., Siraj-Blatchford, I., & Taggart, B. (2008). Effects of the home learning environment and preschool center experience upon literacy and numeracy development in early primary school. *Journal of Social Issues, 64,* 95-114.

Mendelsohn, A. L., Mogilner, L. N., Dreyer, B. P., Forman, J. A., Weinstein, S. C., Broderick, M., et al. (2001). The impact of a clinic-based literacy intervention on language development in inner-city preschool children. *Pediatrics, 107,* 130-134.

Miller, G. (2006). *Bush Fiscal Year 2007 education budget.* Washington, DC: U.S. House of Representatives, Committee on Education and the Workforce.

Miyazaki, Y., & Frank, K. A. (2006). A hierarchical linear model with factor analysis structure at level 2. *Journal of Educational and Behavioral Statistics, 31,* 125-156.

Moerk, E. L. (1985). Picture book reading by mothers and young children and its impact upon language development. *Journal of Pragmatics, 9,* 547-566.

Moerk, E. L. (1991). Positive evidence for negative evidence. *First Language, 11,* 219-252.

Moerk, E. (1992). *A first language taught and learned.* Baltimore, MD: Brookes.

Moerk, E. (2000). *The guided acquisition of first language skills.* Stamford, CT: Ablex.

Molfese, V. J., Modglin, A., & Molfese, D. L. (2003). The role of environment in development of reading skills: A longitudinal study of preschool and school-age measures. *Journal of Learning Disabilities, 36,* 59-67.

Moore, K., Manlove, J., Richter, K., Halle, T., Le Menestral, S., Zaslow, M., et al. (1999). *A birth cohort study: Conceptual and design considerations and rationale* (Working Paper No. 1999-01). U.S. Department of Education, Washington, DC: National Center for Education Statistics.

Mullis, I. V. S., Campbell, J., & Farstrup, A. (1993). *NAEP 1992 Reading Report Card for the Nation and the States.* Washington, DC: U.S. Department of Education, Office of Educational Research and Improvement.

Muter, V., & Diethelm, K. (2001). The contribution of phonological skills and letter knowledge to early reading development in a multilingual population. *Language Learning, 51,* 187-219.

Nathanson, L., Lang, N., Than, V., Ketchie, B., & Kirshstein, R. (2003). *Recommended cognitive assessment instrument for the ECLS-B Preschool battery: Results of the 2003 pilot test.* Prepared for the National Center for Education Statistics, U.S. Department of Education. Washington, DC: American Institutes for Research.

National Assessment of Educational Progress (NAEP). (2005). *The NAEP 2005 technical report.* Washington, DC: National Center for Educational Statistics.

National Center for Children in Poverty. (2006). *Basic facts about low-income children: Birth to age 3.* New York: National Center for Children in Poverty, Columbia University Mailman School of Public Health.

National Center for Education Statistics. (2003). *NCES Statistical Standards* (NCES 2003-601). Washington, DC: U.S. Department of Education.

National Center for Education Statistics. (2008). *Early Childhood Longitudinal Study, Birth cohort (ECLS-B), Longitudinal 9-Month-Preschool Restricted-Use Data File and User's Manual* (NCES 2008-024). Washington, DC: U.S. Department of Education.

National Center for Health Statistics. (2006). Birth data. Retrieved on 23 May 2008 from www.cdc.gov/nchs/births.htm#new%20reports.

National Institute of Child Health and Human Development Early Childcare Research Network (1997). Poverty and patterns of child care. In G. J. Duncan & J. Brooks-

Gunn (Eds.), *Consequences of growing up poor* (pp. 100-131). New York: Russell Sage Foundation.

National Institute of Child Health and Human Development Early Childcare Research Network. (2005). Pathways to Reading: The role of oral language in the transition to reading. *Developmental Psychology, 41,* 428-442.

National Research Council. (2001). *Eager to learn: Educating our preschoolers.* Washington, DC: National Academy Press.

National Research Council (2002). *Scientific research in education.* Committee on Scientific Principles in Education Research. R. Shavelson & L. Towne (Eds.). Washington, DC: National Academy Press.

National Research Council and Institute of Medicine. (2000). *From neurons to neighborhoods: The science of early childhood development.* J. P. Shonkoff & D. A. Phillips (Eds.), Board on Children, Youth, and Families, Commission on Behavioral and Social Sciences and Education. Washington, DC: National Academy Press.

Needlman, R., Fried, L. E., Morley, D. S., Taylor, S., & Zuckerman, B (1991). Clinic-based intervention to promote literacy. *American Journal of Diseases of Children, 145,* 881-884.

Nelson, K. (1973). Structure and strategy in learning to talk. *Monographs of the Society for Research in Child Development, 38* (1-2, Serial No. 149).

Neumann, S. B. (1995). Enhancing adolescent mothers' guided participation in literacy. In L. M. Morrow (Ed.), *Family literacy* (pp. 104-114). Newark, DE: International Reading Association.

Neuman, S. B. (1999). Books make a difference: A study of access to literacy. *Reading Research Quarterly, 34,* 286-311.

Neumann, S., & Celano, D. (2001). Access to print in low-income and middle-income communities: An ecological study of four neighborhoods. *Reading Research Quarterly, 36,* 8-26.

Neumann, S. B., & Roskos, K. (1997). Literacy knowledge in practice: Contexts of participation for young writers and readers. *Reading Research Quarterly, 32,* 10-32.

NICHD Early Child Care Research Network. (1999). Child outcomes when child care center classes meet recommended standards for quality. *American Journal of Public Health, 89,* 1145-1170.

NICHD Early Child Care Research Network. (2000a). Characteristics of quality and of child care for toddlers and preschoolers. *Applied Developmental Science, 4,* 116-135.

NICHD Early Child Care Research Network. (2000b). The relation of child care to cognitive and language development. *Child Development, 71,* 960-980.

NICHD Early Child Care Research Network. (2002). Early child care and children's development prior to school entry: Results from the NICHD Study of Early Child Care. *American Educational Research Journal, 39,* 133-164.

NICHD Early Child Care Research Network. (2005). Pathways to reading: The role of oral language in the transition to reading. *Developmental Psychology, 41,* 428-442.

NICHD Early Child Care Research Network & Duncan, G. J. (2003). Modeling the impacts of child care quality on children's preschool cognitive development. *Child Development, 74,* 1454-1475.

Nichols, W. D., Rupley, W. H., & Rickelman, R. J. (2004). Examining phonemic awareness and concepts of print patterns of kindergarten students. *Reading Research and Instruction, 43*(3), 61.

Ninio, A. (1983). Joint book reading as a multiple vocabulary acquisition device. *Developmental Psychology, 19,* 445-451.

Ninio, A., & Bruner, J. (1978). The achievements and antecedents of labeling. *Journal of Child Language, 5,* 1-15.

Noh, M., & Lee, Y. (2007). REML estimation for binary data in GLMMs. *Journal of Multivariate Analysis, 98,* 896-915.

Ogasawara, H. (2000). Some relationships between factors and components. *Psychometrika, 65,* 167-185.

Ogasawara, H. (2002). Exploratory second-order analyses for components and factors. *Japanese Psychological Research, 44,* 9-19.

Pan, B. A., Rowe, M. L., Singer, J. D., & Snow, C. E. (2005). Maternal correlates of growth in toddler vocabulary production in low-income families. *Child Development, 76,* 763-782.

Paulesu, E., Démonet, J.-F., Fazio, F., McCrory, E., Chanoine, V., Brunswick, N., et al. (2001). Dyslexia: Cultural diversity and biological unity. *Science, 291,* 2165-2167.

Paulesu, E., Frith, U., Snowling, M., Gallagher, A., Morton, J., Frackowiak, R. S. J., et al. (1996). Is developmental dyslexia a disconnection syndrome? Evidence from PET scanning. *Brain, 119,* 143-157.

Payne, A. C., Whitehurst, G. J., & Angell, A. L. (1994). The role of home literacy environment in the development of language ability in preschool children from low-income families. *Early Childhood Research Quarterly, 9,* 427-440.

Peugh, J. L., & Enders, C. K. (2004). Missing data in educational research: A review of reporting practices and suggestions for improvement. *Review of Educational Research, 74,* 525-556.

Pfeffermann, D., Skinner, C. J., Holmes, D. J., Goldstein, H., & Rasbash, J. (1998). Weighting for unequal selection probabilities in multilevel models. *Journal of the Royal Statistical Society, Series B, 60,* 23-40.

Phillipsen, L. C., Burchinal, M. R., Howes, C., & Cryer, D. (1997). The prediction of process quality from structural features of child care. *Early Childhood Research Quarterly, 12,* 281-303.

Piaget, J. (1952). *The origins of intelligence in children.* New York: Norton.

Piaget, J. (1962). *Play, dreams, and imitation in childhood.* New York: Norton.

Purcell-Gates, V. (1998). Growing successful readers: Homes, communities and schools. In J. Osborn & F. Lehr (Eds.), *Literacy for all: Issues in teaching and learning* (pp. 51-72). New York: The Guilford Press.

Rabe-Hesketh, S., & Skrondal, A. (2006). Multilevel modeling of complex survey data. *Journal of the Royal Statistical Soceity, 169,* 805-827.

Raikes, H., Green, B. L., Atwater, J., Kisker, E., Constantine, J., & Chazan-Cohen, R. (2006). Involvement in Early Head Start home visiting services: Demographic predictors and relations to child and parent outcomes. *Early Childhood Research Quarterly, 21,* 2-24.

Raikes, H. H., & Love, J. M. (2002). Early Head Start: A dynamic new program for infants and toddlers and their families. *Infant Mental Health Journal, 23,* 1-13.

Raikes, H., Pan, B. A., Luze, G., Tamis-LeMonda, C. S., Brooks-Gunn, J., Constantine, J., et al. (2006). Mother-child bookreading in low-income families: Correlates and outcomes during the first three years of life. *Child Development, 77,* 924-953.

Ramey, C. T., & Campbell, F. A. (1984). Preventive education for high-risk children: Cognitive consequences of the Caroline Abecedarian Project. *Journal of Mental Deficiency, 88,* 515-523.

Ramey, C. T., Campbell, F. A., Burchinal, M., Skinner, M. L., Gardner, D. M., & Ramey, S. L. (2000). Persistent effects of early childhood education on high-risk children and their mothers. *Applied Developmental Science, 4,* 2-14.

Raudenbush, S. W. (2001). Comparison personal trajectories and drawing causal inferences from longitudinal data. *Annual Review of Psychology, 52,* 501-525.

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods* (2nd ed.). Thousand Oaks, CA: Sage.

Raudenbush, S. W., Bryk, A. S., Cheong, Y. F., Congdon, R., & du Toit, M. (2005). *HLM6: Hierarchical linear and nonlinear modeling.* Lincolnwood, IL: Scientific Software International.

Reese, E., & Cox, A. (1999). Quality of adult book reading affects children's emergent literacy. *Developmental Psychology, 35,* 20-28.

Reese, L., Goldenberg, C., Loucky, J., & Gallimore, R. (1995). Ecocultural context, cultural activity, and emergent literacy of Spanish-speaking children. In S. W. Rothstein (Ed.), *Class, culture, and race in American schools: A handbook.* Westport, CT: Greenwood.

Reilly, M. (1993). Data analysis using hot deck multiple imputation. *The Statistician, 42,* 307-313.

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. *Journal of American Medical Association, 285,* 2339-2346.

Riley, J. (1996). The ability to label the letters of the alphabet at school entry: A discussion on its value. *Journal of Research in Reading, 19,* 87-101.

Roberts, J., Jurgens, J., & Burchinal, M. (2005). The role of home literacy practice in preschool children's language and emergent literacy skills. *Journal of Speech, Language, and Hearing Research, 48,* 345-359.

Rog, L. J. (2001). *Early literacy instruction in kindergarten.* Newark, DE: International Reading Association.

Rogoff, B., Mossier, C., Mistry, J., & Goncu, A. (1993). Toddlers' guided participation with their caregivers in cultural activity. In E. Forman, N. Minick, & A. Stone (Eds.), *Sociocultural dynamics in children's development* (pp. 230-253). New York: Oxford University Press.

Rosenbaum, P. R. (1989). Optimal matching for observational studies. *Journal of the American Statistical Association, 408,* 1024-1032.

Rosenbaum, P., & Rubin, D. B. (1983a). The central role of the propensity score in observational studies for causal effects. *Biometrika, 70,* 41-55.

Rosenbaum, P., & Rubin D. B. (1983b). Assessing sensitivity to an unobserved binary covariate in an observational study with binary outcomes. *Journal of the Royal Statistical Society,* Series B., *45,* 212-218.

Rosenbaum, P. R., & Rubin, D. B. (1984). Reducing bias in observational studies using subclassification on the propensity score. *Journal of the American Statistical Association, 79,* 516-524.

Rubin, D. B. (1973). The use of matched sampling and regression adjustment to remove bias in observational studies. *Biometrics, 29,* 185-203.

Rubin, D. B. (1978). Bayesian inference for causal effects: The role of randomization. *The Annals of Statistics, 6,* 34-58.

Rubin, D. B. (1979). Using multivariate matched sampling and regression adjustment to control bias in observational studies. *Journal of the American Statistical Association, 74,* 318-328.

Rubin, D. B. (1987). *Multiple imputation for nonresponse in surveys.* New York: Wiley.

Rubin, D. B. (1997). Estimating causal effects from large data sets using propensity scores. *Annals of Internal Medicine, 127,* 757-763.

Rubin, D. B., & Thomas, N. (1996). Matching using estimated propensity scores: Relating theory to practice. *Biometrics, 52,* 249-264.

Rubin, D. B., & Thomas, N. (2000). Combining propensity score matching with additional adjustments for prognostic covariates. *Journal of the American Statistical Association, 95,* 573-585.

Rutter, M., Dunn, J., Plomin, R., Simonoff, E., Pickles, A., Maugham, B., et al. (1997). Integrating nature and nurture: Implications of person-environment correlations and interactions for developmental psychopathology. *Development and Psychopathology, 9,* 335-364.

Sanders, L. M., Zacur, G., Haecker, T., & Klass, P. (2004). Number of children's books in the home: An indicator of parent health literacy. *Ambulatory Pediatrics, 4,* 424-428.

Saussure, F. de (1983). *Course in general linguistics.* London: Duckworth. (Original work published in 1922).

Scarborough, H. (2001). Connecting early language and literacy to later reading (dis)abilities: Evidence, theory, and practice. In S. B. Newman & D. K. Dickinson (Eds.), *Handbook of early literacy research* (pp. 97-110). New York: Guilford Press.

Scarborough, H., & Dobrich, W. (1994). On the efficacy of reading to preschoolers. *Developmental Review, 14,* 245-302.

Schafer, J. L., & Graham, J. W. (2002). Missing data: Our view of the state of the art. *Psychological Methods, 7,* 147-177.

Schneider, B., Carnoy, M., Kilpatrick, J., Schmidt, W. H., & Shavelson, R. J. (2007). *Estimating causal effects: Using experimental and observational designs.* Washington, DC: American Educational Research Association.

Schweinhart, L. J., & Weikart, D. P. (1997). The High/Scope Preschool curriculum comparison study through age 23. *Early Childhood Research Quarterly, 12,* 117-143.

Schweinhart, L. J., Weikart, D. P., & Larner, M. B. (1986). Consequences of three preschool curriculum models through age 15. *Early Childhood Research Quarterly, 1,* 15-45.

Sénéchal, M., & LeFevre, J. A. (2001). Storybook reading and parent teaching: Links to language and literacy development. In P. R. Britto & J. Brooks-Gunn (Eds.), *The role of family literacy environments in promoting children's emergent literacy skills. New directions for child and adolescent development, vol. 92,* (pp. 39-52).

Sénéchal, M., & LeFevre, J. A. (2002). Parental involvement in the development of children's reading skills: A five-year longitudinal study. *Child Development, 73,* 445-460.

Sénéchal, M., LeFevre, J. A., Smith-Chant, B. L., & Colton, K. V. (2001). On refining theoretical models of emergent literacy: The role of empirical evidence. *Journal of School Psychology, 39,* 439-460.

Sénéchal, M., LeFevre, J. A., Thomas, E. M., & Daley, K. E. (1998). Differential effects of home literacy experiences on the development of oral and written language. *Reading Research Quarterly, 33,* 96-116.

Shaywitz, B. A., Fletcher, J. M., & Shaywitz, S. E. (1995). Defining and classifying learning disabilities. *Journal of Child Neurology, 10,* 50-57.

Shaywitz, B. A., Shaywitz, S. E., Pugh, K. R., Skudlarski, R. K., Fulbright, R. K., Constable, R. et al. (1996). The functional organization of brain for reading and reading disability (dyslexia). *The Neuroscientist, 2,* 245-255.

Singer, J. D., Fuller, B., Keiley, M. K., & Wolf, A. (1998). Early child-care selection: Variation by geography, location, maternal characteristics, and family structure. *Developmental Psychology, 34,* 1129-1144.

Singer, J. D., & Willett, J. B. (2002). *Applied longitudinal data analysis.* New York: Oxford University Press.

Slavin, R. E. (2002). Evidence-based education policies: Transforming educational practice and research. *Educational Researcher, 31* (7), 15-21.

Smith, K., Downs, B., & O'Connell, M. (2001). Maternity leave and employment patterns: 1961-1995. *Current Population Reports, P70* (79), 1-21.

Smylie, M. A. (1989). Teachers' view of the effectiveness of sources of learning to teach. *Elementary School Journal, 89,* 543-558.

Snow, C. E. (1983). Literacy and language: Relationships during the preschool years. *Harvard Educational Review, 53,* 165-189.

Snow, C. E. (1991). The theoretical basis for relationships between language and literacy development. *Journal of Research in Childhood Education, 6,* 5-10.

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

Snow, C. E., Burns, M. S., & Griffin, P. (1998). *Preventing reading difficulties in young children.* Washington, DC: National Academy Press.

Snow, C. E., & Goldfield, B. A. (1982). Building stories: The emergence of information structure from conversation and narrative. In D. Tannen (Ed.), *Analyzing discourse: Text and talk.* Washington, DC: Georgetown University Press.

Snow, C. E., & Goldfield, B. A. (1983). Turn the page please: Situation-specific language acquisition. *Journal of Child Language, 10,* 551-569.

Snow, C. E., & Ninio, A. (1986). The contracts of literacy: What children learn from learning to read books. In W. H. Teale & E. Sulzby (Eds.), *Emergent literacy: Writing and reading* (pp. 116-138). Norwood, NJ: Ablex.

Snow, K., Thalji, L., Derecho, A., Wheeless, S., Lennon, J., Kinsey, S., et al. (2007). *User's manual for the ECLS-B longitudinal 9-month – Preschool restricted-use data file and electronic codebook.* Washington, DC: National Center for Education Statistics.

Snowling, M. J. (1995). Phonological processing and developmental dyslexia. *Journal of Research in Reading, 18,* 132-138.

Sroufe, G. E. (1997). Improving the "awful reputation" of education research. *Educational Researcher, 26*(7), 26-28.

Stahl, S. A. (1992). Saying the "p" word: Nine guidelines for exemplary phonics instruction. *The Reading Teacher, 45,* 618-625.

Strickland, D. S., & Morrow, L. M., (Eds.) (1989). *Emerging literacy: Young children learn to read and write.* Newark, DE: International Reading Association.

Stuart, E. A. (2007). Estimating causal effects using school-level data sets. *Educational Researcher, 36,* 187-198.

Sulzby, E. (1985). Children's emergent reading of favorite storybooks: A developmental study. *Reading Research Quarterly, 20,* 458-481.

Sulzby, E., & Teale, W. H. (1991). Emergent literacy. In R. Barr, M. L. Kamil, P. Mosenthal, & P. D. Peason (Eds.), *Handbook of reading research* (Vol. 2, pp. 727-757). New York: Longman.

Summers, J. A., Steeples, T., Peterson, C., Naig, L., McBride,S., Wall, S., et al. (2001). Policy and management supports for effective service integration in Early Head Start and Part C programs. *Topics in Early Childhood Special Education, 21,* 16-30.

Sumner, G., & Spietz, A. (1994). *NCATS Caregiver/Parent-Child interaction teaching manual.* Seattle, WA: NCAST Publications, University of Washington, School of Nursing.

Tate, R. L. (2000). Elaboration of HLM growth modeling results. *Florida Journal of Educational Research, 40,* 53-75.

Teale, W. H., & Sulzby, E. (Eds.) (1986). *Emergent literacy: Writing and reading.* Norwood, NJ: Ablex.

Teale, W. H., & Sulzby, E. (1989). Emergent literacy: New perspectives. In D. S. Strickland & L. M. Morrow (Eds.), *Emerging literacy: Young children learn to read and write.* Newark, DE: International Reading Association.

Temple, J. A., & Reynolds, A. J. (2007). Benefits and costs of investment in preschool education: Evidence from the Child-Parent Centers and related programs. *Economics of Education Review, 26,* 126-144.

Thomas, S. L., & Heck, R. H. (2001). Analysis of large-scale secondary data in higher education research: Potential perils associated with complex sampling designs. *Research in Higher Education, 42,* 517-540.

Thompson, W. W. (1985). Environmental effects on educational performance. *The Alberta Journal of Educational Psychology, 31,* 11-25.

Tomlin, J. B., & Buckwalter, P. R. (1994). Studies of genetics of specific language impairment. In R. Watkins & M. Rice (Eds.), *Specific language impairment in children* (pp. 17-34). Baltimore, MD: Brookes Publishing.

Torgensen, J. K., Wagner, R. K., & Rashotte, C. A. (1994). Longitudinal studies of phonological processing and reading. *Journal of Learning Disabilities, 27,* 276-286.

Tseng, V., & Seidman, E. (2007). A systems framework for understanding social settings. *American Journal of Community Psychology, 39,* 217-228.

U.S. Bureau of the Census. (1999). *Statistical abstract of the United States, 1999.* Washington, DC: U.S. Census Bureau.

U.S. Department of Labor, Bureau of Labor Statistics. (2007). *Employment characteristics of families in 2006.* Retrieved on 22 May 2008, from http://stats.bls.gov/news.release/famee.nr0.htm

Velicer, W. F., & Jackson, D. N. (1990). Component analysis versus common factor analysis: some issues in selecting an appropriate procedure (with comments and replies). *Multivariate Behavioral Research, 25,* 1-114.

Vinovskis, M. A. (1999). Do federal compensatory education programs really work? A brief historical analysis of Title I and Head Start. *American Journal of Education, 107,* 187-209.

Vinovskis, M. A. (2005). *The birth of Head Start.* Chicago: University of Chicago Press.

Vygotsky, L. (1962). *Thought and language.* Cambridge, MA: MIT Press.

Vygotsky, L. (1978). *Mind in society: The development of higher psychological functions.* Cambridge, MA: MIT Press.

Wagner, R. K., Torgensen, J. K., Rashotte, C. A., Hecht, S. A., Barker, T. A., Burgess, S. R., et al. (1997). Changing relations between phonological processing abilities and word-level reading as children develop from beginning to skilled readers: A five-year longitudinal study. *Developmental Psychology, 33,* 468-479.

Walsh, D., Price, G., & Gillingham, M. (1988). The critical but transitory importance of letter naming. *Reading Research Quarterly, 28,* 108-122.

Werner, H. (1957). The concept of development from a comparative and organismic point of view. In D. B. Harris (Ed.), *The concept of development.* Minneapolis, MN: University of Minnesota Press.

Werner, H., & Kaplan, B. (1962). *Symbol formation.* New York: Wiley.

Wertsch, J. (1991). *Voices of the mind: A sociocultural approach to mediated action.* Cambridge, MA: Harvard University Press.

Whitehurst, G. J., & Lonigan, C. J. (1998). Child development and emergent literacy. *Child Development, 69,* 848-872.

Whitehurst, G. J., Zevenbergen, A. A., Crone, D. A., Schultz, M. D., Velting, O. N., & Fishcel, J. E. (1999). Outcomes of an emergent literacy intervention from Head Start through second grade. *Journal of Educational Psychology, 9,* 261-272.

Yoshikawa, H. (1995). Long-term effects of early childhood programs on social outcomes and delinquency. *The Future of Children, 5,* 51-75.

Zanutto, E., Lu, B., & Hornik, R. (2005). Using propensity score subclassification for multiple treatment doses to evaluate a national antidrug media campaign. *Journal of Educational and Behavioral Statistics, 30,* 59-73.

Zigler, E. (1970). The environmental mystique: Training the intellect versus development of the child. *Childhood Education, 46,* 402-412.

Zill, N., Collins, M., West, J., & Hausken, E. (1995). *Approaching kindergarten: A look at preschoolers in the United States.* Washington, DC: Office of Educational Research and Improvement, NCES and NHES.