A thesis

submitted by

Brandon Foster

entitled

A Longitudinal Study of the Relationship Between Children's Lexical Acquisition, Socioeconomic Status and Classroom Environment

In partial fulfillment of requirements
for the degree of

Master of Arts

in

Child Development

TUFTS UNIVERSITY

August, 2013

ADVISER: Calvin Gidney, Ph.D.

An Abstract of

A Longitudinal Study of the Relationship Between Children's Lexical Acquisition, Socioeconomic Status and Classroom Environment

by

Brandon Foster

Submitted to the Graduate School of Arts and Sciences in partial fulfillment of requirements for a Master's of Arts in Child Development

Tufts University

June 18, 2013

This thesis utilizes multilevel growth curve modeling to examine the impact of socioeconomic status (SES) and classroom environments on children's lexical development from the fall of preschool to the spring of kindergarten. Fitting with prior research finding that macro measures of SES (i.e., mother's highest level of education and family income) is predictive of children's lexical abilities, this study found that both mother's highest level of education and family income were predictive of children's initial level of lexical ability, but not changes in their abilities. This study also found that measures of classroom environment, specifically the Concept Development and Quality of Feedback subscales of the Classroom Assessment Scoring System (CLASS) predicted children's initial level of lexical abilities, but not changes in in lexical development across time. Findings and limitations are explored.

Table of Contents

List of Tables

Impact

Learning a language is a foundational ability that children draw on as they enter into the first formal years of education in order to access curriculum and gain subsequent literacy. Lexical acquisition, or receptive language as it is sometimes called in strictly developmental literatures, is the foundation and catalyst for acquiring any language. It is a process that involves the acquisition of word forms, their subsequent meanings and later associations (Kit, 2003), all of which are the most critical precursors to the development of subsequent higher-order linguistic abilities, and ultimately language (Kit, 2003).

Lexical acquisition begins during infancy, and because languages adapt to the times, it is a process that persists throughout the lifespan. As is the case with many developmental processes, lexical acquisition demonstrates remarkable progress in children's earliest years, a fact that bootstraps with children's continued path to developing higher-order cognition. In fact, by 30 months of age children acquire on average 570 words (Fension, et. al., 1994), and 18 months later children know and average of 6000 words (Chall, 1987).

This trajectory, like many other aspects of language, remains ontogenetically stable across time – in so far as the best predictors of future language skills are the autoregressive paths that precede it (Bornstein & Putnick, 2012). However, despite this children demonstrate great variability in their patterns of lexical acquisition (Hart & Risley, 2003; Weizman & Snow, 2001). This is a fact that can be traced to differences in children's educational experiences at home with primary caregivers (Hart & Risley, 2003), and these differences have been examined continually in the research over the last two decades as related to socioeconomic status. There is little denying the insidious effects of poverty on children's early development (Duncan & Brooks-Gunn, 2000). With language specifically, much has been talked about amongst practitioners in early childhood education settings about the "word gap." With language specifically, much has been talked about amongst practitioners in early childhood education settings about the "word gap", and it is estimated that by age 3 children living in poverty have a 30 million-word deficit when compared against their high SES peers (Hart & Risley, 2003). The "word gap" that is created in low-income children is in part due to family-level inequities. These include, but are not limited to: parents' lack of access to college educations, lack of monetary resources that allow for the continual providing of rich educational materials that promote language development in children, etc. These inequities, in turn, result in close dyadic interactions between parents and their children that lack in the quality of speech patterns that has been demonstrated to promote children's lexical development (Hart & Risley, 2003).

These early differences in lexical acquisition profoundly impact children's experiences in the first formative years of formal education, as initial linguistic abilities affect school readiness, and subsequent access to curriculums. With two-thirds of four year olds attending preschool (Barnett & Yarosz, 2004), and with the linguistic skills fostered during this time portending later kindergarten achievement (La Paro & Pianta, 2000**;** Duncan et. al., 2007), the classroom has become a critical part of a child's ecology for developmental scientists, policymakers, teachers and parents to understand.

In addressing this aim researchers need to better understand the relationship between school contexts and specific developmental phenomena (i.e., lexical acquisition). To the extent that children's early academic achievement in preschool and kindergarten is a product of sequential processes of skill acquisition embedded in a larger linear developmental trend, understanding the aforementioned relationships might bolster practitioners' and policy makers' attempts at improving children's achievement (Duncan, et.al., 2007). Additionally, it is critical that researchers continue to probe interactions between school learning contexts and children's at home learning contexts, as this can help to explain how home experiences may mediate or moderate developmental outcomes (i.e., lexical acquisition). To the extent that those at the vanguard of public policy at all levels understand these kinds of interactions, the design of truly targeted interventions that focus on domain-specific developmental phenomena, such as the critical linguistic pathways that promote school readiness, will be improved.

Chapter One

Literature Review

The Importance of Considering Caregivers' Interactions

Understanding how children acquire language was historically viewed from two perspectives. The inside-to-out perspectives of language acquisition were influenced by nativist theories, namely the work of Chomsky (1965, 1986), and attributed the task of word learning to largely genetic factors. Within these perspectives the role of the environment was simply to activate pre-existing language modules inside children's brains, and the word learning process automatically unfolded (MacWhinney, 2004). Modular theories such as Chomsky's were viewed as parsimonious solutions to the "logical problem" of language acquisition, namely the issue of poverty of the stimulus in caregiver's speech (MacWhinney, 2004). In reaction to these deterministic views, the field moved to perspectives emphasizing the importance of environmental factors in the word learning process, or outside-to-in perspectives of language acquisition. Within these perspectives, the role of children's early linguistic interactions with caregivers was of paramount importance, as these early linguistic interactions were thought to drive subsequent language acquisition in children (MacWhinney, 2004). These theories solve the "logical problem" of language acquisition with research that continually highlights the consistency, regularity and sensitivity of caregivers' linguistic interactions with their children (Chapman, 2000; Tomasello, 2000). This indicates that what children hear from the time they are born onward through the first few years of life is not a chaotic wash of atonal and arrhythmic sounds but rather a finely tuned symphony of rich linguistic cues and context for children to discover as they chart their own path through the acquisition of a language.

Theories of language acquisition that emphasize the environmental factors that promote the word learning process in children are situated inside larger sociocultural theories of development (Bruner, 2002; Vygotsky, 1962, 1978). Broadly speaking, the primary goal of these theories is to understand development as a cultural exchange of knowledge brought about through processes evident in many day-to-day interactions (Bruner, 2002; Cristofaro & Tamis-LeMonda, 2011; Vygotsky, 1978, 1986). Here the processes inherent in these day-to-day interactions catalyze development, as parents alter these processes to the individual needs of their children in order to scaffold them to higher levels of cognition. (Vygotsky, 1978, 1986).

The Social Pragmatic Theory of Word Learning (Tomasello, 2000) is steeped in the broader sociocultural movement, and is the most refined and updated version of a theory of language acquisition emphasizing the outside-to-in perspective. The theory takes into account the dyadic interactions between children and caregivers by emphasizing *what* caregivers do in their day-to-day interactions with children to provide rich linguistic environments for their children to learn words (Poll, 2011; Tomasello, 2000). This theory builds on the larger sociocultural movement within a word-learning framework by positing that language is a shared attention skill, and is a product of a child's advanced social and cognitive skills. In fact, Tomasello (2000) describes the primary goal of acquiring language as the ability to manipulate attention in shared conversational experiences. These advanced cognitive skills on the part of the child allow for children to accommodate to the speaker, and intent of the speaker, in context. The subsequent interactions that unfold in these joint attention episodes drive language acquisition in the child. As the child becomes able to control the joint attention frame it opens up the door to new linguistic experiences and higher levels of linguistic competencies, creating a feedback loop in which these new opportunities allow caregivers to continually individualize the quality of their speech to the child's linguistic needs (Tomasello, 2000). Here the link to the larger sociocultural perspectives of Vygotsky and Bruner is evident, as the fundamental importance of social environments as the drivers of development cannot be obviated.

More specifically, the research situated within this theoretical perspective has called attention to *what* caregivers do with words in close dyadic interactions with their children to promote their children's language acquisition. This research has focused on the regularity, sensitivity and variation in how parents direct their interactions with their children. Many themes have emerged from this research that center on the quantity and quality of caregivers' language input to their children. This has led to an initial understanding of the environmental inputs necessary in close dyadic interactions between caregivers and children that promote language acquisition in children.

First, research has demonstrated that the overall quantity of maternal child directed speech is an important factor to consider in predicting children's lexical acquisition. The theory of change governing the importance of quantity is simply that part of the word learning process, especially in early years, is an ability to consider word flow as a statistical distribution within which the child extrapolates patterns occurring with statistical regularity. The more words a child is exposed to, the more precise the linguistic distribution becomes, and the more words can be extrapolated and enter into the child's lexicon – as initially the association between word sounds and object referents in the real world becomes more apparent and correlated across time, and as subsequent linguistic word associations become more correlated through the refinement of morphosyntactic alignment due to the repeated exposure to words (Brent, 1997; Kuhl, 2004). Support for this can be found in the work of Huttenlocher, Haight, Bryk, Seltzer & Lyons, (1991), who utilized a growth curve framework to examine the lexical acquisition of 22 typically developing children. The researchers found that the quantity of maternal speech was related to the growth of their child's lexical acquisition. Additional support for this result is found in the work of Hart & Risely (1995), who's seminal work is frequently cited to underline how the frequency of parental talk is related to the changes in the quantity of children's lexical acquisition up through age 9, and differences in performance scores on standardized linguistic tests. However, other research has diverged slightly from the aforementioned findings by demonstrating that the effect of frequency on children's language acquisition differs by the category of language examined. Here frequency is defined as the quantity of multiple exposures to a word. For example, Goodman, Dale & Li (2008) utilized the Child Language Data Exchange System (CHILDES), the largest database for probing first language acquisition with data consisting of many recordings of close dyadic interactions, to investigate the relationship between parent child interactions and subsequent children's linguistic capabilities (MacWhinney, 2000). Researchers found that the frequency of parental talk predicted later language acquisition in children, but the effect of frequency differentiated by the kind of language under investigation. Here results showed that parental frequency predicted earlier lexical acquisition in children. This is a finding that indicates that the association between caregivers' quantity of speech and children's lexical acquisition might be more complex than a simple 1 to 1 explanation. Taken in conjunction this early work suggests that predicting children's lexical acquisition might have more to do with the amount of repeated exposure to novel words.

The diversity and sophistication of caregiver speech is another critical component in conceptualizing the quality of their speech. This work is centered on the importance of children's exposure to novel words in dyadic interactions. The central idea behind this research is that quantity alone is not an adequate predictor of language acquisition. For example, computational models of language acquisition, have examined the diversity of caregivers' speech. Diversity is defined as the number of different word forms and meanings caregivers express to their children (McKee, Malvern & Richards, 2000). More pragmatically, diversity is a metric for the novelty represented in caregivers' speech. Interestingly, this line of research has suggested that quantity of caregivers' speech might dampen the variety of their child-directed speech. Sophistication is another measure of lexical diversity, and has been linked to children's lexical development. For example, Weizman & Snow (2001) examined maternal talk in parent-child interactions with a focus on examining the frequency of exposure to sophisticated words, defined as words outside of the 3,000 most common words children encounter in home or in the classroom. They found that a higher ratio of sophisticated words to 1,000 word tokens predicted children's lexical acquisition at age 5. This result has also been replicated within a longitudinal design, which used growth curves to examine the maternal predictors of children's language acquisition in the first 3 years of life. Again, results indicated that lexical sophistication is a major predictor of children's lexical acquisition, particularly around the second year of life (Pan, Rowe, Singer & Snow, 2013). Lastly, other research has replicated these results in the classroom, finding that teachers use many of the same aforementioned techniques to assist children in acquiring a language (Bowers & Vasilyeva, 2011).

Just as the quantity of caregivers' speech was more nuanced than originally conceptualized, sophistication and diversity of caregivers' speech is also not without its nuance. Researchers have explored *what* caregivers do when introducing novel lexical items to children. Of principal importance in this research are the children's conditions of exposure to sophisticated lexical items, as it is argued that an understanding of these conditions are a critical pathway in unlocking the mechanisms that drive children's lexical acquisition (McKee, et.al., 2000; Weizman & Snow, 2001). This work has demonstrated the importance of meaningful exposures to novel words in close dyadic interactions between parents and caregivers by highlighting the importance of supportive contexts that provide interpretable meaning to novel words introduced to children in close dyadic interactions. More specifically, it has been reported that mothers who provide their children with up to 30 helpful interactions for every 1,000 words spoken have children with improved lexical abilities (Weizman & Snow, 2001). These interactions can be described as containing high degrees of scaffolding from parents in which they provide contextual cues to the meaning of novel words in order to aid children in incorporating the words into their lexicons (Bruner, 1975; Bruner, 1983; Snow & Beals, 2006; Weizman & Snow, 2001). This most frequently occurs within the context of joint attention episodes, as parents are fluid in their ability to track the objects that their children are paying attention to, and adjust their context specific language accordingly (Estigarribia & Clark, 2007; Tomasello & Farrar, 1986; Tomasello, 2000). The increased use of joint attention episodes by teachers has also shown to be predictive of children's language development in the classroom (Rudd, Cain & Saxon, 2008). Within these joint attention episodes, wh- questions (who, what, where, why, how, etc.) function as a linguistic tool caregivers use to guide interactions and force children to utilize advanced metacognitive abilities to respond to their enquiries, and these questions have been associated with children who have advanced linguistic abilities (Rowe, Coker & Pan, 2004). Maternal pointing is a tool that mothers use within these episodes to aid in drawing attention to their context specific language, and has also been related to their frequency of talk and children's later lexical acquisition (Goldfield & Reznick, 1990; Rowe & Goldin-Meadow, 2009). Routinized games are another opportunity parents provide their children with, and these have been shown to provide children with predictable expectations about the contexts in which new word exposures occur, and aid children in the in the process of growing a lexicon (Bruner, 1975; Bruner, 1983).

Lastly, shared book reading is a regularized routine in which context plays an important role in children's lexical acquisition. These are routine experiences that children have at home and in the classroom in which they are repeatedly exposed to a high quantity of novel words and are provided many cues (i.e., prosodic emphasis to unfamiliar words, picture aids, etc.) and this has been shown to promote lexical acquisition in children (Brett, Rothlein & Hurley, 1996; Clark, 2010; Elley, 1989; Feitelson, Goldstein, Iraqi & Share, 1993).

The take-away from this research is clear. Caregiver interactions with children do matter, and do foster lexical acquisition in children. This research highlights just how complex an endeavor it is to understand these dyadic interactions. What we know is that lexical quantity, sophistication and support are the three defining features that caregivers use to promote lexical acquisition in children (Weizman & Snow, 2001). However, the focus of this research has been to understand lexical acquisition from an exclusively outside-to-in perspective (Chapman, 2000). Consequently, this body of research lacks in that it considers the processes that drive lexical acquisition as anything other than unmediated construct. Solely focusing on the interactions of caregivers and children is invaluable for understanding the processes that propel development. However, it does little to address individual differences in development. To address these issues, researchers need to consider important contextual factors that mediate or moderate the processes related to lexical development.

An Emergentist Perspective

The research on language acquisition has recently moved towards emphasizing emergentist perspectives to better understand how children acquire language (Chapman, 2000; MacWhinney, 2004; Poll, 2011). Both the technological and methodological advancements of the 21st century have led language researchers down several seemingly discrete lines of research.

New technological paradigms have included studies of brain imaging and neural networks, which have highlighted the importance of accounting for the emergence of language with person-specific data. Simultaneously, methodological advancements have allowed researchers to better utilize complex longitudinal datasets to understand language acquisition. This work has highlighted the statistical regularity of linguistic input across all children, and does so by emphasizing how context-specific variables affect the processes that lead to the acquisition of language, and in turn produce individual variations in patterns of lexical acquisition (MacWhinney, 2004).

All of this work is influenced by a larger movement in developmental science that embraces a dynamic systems perspective in understanding issues of development (Barnett, Gustafsson, Deng, Mills-Koonce & Cox, 2012; Bronfenbrenner & Evans, 2000; Chapman, 2000; Gottlieb, 1992; Poll, 2011; Thelen, 1995; Thelen & Smith, 2006). Bronfenbrenner's Bioecological Model of Human Development (Bronfenbrenner & Morris, 1983) is often cited within these perspectives. The model considers all developmental phenomena through four constructs: the process, person, context and time. It posits that developmental phenomena are understood best as a function of reciprocal interactions between systems (i.e., processes) that are both person-specific (i.e., internal factors) and context specific (i.e., external factors) across time. Additionally, this theory posits increasing levels of developmental organization within organisms that are brought about through small changes in the person and context reciprocal interactions, and that these changes within organisms can, in turn, change context-specific and person-specific factors (Barnett, Gustafsson, Deng, Mills-Koonce & Cox, 2012; Bronfenbrenner & Evans, 2000; Chapman, 2000; Gottlieb, 1992; Lerner & Kauffman, 1985; MacWhinney, 2004; Poll, 2011; Thelen & Smith, 2006).

This theoretical perspective allows researchers to consider the important proximal factors that are associated with lexical acquisition, such as parents, teachers and classrooms. Much of this work resembles the research covered in the previous section pertaining to the social pragmatic perspective of language acquisition. Within the Bioecological Model framework the proximal processes of interest are the linguistic exchanges that unfold in the close dyadic interactions between caregivers and children. However, this theoretical perspective goes further in allowing us to understand how proximal processes can be mediated or moderated by important contextual factors, such as the factors associated with socioeconomic status (Snow, 1983). These mediated or moderated interactions result in considerable variation in the acquisitional patterns associated with lexical development, and in turn influence further development within the domain of lexical acquisition and across other domains (Bronfenbrenner & Morris, 1983; Chapman, 2000; Poll, 2011; Raviv, Kessenich & Morrison, 2004; Snow, 1983).

Socioeconomic Status, Development & Language. Socioeconomic status (SES) has been shown to be an important context that influences the proximal processes that promote development in children (Snow, 1983). Census data from 2010 indicated that 22% of all children in the United States are being raised in poverty, with 6 million of these children under the age of 6 (Bureau of Census, 2010). This in particular is a period of rapid language development, making it all the more critical to understand the impact of factors associated with growing up in low-income families on children's lexical development.

So, what is it about these environments that influence caregivers, and the subsequent proximal processes they provide their children to influence their lexical development? Depression has been called the defining psychological response to living in poverty (Newland, Crnic, Cox & Mills-Koonce, 2013). Depression, in turn, predicts increased levels of adversity, such as increases in instances of divorce, unemployment and higher levels of financial difficulty (Ertel, Rich-Edwards & Koenen, 2011). It is hypothesized that these adversities lead to dissipations of important social supports, and decreases in caregivers' sensitivity in interactions with their children (Bettes, 1988; Lovejoy, Graczyk, O' Hare & Neuman, 2000; Newland, et. al., 2013).

The most traditional and general indices of SES, such as family education, income and occupational status, have continually linked the deleterious effects of poverty to a range of global cognitive processes in children (Brooks-Gunn, Duncan, & Britto, 1999, Duncan, Brooks-Gunn & Klebanov, 1994; Felner, et. al., 1995). When language is examined separately many of these global SES measures predict language outcomes in children. For example, an often-cited meta-analysis by White (1982) found an average correlation of .34 between family SES factors and children's verbal development, after controlling for measurement differences of the constructs. A replication of this meta-analysis by Sirin (2005) found a slight decrease in the strength of this relationship, with the correlation falling to .30. More importantly, the effects of SES on lexical acquisition have been demonstrated to persist through the first formal years of education, and have been shown to influence academic performance through 3rd grade (Walker, Greenwood, Hart & Carta, 1994).

Many general proxies for SES have been demonstrated to impact the proximal processes parents provide to their children. These also have been posited as prime candidates in predicting the quality of parental talk and subsequent lexical development of children from low-income families. Much of this work was catalyzed by the early research of Hart and Risley's (1992, 1995) – who's seminal work drew attention to the "word gap," which underscored how early differences in home environments led to an estimated 30 million word gap between children growing up in low income families and those brought up in more privileged families (Hart & Risley, 1995). The studies can be described as both qualitative and longitudinal in nature, as 42 children from a wide range of socioeconomic backgrounds were followed from birth to age 3. Parent and child talk was recorded for several hour-long intervals throughout the 3 years. Researchers found that SES impacted both the quality and quantity of maternal speech to children across the first 3 years of life, and this predicted children's vocabularies by age 3. In a smaller cohort of families recruited from the original study, these early differences predicted children's abilities on standardized vocabulary assessments at age 9. While this work was ground breaking in scope and detail, it was conducted with a small sample, lacked socioeconomic diversity and was prone to selection effects. Analyses of the data consisted primarily of simple frequency overtime graphs and simplified regression techniques. Regardless of the flaws in Hart & Risley's work, their research drew attention to the importance of examining how these early linguistic environments are impacted by factors associated with SES. Additionally, the general conclusions of the study have been replicated in the research. For example, caregivers' education and vocabulary and literacy skills have been shown to predict the quality of their talk to children, with increased levels of caregiver education and occupational status predicting both the richness of their vocabulary and length of their utterances spoken to children in close dyadic interactions (Dollaghan, et. al., 1999; Hoff & Tian, 2005). Additionally, parents from high SES backgrounds tend to provide their children with more gestures to guide their attention to context specific aids when conversing with their children, and this predicts children's lexical acquisition at 54 months (Row & Goldin-Meadow, 2009).

Recent advancements in developmental methodology have allowed researchers to address the role of SES and children's lexical acquisition with considerable sophistication and nuance.

For example, a mediation model examined the mechanisms through which SES led to later variation in children's lexical acquisition. This model found several important paths between SES and subsequent children's lexical acquisition. Maternal sensitivity, children's home cognitive environment and maternal affectivity were demonstrated to partially mediate the relationship between SES and children's lexical acquisition, as the effect of SES factors was demonstrated to impact children's vocabulary at age 3 above and beyond parent proximal factors (Raviv, et al., 2004). Other important parental proximal processes that promote lexical acquisition in children have been examined with longitudinal data. Cristofaro & Tamis-LeMonda (2012) examined the parental proximal processes affecting children's lexical development in 75 low-income families. Results showed that the frequent use of mothers' "wh-" questions and overall lexical diversity predicted the level of children's lexical acquisition at age 3, and subsequent school readiness in kindergarten. Pan et. al., (2005) mirrored these results with multilevel growth curve modeling in a sample of low income families. Researchers found considerable intra-individual differences in prototypical patterns of change in children's lexical development from birth to age 3. This variation was predicted by the quality of maternal lexical input, maternal language and literacy skills and maternal depressiveness. Low levels of the quality of maternal speech and language and literacy skills, combined with high levels of maternal depression predicted slower growth in children's language acquisition; these effects became more pronounced across time. Lastly, these early language experiences have been shown to explain 1 SD in children's vocabulary development by the time they enroll in preschool (Rodriguez & Tamis-LeMonda, 2011).

Taken in conjunction, these studies highlight several important points. First, that SES does impact the parental proximal processes that promote language acquisition in children in dynamic ways. Children from low-income families show slower rates of lexical development than their advantaged peers. Enriched home environments, with parents who support their children's language acquisition with rich, sensitive child-centered talk and supplemental materials, which promote literacy, are important factors in predicting children's lexical development. However, SES can impact the quality of these environments through maternal affectivity. The stresses that come with living in low-income environments can increase maternal depression, lower maternal affectivity and sensitivity, and in turn predict the quality of maternal speech to children.

Formative Experiences in Early Childhood Settings. Preschool is another important context with unique proximal process to consider when examining children's lexical development. These programs are inherently designed to foster children's academic skills and later school readiness, and have been critical in efforts aimed at closing the achievement gap (Howes, Burchinal, Pianta, Bryant, Early, Clifford & Barbain, 2008). It is estimated that 60% of children experience some kind of formal preschool program before enrolling in school, and this number has increased markedly for children who come from low-income families (Curby, Rimm-Kaufman & Ponitz, 2009). In theory the best programs are ripe with rich learning opportunities, rich instructional materials and qualified staff that provide positive teacher and peer interactions. These in turn enhance children's lexical skills as they provide rich language experiences and exposure to new words (NICHD & Duncan, 2003, Weiland, Ulvestad, Sachs & Yoshikawa, 2013).

Classroom quality has been conventionally dichotomized into structural features of the classroom and environmental processes inherent within the classroom. Structural features include: teacher credentials, program location, adult to child ratio, etc. These are often features of the classroom that can be regulated easily in state funded preschools (Howes, et. al., 2008). Structural features alone have been modestly related to children's lexical development with small effect sizes (Duncan & Gibson-Davis, 2006; Cassidy, Hestenes, Hegde, Hestenes & Mims, 2005).

Of more interest to researchers have been the proximal processes within the classroom that drive children's development. In fact, the NICHD ECCRN (2002) has called attention to this and emphasized the importance of documenting the variations in the quality and quantity of teachers' interactions with children in investigating issues of development. Proxies for these interactions have been examined in the literature through measures of classroom environment. Indicators of these measures of classroom quality typically include social, emotional and instructional aspects of the classroom. Theories of change underlying the critical pathways for enhancing children's academic competencies utilizing these measures are situated in developmental literature focused on bolstering socioemotional and motivational levels in the class (Connell & Wellborn, 1991; Deci & Ryan, 1985; Eccles, 1993; Raver, 2002; Wentzel, 2002) as a means for enhancing instructional levels in the classroom (Resnick, 1994; Stevenson & Lee, 1990) to improve children's academic outcomes.

Within the preschool classroom two factors of class environment have emerged as predictive of children's achievement. Instructional Support and Emotional Climate, both explicit latent factors of the Classroom Assessment Scoring System (CLASS) (Pianta, Laparo & Hamre, 2004), have been associated with developmental outcomes in two distinct ways. First, Instructional Support, when evaluated both in conjunction with and separately from Emotional Climate, consistently predicts children's general academic outcomes (Howes, et. al., 2005). Emotional Climate tends to predict secondary abilities that are important for children's subsequent academic achievement such as self-regulation skills and motivational abilities (Howes, et. al., 2005). However, some researchers have argued the fostering of socioemotional abilities in children is more predictive of their later academic success across the school years (Zins, Bloodworth, Weissberg & Walberg, 2004). It is argued that classrooms with high degrees of positive climates, marked by increased levels of teacher sensitivity, enthusiasm, encouragement, increase children's attitudes about their teachers and education, and improve their academic motivational abilities by increasing self-efficacy (Cronsoe, Johnson & Elder, 2004; Skinner & Belmont, 1993; Zins, et. al., 2004).

The relationship between child, family and classroom-level factors to the Instructional Support and Emotional Climate in classrooms has been examined across a range of children's ages. Researchers have found that children experience stability in the Emotional Climates that they are exposed to in the first formal years of early education, but that the Instructional Support they receive tends to waver across time (Pianta, Belsky, Houts & Morrison, 2007). Additionally, children rarely ever experience consistently high scores in either domain (Pianta, et. al, 2007). The associations between the classroom environments and the structural components of the classroom are another important potential predictor of the overall classroom environment that children experience. These components include education of teachers and aids, professional development opportunities, class size, etc. Structural components alone have not been consistent predictors of children's overall academic achievement (Early et. al., 2007). However, these components have been associated with measures of classroom environment. For example, large class sizes have been associated with lower levels of positive climate in the classroom (Pianta, et. al., 2007). In terms of Instructional Support, those teachers with fewer years of education and who are paid higher salaries tend to provide children with higher levels of Instructional Support (Pianta, et. al., 2007). However, LoCasale-Crouch, et.al. (2007) diverged slightly from these results. Their research utilized cluster analysis to demonstrate that classrooms show a wide range of individual differences in the quantity of the environmental processes evident in classroom. General clusters show classrooms with both high and low overall levels of Emotional Climate and Instructional Support, and middle-tier classes with a mix of both high or low Instructional Support and Emotional Climate. However, the researchers found structural aspects of the classroom such as teachers' educations were not linked to clusters containing like levels of classroom environments. Another important association is the one between family level characteristics and classroom environments. What researchers have discovered is that children who come from families with more highly educated mothers experience higher levels of Instructional Support and Emotional Climate (Pianta, et. al., 2007; NICHD, 2006). Moreover, those children who come from middle-tier SES backgrounds, and who have higher scores on standardized batteries for cognitive assessment experience higher levels of classroom environment (Pianta, et. al., 2007). Lastly, classrooms with the lowest quality ratings tend to serve the highest proportion of low-income families (LoCasale-Crouch, et. al., 2007).

In recent years the relationship between classroom environments and language outcomes has been examined with latent constructs for classroom environment. However, the research is not as extensive when lexical acquisition is the developmental construct of interest. Pianta, Bryant, Hamre, Downer, Burchianl, Early & Howe (2008) utilized the Classroom Assessment Scoring System (CLASS) (Pianta, LaParo & Hamre, 2007) to assess the impact of these classroom processes in relation to children's lexical development. Here several indicators for classroom environment were extrapolated into 2 factors that include the emotional and instructional climate of the class (Pianta, et.al., 2008). Their study accounted for prior language levels at time 1 and found that the only predictor of children's lexical development was the instructional support factor. This result has been replicated in another study conducted by Howes et. al. (2008), which utilized hierarchical linear modeling and also accounted for children's initial levels of academic preparation at time 1. The researchers relaxed the constraint of just examining children's lexical acquisition, and included several dimensions of overall language acquisition. They found that classroom processes, particularly instructional support, followed then by the teacher's perception of closeness to a particular child, predicted children's language abilities. The study also found no indication that structural components of programs predicted these outcomes, a finding that diverged slightly from research examining the sole effect of structural components on language outcomes (Duncan & Gibson-Davis, 2006; Cassidy, et. al., 2005). Lastly, a recent study utilized dueling model estimation techniques with children enrolled in state funded preschool programs in Boston, MA. This study is particularly interesting because preschools in the Boston Public School System have been demonstrated to impact children's development in substantially positive ways in regression discontinuity designs, which some argue are better than randomized controlled studies (Weiland & Yoshikawa, 2013). When the relationship between classroom quality and children's lexical development was estimated with linear models there was no significant relationship between the variables. When spline regression techniques were used to model a non-linear relationship between CLASS factors and children's language outcomes the only significant association between children's lexical development and classroom quality was for the emotional climate factor from the CLASS, a finding that is in contrast to the aforementioned research. Children with low lexical development showed increases in the level of positive emotional climate in their classrooms, which indicated possible threshold effects between these variables. This provides support for the idea that children who demonstrate considerable need in lexical development might benefit from teachers who provide emotionally supportive classrooms, which promote opportunities for children to access and engage with the curriculum. More importantly, this work highlights the importance of utilizing statistical techniques that allow for researchers to consider development as a non-linear process.

Taken in conjunction, these studies support the idea that teachers do, in fact, scaffold their students to higher levels of development, and that the most important factors to consider in examining this are the social emotional and instructional aspects of the classroom. However, there is still work to be done in teasing out exactly what classroom quality features relate to children's lexical development. Much of the aforementioned work has utilized latent constructs extrapolated from measures of classroom environments. This is an effective means for creating parsimonious models; however, there is the potential that the nuance of how the indicators for these constructs relate to specific developmental phenomenon is lost when latent model techniques are used to investigate children's lexical development. It might be the case that unique aspects of indicator behavior emerge in relation to children's lexical development when just subscales from the CLASS are used in models. Additionally, while much of this work has elucidated the proximal processes inherent in the classroom that promote language development, it still lacks in explaining how these classroom quality measures might be moderated by SES measures, and potentially lead to differences in lexical development. Prior research has highlighted how parent/child interactions are important for understanding children's lexical development, and that these interactions are moderated by SES factors. We know that children arrive in preschool with incredible differences in language ability as a result of how SES impacts children's language development. As posited by Bronfenbrenner's Bioecological Model of Development (2006), we can predict that these differences in turn affect not just the quality of classrooms children can access from a standpoint of financial means, but also the proximal processes within the classroom. For example, is it the case specific aspects of the emotional climate in the classroom affects children's lexical development for children from low-income families only? Perhaps aspects of instructional climate lead to the more rapid acceleration of lexical development for children from low-income families who have lower initial levels of lexical development? The point is that we need to continue to probe the interaction of SES factors and measures of classroom quality, for these are a primary means for answering these crucial questions. Lastly, much of this work, despite the use of modern statistical techniques such as hierarchal liner modeling, has failed to examine lexical acquisition as a developmental phenomenon. Large and diverse sample sizes go far in mitigating spurious results, while maximizing the inferential power of statistical models. However, examining developmental processes requires statistical models that do more than reduce the process under development to a residualized change score, which is what many studies do when only two time points are considered in the model. Examining lexical acquisition as a process under development necessitates longitudinal data. This includes not just longitudinal data pertaining to the processes of interest (i.e., language), but also longitudinal data for factors that affect change. In doing so, we will gain a deeper understanding of the intra-individual differences in inter-individual change. This would allow us to better understand how to construct more person-centered policies that could promote the positive and equitable development of children.

Research Questions

1. What is the relationship between macro measures of SES (i.e., mother's highest level of education and family income) and children's lexical development? It is expected that children's scores on a test of lexical development will be impacted by these factors, whereby children coming from higher SES families will demonstrate more advanced lexical development.
2. What is the relationship between the subscales of the Classroom Assessment Scoring System (CLASS) and children's lexical development? It is expected that all indicators of the Instructional Support construct, specifically the Concept Development, Learning Formats and Quality of Feedback subscales will be significantly related to children's lexical development, and that the remaining indicators of the Emotional Climate subscale (i.e., Positive Climate, Negative Climate, Teacher Sensitivity, Over-control, Behavior Management and Productivity) will demonstrate patterns of partial significance with children's lexical abilities, but that the effect sizes for these results will be smaller than the subscales that are derivative of the Instructional Support construct.
3. To what extent do the CLASS subscales interact with children's SES background to predict differences in children's lexical development? It is expected that SES measures will significantly interact with subscales from the CLASS to show that children from high SES families experience higher quality classroom environments, and that this will relate to children's lexical development.

Chapter Two

Methods

Growth Curve Modeling

Growth curve modeling can be viewed as an extension of the multilevel modeling framework: variables are measured across time and are nested within individuals. The primary aim of growth curve modeling is to estimate the inter-individual variability within intra-individual change patterns that occur across time (Curran, Obeidat, & Losardo, 2010; Singer, 1998; Singer & Willett, 2003). Put more simply, growth curve modeling is capable of investigating not just the average trend of a phenomenon of interest over time, but also the between person differences that surround the trend pattern (Grimm & Ram, 2009; Singer, 1998; Singer & Willett, 2003). Consequently, growth curve modeling is ideal for examining how a construct changes over time, how inter-individual differences might manifest in differences in the rate of change over time, how the level of the construct is related to the rate of change (Grimm & Ram, 2009; Singer, 1998; Singer & Willett, 2003).

The change in a construct of interest across time is described as a growth curve, and these curves can represent stability and change and growth and decay. Curves can be represented by linear, quadratic, cubic and polynomial functions (Grimm & Ram, 2009). Lastly, these growth trajectories can be influenced by time-invariant and/or time-variant covariates. Time-invariant covariates are often conceptualized as stationary covariates that influence the intercept and/or the slope of a model. Stationary implies that these are variables that do not change across measurement occasions, while time-varying covariates are items that change across measurement occasions, and for which the effect of the covariate on any given time is estimated by accounting for the effect at previous measurement occasions. Of course, the aforementioned descriptions are ideal examples of how covariates work. In practice longitudinal datasets are imperfect, and it is often the case that some information within these datasets is only collected at the first measurement occasion. Consequently, some variables that might be considered time-varying in theory only work as time-invariant in practice. The multilevel growth curve models necessitates a person-period dataset, time-varying covariates have multiple values across measurement occasions, while time-invariant covariates simply have the same value entered across all measurement occasions. At last, growth curve modeling is ideal for succinctly describing how differentiated and shared development is influenced by varying contexts across individuals (Baltes, 1987). Lastly, this framework for analysis fits well with the 5 objectives of longitudinal research, as described by Baltes & Nesselroade in 1979. These objectives are:

1. Direct identification of intra-individual change
2. Identification of inter-individual differences in intra-individual change
3. Analysis of interrelationships in behavioral change
4. Analysis of causes of intra-individual change
5. Analysis of cases of inter-individual differences in intra-individual change

Data

Data was drawn from The National Study of Early Development and Learning Multistate Study of Pre-Kindergarten, an 18-month longitudinal study (Clifford, Bryant, Burchinal, Early, Howes, Pianta & Winton, 2001). The aims of the study were to describe the varied experiences in school settings, and to examine how these experiences influence academic achievement in elementary school. Children were assessed on measures of academic achievement across 4 waves of data collection. These waves spanned the fall and spring of preschool and kindergarten, respectively. Data pertaining to children's background was gathered at the beginning of the study (see Clifford, et. al., 2003, for a more through outline of procedures).

Participants and Procedures

Participants were selected with a stratified random sampling method programs within states, and from classrooms and schools. These states included: California, Illinois, New York, Ohio, Kentucky and Georgia. A total of 940 children and parents participated in the original study. The sample for this study consisted of 786 children, families and teachers. These children were chosen for the study based on criteria of having a first language that was English, and they also took the PPVT-III in English. The gender cross-section in the study consisted of 51% females and 49% males. Children in the study were predominantly White (50%) this was followed by (30%) African American, (10%) Latino(a), (9%) Multiracial, (.5%) Asian and (.5%) Native American. Children were an average age of 4.57 (SD = 0.31) years old at the first measurement occasion. The average income for families in the study was 31,231$ (SD = 23,783$, Min = 2,500$ and Max = 87,500$). The average highest level of education achieved by mothers in the sample was 12.76 years (SD = 2.02, Min = 8 and Max = 20).

Measures

The *Peabody Picture Vocabulary Test 3rd edition* (PPVT-III) was used to assess children's lexical development (Dunn & Dunn, 1997). The test is a norm-referenced and culturally fair (Qi Huaqing, Kaiser, Milan & Hancock, 2006). During testing children are presented with a series of pictures. An examiner then states a word matching one of the items or scenes in the pictures and the child is asked to point to the picture that best matches the description. A variety of score types can be computed with results. The PPVT-III shows excellent test-retest reliability (Williams & Wang, 1997). Table 1 provides descriptive statistics for standard scores for the sample across all measurement occasions. As can be seen in Table 2 the PPVT-III showed strong positive stability across all measurement occasions.

Table 1

PPVT-III Scores Across All Measurement Occasions

	N	M	SD	Percent Missing
Preschool Fall	714	93.14	14.48	9%
Preschool Spring	733	96.22	13.51	7%
Kindergarten Fall	682	98.04	12.59	13%
Kindergarten Spring	673	99.56	11.58	14%

Table 2

Stability and Change of PPVT-III Scores Across All Measurement Occasions

	Preschool Fall	Preschool Spring	Kindergarten Fall	Kindergarten Spring
Preschool Fall	1.00			
Preschool Spring	.75***	1.0		
Kindergarten Fall	.75***	.79***	1.0	
Kindergarten Spring	.71***	.75***	.82***	1.0

Note. **p* < .01. ***p* < .001. ****p* < .0001.

The *Classroom Assessment Scoring System* (CLASS) was used to assess the socioemotional aspects, classroom supports and instructional practices (Pinata, Laparo & Hamre, 2004). Observational scoring is completed along 9 dimensions. Scores are assessed using a 7-point likert scale, with low scores indicating the classroom is low in a particular dimension, and high scores indicating the classroom is high in a particular domain. The CLASS subscales consist of: Positive Climate, Negative Climate (reverse coded), Teacher Sensitivity, Over-control (reverse coded), and Effective Behavior Management, Productivity, Concept Development, Instructional Learning Formats and Quality of Feedback. Positive Climate is a reflection of the enthusiasm a teacher displays in interactions with children, and also among children. Negative Climate taps into the anger, aggressiveness and harshness in a classroom. Teacher Sensitivity measures the comfort, encouragement and reassurances teachers' use in interactions with children. Over-control is a measure classroom regiment and rigidity. Effective Behavior Management assesses how well a teacher helps children redirect misbehaviors in the classroom. Productivity examines how well teachers effectively manage classroom routines and lessons to lead to better learning in children. Concept Development is how teachers utilize higher-order cognitive processes conducive to classroom problem solving. Instructional Learning Formats measures how teachers maximize student engagement through materials, presentations and groupings. Lastly, Quality of Feedback is a measure of the verbal feedback a teacher gives children about their work, comments and ideas. This assessment was administered twice in the fall and spring of preschool, and several times in kindergarten. The kindergarten CLASS data was provided in the dataset as one average for the entire year. Descriptive statistics for the CLASS across all measurement occasions are provided in Table 3. All subscales showed moderate positive stability across measurement occasions. Deviations from strong significance most often occurred in the jump between spring of preschool and fall of kindergarten.

Table 3

CLASS Scores Across Measurement Occasions

	N	M	SD	Percent Missing
		Preschool Fall		
Positive Climate	751	5.05	.93	4%
Negative Climate	751	1.82	.74	4%
Teacher Sensitivity	751	4.51	1.03	4%
Over-control	751	2.43	1.06	4%
Behavior Management	751	4.77	1.07	4%
Productivity	751	4.43	1.02	4%
Concept Development	751	3.00	1.21	4%
Learning Formats	751	4.15	1.06	4%
Quality of Feedback	751	2.12	1.18	4%
		Preschool Spring		
Positive Climate	786	5.00	.94	0%
Negative Climate	786	1.69	.82	0%
Teacher Sensitivity	786	4.41	1.09	0%
Over-control	786	1.87	.91	0%
Behavior Management	786	4.79	1.01	0%
Productivity	786	4.36	.97	0%
Concept Development	786	2.12	.95	0%
Learning Formats	786	4.13	.98	0%

Quality of Feedback	786	1.66	.68	0%
Kindergarten Aggregated				
Positive Climate	689	5.16	.81	12%
Negative Climate	689	1.52	.69	12%
Teacher Sensitivity	689	4.70	.92	12%
Over-control	689	1.88	.79	12%
Behavior Management	689	5.21	.82	12%
Productivity	689	4.64	.80	12%
Concept Development	689	2.10	.73	12%
Learning Formats	689	4.07	.89	12%
Roteness	689	2.30	.93	12%
Quality of Feedback	689	1.79	.63	12%

Data Preparation

The dataset was reduced from the original version to include children whose first language was English, and who took the PPVT-III in English. All predictors were centered to easily interpret parameter estimates. Centering is also important for assuring that all variables meet assumptions about multivariate normality (Robinson & Schumaker, 2009). Age was centered on the grand mean at time 1, mother's highest level of education was centered at 12, family income was centered at the grand mean and the CLASS subscales were all centered at the aggregate grand mean. Lastly, all variables were examined individually to make sure each met assumptions for multivariate normality, which is an important assumption of variables used in multilevel growth curve modeling (Singer, 1998; Singer & Willett, 2003; Tabachnick & Fidell, 2007).

Analysis

Analyses were conducted in SAS (v9.3) using PROC MIXED (see Singer, 1998; Singer & Willett, 2003 for a clear description of the procedures). Models were run using maximum likelihood estimation – a technique that maximizes the likelihood function via an expectation-maximization (EM) algorithm (Truxillo, 2005). SAS provides many methods for model estimation, and the most frequently used are maximum likelihood estimation (ML) and restricted maximum likelihood estimation (REML). ML was chosen due to the comparability of nested models, but also because the REML method only allows for the comparability of models that have identical fixed effects (Kreft & de Leeuw, 1998; Singer & Willett, 2003). Another important component of multilevel growth curve models is the coding of time, and much has been written about how the coding of time dramatically influences a model's parameter estimates (Biesanz, Deeb-Sossa, Papadakis, Bollen & Curran, 2004). All models were coded with the initial measurement occasion equal to 0, and the 3 subsequent measurement occasions equal to 1, 2, 3, respectively – meaning that the intercept reflected each person's true initial status. Model fit statistics (i.e., -2 log likelihood, AIC and SBC) were used to evaluate the overall influence of combined covariates on PPVT-III scores, and also to compare model predictability across nested models. Lastly, in all models Cohen's f^2 were calculated in SAS for all models both across all measurement occasions, and within measurement occasions. Teasing out the effect size for a single variable in the context of any larger multivariate regression model is a thorny issue. Cohen's f^2 was chosen for it's utility in models that consist of primarily both continuous independent and dependent variables (Selya, Rose, Dierker, Hedeker & Mermelstein, 2012, for an excellent demonstration of this technique in SAS).

Chapter Three

Results

Unconditional Means Model

The first step in the hierarchical sequence of testing growth models is to examine the unconditional means model (Singer & Willett, 2003). This model simply serves to justify further analyses in a growth model framework by establishing the amount of within and between person variance represented in the outcome variable. This is done via the interclass correlation (ICC) statistic, which is calculated with the variance components of the model, and is done so with the following equation $\frac{\sigma_\varepsilon^2}{\sigma_\varepsilon^2+\sigma_0^2}$. The equations for the unconditional means model are as follows:

$$\textit{Level-1}: Y_{ij} = \pi_{oi} + \varepsilon_{ij}$$

$$\textit{Level-2}: \pi_{0i} = \gamma_{00} + \zeta_{0i}$$

$$\textit{Combined}: Y_{ij} = \gamma_{00} + \zeta_{0i} + \mathcal{E}_{ij}$$

In the combined equation above γ_{00} is the grand mean of PPVT-III scores, while ζ_{0i} is the person-specific mean and $\mathcal{E}_{ij}$ represents the within-person deviations. Results for the unconditional means model are outlined in Table 4 below. The ICC statistic showed that 27% of the variance in PPVT-III was attributed to within-person differences, and 73% of could be attributed to between person differences.

Table 4

Estimates of the Fixed and Random Effects for the Unconditional Means Model

Fixed Effects	Variable	Parameter	Estimate (SE)	Upper	Lower
Initial	Intercept	γ_{00}	96.24***	97.01	95.39

Status, π_{0i}			(0.43)
Variance Components			
Level 1	Within-person	σ_{ε}^2	47.64 (1.50)
Level 2	In initial *status*	σ_0^2	129.44 (7.37)
Fit Statistics			
	-2LL		20593.30
	AIC		20599.30
	BIC		20613.30

Note. **p* < .01. ***p* < .001. ****p* < .0001. All estimates do not include sample weights.

Specifying a Model for Growth

The next step in the analyses was to establish the growth trajectory. This step of the analyses allows for the examination of variations in the initial status of PPVT-III scores, and also variations in the rates of change (Singer & Willett, 2003). Here linear and curvilinear models were specified. It was hypothesized that a linear model would be the best fitting model. There were two reasons for this prediction. First, the measurement occasions were very close in time. Second, there was a rather short time-span (i.e., 1.5 years) to investigate development. Taken in conjunction these factors do not often yield any kind of curvilinear trend. The linear model was, in fact, the only model to show a significant result for interactions between PPVT-III growth and time, and also had the lowest value for the −2-log-liklihood [-2LL] and both Akike and Bayesian Information Criteria. Additionally, none of the curvilinear interactions with time were significant. The equations for the final linear growth model are as follows:

$$\textit{Level 1}: Y_{ij} = \pi_{oi} + \pi_{1i}(TIME_{ij}) + \varepsilon_{ij}$$

$$\textit{Level 2}: \pi_{01} = \gamma_{00} + \zeta_{0i}$$

$$\pi_{1i} = \gamma_{10} + \zeta_{1i}$$

$$\textit{Combined}: PPVT_{ij} = \gamma_{00} + \gamma_{10}WAVE_{ij} + [\zeta_{0i} + \zeta_{1i}WAVE_{ij} + \mathcal{E}_{ij}]$$

In the combined equation above γ_{00} represents the intercept for the fixed effect of PPVT-III growth, ζ_{0i} are the person-specific intercepts, $\gamma_{10}(WAVE)_{ij}$ is the fixed effect for slope, $\zeta_{1i}(WAVE)_{ij}$ are the person-specific slopes and $\mathcal{E}_{ij}$ are the within-person deviations. The results for the linear model are outlined in Table 5. The parameter estimate representing the intercept for PPVT-III scores was 93.44, $p < .001$, while the linear rate of change was 2.00, $p < .001$ across the measurement occasions. The correlation between the intercept and slope was $r = -0.57$, which indicated that children who started with higher levels of PPVT-III scores at the first measurement occasion showed smaller increases in PPVT-III scores across time. All variance components for the model were significant indicating follow-up models including covariates were warranted, and this became the model for later comparisons. Lastly, the inclusion of linear time in the model resulted in a 23% reduction of the within person variance.

Table 5

Estimates of the Fixed and Random Effects for a Linear Model of Change

Fixed Effects	Variable	Parameter	Estimate (SE)	Upper	Lower
Initial Status, π_{0i}	Intercept	γ_{00}	93.44*** (0.49)	94.41	92.48
Rate of Change, π_{1i}	Slope	γ_{10}	2.00*** (0.12)	2.24	1.75

Variance Components			
Level 1	Within-person, ε_{ij}	σ_ε^2	36.92*** (1.43)
Level 2	In initial *status,* ζ_{0i}	σ_0^2	159.62*** (9.57)
	In rate of change, ζ_{1i}	σ_1^2	2.86*** (0.64)
	Covariance between ζ_{0i} and ζ_{1i}	σ_{01}	-12.29*** (1.94)
Pseudo R^2 Statistics and Goodness of Fit Statistics			
	R_ε^2		0.23
	Deviance		20250.00
	AIC		20262.00
	BIC		20290.00

Note. * $p < .01$. ** $p < .001$. *** $p < .0001$. All estimates do not include sample weights.

Linear Growth With Covariates

Next a series of models was fit specifying a linear model of change, and three levels of covariates were entered into the model, each indicative of the research question at hand. In the first model (Model 3) child-level covariates were entered into the model (Singer & Willett, 2003). It was expected that both a child's age and gender would significantly predict initial status and rates of change. As such, it was necessary to control for these variables before moving forward with subsequent models. In Model 4 the effects of SES variables, both the highest level of maternal education and family income, were entered into the model to see if the intercept, growth and variance components were related to SES. Model 5 introduced the lone effect of whether or not a child was a full day student into the model, as it was expected that duration of time in school would confound later parameter estimates involving the CLASS. In Model 6 the effect of CLASS subscales was examined; however, before estimating that model the effect of each CLASS subscale was tested individually for the individual effect on the intercept, growth and variance components of PPVT-III scores across time. This served the purpose of gaining a clear picture of the potential CLASS effects on PPVT-III scores across time. Significant results for these subscales were then pooled into Model 6, where combined effects of the CLASS were measured against all significant variables from past models. Lastly, Model 7 tested for interactions between significant SES and CLASS factors. In all models insignificant covariates were pruned from the model if and only if a chi-square test for the differences in both the -2-log-liklihood [-2LL] statistics and degrees of freedom were not significant at $p < .0001$. No difference in the -2LL and the degrees of freedom was indicative of no significant loss in model fit (Singer & Willett, 2003).

The generalized level-1 and level-2 equations for models including covariates are as follows:

$$\textit{Level-1}: Y_{ij} = \pi_{oi} + \pi_{1i}TIME_{ij} + \varepsilon_{ij}$$

$$\textit{Level-2}: \pi_{01} = \gamma_{00} + \gamma_{01}COV_i + \zeta_{0i}$$

$$\pi_{1i} = \gamma_{10} + \gamma_{11}COV_i + \zeta_{1i}\ldots$$

In reality the stochastic (i.e., variance) portion of the model can be modeled with more complexity, but this takes more and more data. This is because 3 new estimates of the variance components would need to be added to the model for every covariate (i.e., the variance associated with the intercept and slope for the covariate and the subsequent covariance of the two). In this step of the model building process a sacrifice was made to let the effects of the time-varying covariates vary across time only, instead of allowing the stochastic portion of the model to be specified so that the effects of the covariates varied across individuals (Singer & Willett, 2003). This was a sacrifice made for two reasons. First, the model building procedure needed to pragmatically reflect the realities of the model. Most of what is being predicted in this model is the 73% of the between person variation indicated by the ICC statistic from the unconditioned means model. Finally, the sample size for this study does not warrant the inclusion of predictors in the stochastic portion of the model.

Model 3

Again, the focus of Model 3 was on the child-centered predictors of the intercept, growth and variance components of a linear growth curve model with PPVT-III scores as the outcome. The combined equation for this step in the analyses was:

$$PPVT_{ij} = \gamma_{00} + \gamma_{01}GENDER_i + \gamma_{02}AGE_{ti} + \gamma_{10}WAVE_{ij} + \gamma_{11}GENDER_i * WAVE_{ij} + \gamma_{12}AGE_{ti} * WAVE_{ij} + [\zeta_{0i} + \zeta_{1i}WAVE_{ij} + \mathcal{E}_{ij}]$$

Age was centered at the grand mean for the sample at the initial wave of assessment, and was entered into the model as a time-varying covariate, while gender was entered as time-invariant and coded with female = 1. Table 6 below shows all of the parameter estimates for the model. Results showed that gender did not significantly predict the intercept or slope in PPVT-III scores, and age showed a significant result for negatively predicting the slope in PPVT-III scores γ_{12} = -0.80, $p < .001$. This indicated that for every one-month change in a child's age above the average age of all children at time 1, there was a decrease in the slope by a factor of -0.80. More generally, older children had slower rates of change than younger children, but no difference in the initial status of their PPVT-III scores. The correlation between the intercept and slope was r = -0.58, which indicated that those with high initial PPVT-III scores tended to have slower rates of change. Significant variance components in the model indicated that follow-up models with additional covariates were justified. These variance components can also be used to examine various reductions in the pseudo R^2 for the overall model, and the variance associates with the level-1 and level-2 predictors. This is accomplished with the following equation $\frac{Comparison\ Model\ \sigma_{\varepsilon}^2 - Predictor\ Model\ \sigma_{\varepsilon}^2}{Comparison\ Model\ \sigma_{\varepsilon}^2}$. For the unconditional growth model the comparison model is the unconditional means model; for subsequent models with covariates the comparison model becomes the unconditional growth model (Singer & Willett, 2003). Therefore, the inclusion of these predictors resulted in a 0.7% reduction of the within person variance, a 0.2% reduction of the level-2 variance associated with the intercept and a 0.7% reduction of the level-2 variance associated with the slope. The insignificant covariates were left in the follow-up model that included the SES covariates to control for any potential influence of the child-specific variables before pruning insignificant results.

Table 6

Estimates of the Fixed and Random Effects for the Inclusion of Child-Level Covariates

Fixed Effects	Parameter		Estimate (SE)	Upper	Lower
	Intercept	γ_{00}	92.94*** (0.69)	94.30	91.59
	Intercept (Gender)	γ_{01}	0.18 (0.98)	2.11	-1.75
	Intercept (Age)	γ_{02}	0.72 (1.26)	3.18	-1.75

Slope	γ_{10}	2.80*** (0.56)	3.91	1.69
Slope (Gender)	γ_{11}	0.06 (0.25)	0.55	-0.42
Slope (Age)	γ_{12}	-0.80** (0.21)	-0.38	-1.22
Variance Components				
	σ_{ε}^2	36.68*** (1.42)		
	σ_0^2	159.37*** (9.58)		
	σ_1^2	2.84*** (0.64)		
	σ_{01}	-12.42*** (1.94)		
Pseudo R^2 Statistics and Goodness of Fit Statistics				
R_{ε}^2		.007		
R_0^2		.002		
R_1^2		.007		
Deviance		20233.60		
AIC		20253.60		
BIC		20300.30		

Note. * $p < .01$. ** $p < .001$. *** $p < .0001$. All estimates do not include sample weights.

Model 4

This model examined the relationship between SES variables, both mother's highest level of education and family salary, on the intercept, growth and variance components of PPVT-III scores across all measurement occasions. It was hypothesized that both variables would positively predict the intercept and slope of children's PPVT-III scores across measurement occasions. Both covariates were entered into the model as time-invariant covariates, and both were centered on the grand mean. Results for this model can be found in Table 7, and the equation for this model is as follows:

$$PPVT_{ij} = \gamma_{00} + \gamma_{01}MOMED_i + \gamma_{02}FAMINCOME_i + \gamma_{10}WAVE_{ij} + \gamma_{11}AGE_{ti} * WAVE_{ij} + \gamma_{12}MOMED_i * WAVE_{ij} + \gamma_{13}FAMICOME_i * WAVE_{ij} + [\xi_{0i} + \xi_{1i}WAVE_{ij} + \mathcal{E}_{ij}]$$

Results showed the same pattern for significant and insignificant results from Model 3, namely no effect for gender on the intercept or slope, and no effect for age on the intercept. Both SES variables showed significant results for the intercept of PPVT-III scores, but no effect on the slope, with mothers' highest level of education γ_{01} = 0.69, *p* < .01, and family income γ_{02} = 0.15, *p* < .0001. A follow-up model with the pruned insignificant covariates was compared against the full model, and the chi-square showed no loss in fit compared to the parsimonious model $\chi^2(5)$ = 12.5, *p* = .03. The correlation between the intercept and slope fell to *r* = -0.50. There was a slight degradation in the variance components of the slope, as it fell from significance at *p* < .0001 to *p* < .001, but these still warranted follow-up models with additional covariates. There was no decrease of the within person variance associated with this set of predictors, in fact it increases slightly. The model showed level-2 reductions in variance, with the variance associated with the intercept falling by 23% and the variance associated with the slope falling to 13%. Typically in these models it is expected that the inclusion of time-invariant predictors will significantly reduce the level-2 variances, but the within person variance should remain relatively constant, as time-invariant predictors do little to explain within person variance in the models (Singer & Willett, 2003).

Table 7

Estimates for the Fixed and Random Effects for the Inclusion of SES Covariates

Fixed Effects	Variable	Parameter	Estimate (SE)	Upper	Lower
Initial Status, π_{0i}	Intercept	γ_{00}	92.75*** (0.50)	93.73	91.77
	Intercept (Mother's Highest Education)	γ_{01}	0.69* (0.24)	1.15	0.23
	Intercept (Family Income)	γ_{02}	0.15*** (0.02)	0.19	0.11
Rate of Change, π_{1i}	Slope	γ_{10}	3.03*** (0.31)	3.64	2.42
	Slope (Age)	γ_{11}	-0.72** (0.19)	-0.35	-1.10
Variance Components					
Level 1	Within-person, ε_{ij}	σ_{ε}^2	37.06*** (1.48)		
Level 2	In initial *status,* ζ_{0i}	σ_0^2	122.46*** (8.04)		
	In rate of change, ζ_{1i}	σ_1^2	2.50** (0.65)		

Covariance between ζ_{0i} and ζ_{1i}	σ_{01}	-8.83*** (1.78)
Pseudo R^2 Statistics and Goodness of Fit Statistics		
R_{ε}^2		0
R_0^2		.23
R_1^2		.13
Deviance		18862.40
AIC		18880.40
BIC		18921.80

Note. *** $p < .0001$. ** $p < .001$. *$p < .01$. All estimates do not include sample weights.

Model 5

This model tested for the effect of whether or not a child was a full-day student. It was hypothesized that duration of exposure to an educational environment would predict both the outcome, and effect of the CLASS subscales on changes in PPVT-III scores across time. Therefore, it was important to establish whether this relationship was significant, and to control for it moving forward in the model building process. The full day variable was entered into the model in conjunction with the finalized version of Model 4. There was no significant effect on the intercept or slope of children's PPVT-III scores. However, this result only established that there was no effect between children's PPVT-III scores and duration of time in school. There was still uncertainty about how this variable would behave in combination with the CLASS subscales, and as such this variable was left in the forthcoming sequence of CLASS to observe how it behaved in conjunction with measures of classroom environment.

Model 6

Model 6 was built off of a series of individual tests of significance for each of the CLASS subscales. This was done in conjunction with the finalized version of significant covariates from Model 5. Each CLASS subscale was entered into the model as a time-varying covariate. After testing each subscale individually only four of the subscales showed significant relationships with some combination of the intercept and slope of children's PPVT-III scores across time. Before talking about the patterns of significant effects of the CLASS subscales, it should be mentioned that in all of the models the full-day variable was not a significant predictor of the intercept or slope of PPVT-III scores. Negative Climates in classrooms was negatively related to the intercept of children's PPVT-III scores, β= -0.91, $p < .01$. Over-Controlling classrooms was also negatively related to the intercept, β= -0.65, $p < .01$. Concept Development was positively related to the slope of PPVT-III scores. β= 0.50, $p < .001$. Lastly, the Quality of Feedback was positively related to both the intercept and slope of children's PPVT-III scores across measurement occasions, with the intercept β= 0.67, $p < .01$, and the slope, β= 0.56, $p < .001$.

Next these significant results were pooled into a model that included the significant covariates from Model 5. Each of the significant CLASS subscales was entered into the model to test for the fixed effects of both the intercepts and slopes, regardless of whether or not either was significant in the aforementioned testing. This was done because it was not known how the covariates would behave when pooled together into one model. The equation guiding the analysis for this model was as follows:

$$\begin{aligned} PPVT_{ij} = \ & \gamma_{00} + \gamma_{01}MOMED_i + \gamma_{02}FAMINCOME_i + \gamma_{03}NEGCLIMATE_{ti} + \gamma_{04}OVERCONTROL_{ti} \\ & + \gamma_{05}CONCEPTDEV_{ti} + \gamma_{06}QUALITY_{ti} + \gamma_{07}FULLDAY_i + \gamma_{10}WAVE_{ij} + \gamma_{11}AGE_{ti} * WAVE_{ij} \\ & + \gamma_{12}NEGCLIMATE_{ti} * WAVE_{ij} + \gamma_{13}OVERCONTROL_{ti} * WAVE_{ij} + \gamma_{14}CONCEPTDEV_{ti} \\ & * WAVE_{ij} + \gamma_{15}QUALITY_{ti} * WAVE_{ij} + \gamma_{16}FULLDAY_i * WAVE_{ij} + [\xi_{0i} + \ \xi_{1i}WAVE_{ij} + \ \mathcal{E}_{ij}] \end{aligned}$$

The patterns of significant parameter estimates differed slightly from the individually tested subscales. Perhaps the major difference was that no CLASS subscale was a significant predictor of the slopes of children's PPVT-III scores. Negative Climate and over-control fell from the model as significant predictors of the both the intercept and slope of PPVT-III scores. Concept Development positively predicted the intercepts of children's PPVT-III scores, γ_{06} = 0.96, p < .01. Lastly, Quality of Feedback negatively predicted children's PPVT-III scores, γ_{07} = -1.52, p < .0001 All of the previous patterns of significant effects for both the child-centered and SES variables held constant in this model. The variance components showed a slight decrease in significance, again specifically for the slopes. Again, the within person variation increased slightly from the comparison model (i.e., the unconditional growth model), and there were reductions in the level-2 variance. The variance associated with the intercept reduced by 28%, and the variation associated with the slope decreased by 51%. The last step in the phase of the model building process was to trim the insignificant covariates, and to see if the chi-square test resulted in a worse fitting model. The chi-square test showed that a model with the pruned insignificant covariates was a worse fitting model χ^2(8) = 457.10, p <.0001. Therefore, Table 8 below shows the parameter estimates for this final version of Model 6. Effect sizes were calculated with a modified version of Cohen's f^2. This was done through comparing nested models that examined the contribution of the predictor in the model with the following equation $f^2 = \frac{R^2_{AB}+R^2_{A}}{1-R^2_{AB}}$, holding constant the variance accounted for by the random effects as to assure the contribution the predictor was due purely to it's fixed effect (Selya, Rose, Dierker, Hedeker & Mermelstein, 2012). The overall effect sizes for the significant predictors are reported in Table 9.

Table 8

Estimates for the Fixed and Random Effects for the Inclusion of CLASS Covariates

Fixed Effects	Parameter	Estimate (SE)	Lower	Upper

Initial Status, π_{0i}	Intercept	γ_{00}	95.02*** (1.24)	92.58	97.45
	Intercept (Mother's Highest Education)	γ_{01}	0.72* (0.24)	0.25	1.18
	Intercept (Family Income)	γ_{02}	0.15*** (0.02)	0.11	0.19
	Negative Climate	γ_{03}	-0.69 (0.39)	-1.46	0.08
	Over-control	γ_{04}	-0.41 (0.28)	-0.96	0.15
	Concept Development	γ_{05}	0.96* (0.35)	0.28	1.64
	Quality of Feedback	γ_{06}	-1.52*** (0.37)	-2.25	-0.79
	Full day	γ_{07}	1.17 (0.91)	-0.63	2.96
Rate of Change, π_{1i}	Slope	γ_{10}	4.41*** (0.80)	2.57	5.72
	Slope (Age)	γ_{11}	-0.65* (0.22)	-1.07	-0.22
	Negative Climate	γ_{12}	0.44 (0.24)	-0.02	.90
	Over-control	γ_{13}	0.18	-0.19	0.55

			(0.19)		
	Concept Development	γ_{14}	0.28 (0.22)	-0.16	0.72
	Quality of Feedback	γ_{15}	0.35 (0.26)	-0.16	0.87
	Full day	γ_{16}	0.41 (0.25)	-0.08	0.91
Variance Components					
Level 1	Within-person, ε_{ij}	σ_{ε}^2	37.50*** (1.54)		
Level 2	In initial *status,* ζ_{0i}	σ_0^2	114.61** (7.79)		
	In rate of change, ζ_{1i}	σ_1^2	1.41* (0.64)		
	Covariance between ζ_{0i} and ζ_{1i}	σ_{01}	-6.31*** (1.54)		
Pseudo R^2 Statistics and Goodness of Fit Statistics					
	R_{ε}^2		0		
	R_0^2		.28		
	R_1^2		.51		
	Deviance		18021.70		
	AIC		18059.70		
	BIC		18146.70		

Note. ***p <.0001. **p < .001. *p < .01. All estimates do not include sample weights.

Table 9

Effect Sizes for Significant Results Across Waves

Variable	Cohen's f^2
Age	.004
Maternal Education	.008
Family Income	0
Concept Development	.005
Quality of Feedback	.007

Note. .01 is considered a small effect, .03 a medium effect and .05 a strong effect.

Model 7

This was the last model tested, and it included interactions between the significant SES parameters and the significant CLASS parameters. It was hypothesized that SES would significantly interact with CLASS variables to positively predict the intercept and slope in children's PPVT-III scores. However, it is also important to note that rarely to multilevel growth curve models contain a large enough sample size to detect significant interactions between covariates. Continuing with that, Model 7 was no exception, as the interactions between SES variables and CLASS subscales were not significant. This suggested that Tables 8 and 9 represented the parameter estimates for the most parsimonious model answering the research questions for this study.

Chapter Four

Conclusions

Consistent with past research this study found that measures of SES impacted children's lexical acquisition (Sirin, 2005; White, 1982). However, SES impacted children's initial level of lexical acquisition, and not the changes in lexical abilities across time. On one hand this finding is partially in contrast to the seminal work of Hart & Risley (1995), which is one often depicted in the field as the defining longitudinal exploration of children's lexical development. However, that work was more qualitative in nature, and lacked methodology that warranted talking about the development of lexical acquisition. Longitudinal studies investigating lexical development with sophisticated developmental methodology are rare in the research. As such, it is not yet clear whether or not there exists a window for lexical development, and how much of that rapid lexical acquisition within that developmental window could potentially be impacted by SES. It should be noted that the unconditioned growth model did show a positive linear trend across all measurement occasions, which certainly suggests a leveling off of the well-documented explosive phase of word growth that children go through from 2 to 4 years of age (Hart & Risley, 1995). Additionally, the lack of evidence for these factors impacting lexical development might indicate that the "word gap" settles into place as children enter into formal education. However, research should continue to investigate this, as a clear understanding of when developmental periods for language acquisition are impacted the most by proximal processes can help to design interventions that target not just specific aspects of language development, but populations at risk for developing language delays. For instance, if it is indeed the case that the "word gap" settles into place early on it would mean that any interventions tasked with closing this gap would need to begin in the earliest years, and would also need to consider intervention components that focus on the those close dyadic interactions between parents and children known to promote lexical development in children.

This study also found support congruent with past research finding that the CLASS, impacted children's lexical acquisition (Howes, 2008; Pianta, et. al., 2008). More specifically, the subscales of the CLASS that showed significance were indicators of the Instructional Support construct, which has demonstrated consistent relationships with children's language and academic outcomes (Howes, 2008; Pianta, et. al., 2008). Utilizing the subscales instead of the construct showed interesting patterns of relationships to children's levels of lexical abilities. The Concept Development and Quality of Feedback subscales were both significantly related to children's lexical abilities, but only the Concept Development subscale was significant in a direction consistent with past research. Children who demonstrated higher levels of lexical ability at the initial measurement occasion experienced classroom environments that were richer in Concept Development. However, those children with lower initial lexical abilities experienced classrooms with more Quality of Feedback.

First, it must be acknowledged that there is the potential that this reversal of expected directionality is evidence for a suppression effect. In instances of suppression a predictor that has a small to null relationship with an outcome of interest captures unique variance from a more primary model predictor, and this alters the relationship of the predictors to the outcome by either increasing or decreasing the magnitude of the relationship or reversing the direction of the relationship altogether (Hamilton, 1987; Tzelgov, & Henik, 1991). This often happens with multicolinear data. More follow-up analyses of these subscales showed that the two were correlated both with one another and the outcome, but the strength and directionality of these relationships was very different when comparisons of the items were made across measurement occasions. Additionally, the variance inflation factor (VIF) (Robinson & Schumakcer, 2009) of both these subscales was high, but not high enough to consider removing the two from the analyses, which was not supportive of an issue of multicolinearity.

Instead, these patterns of significance might also be indicative of an evocative effect. As children enter into preschool any differences in their lexical abilities might be obvious to teachers. These differences could evoke from teachers conversational frames conducive to addressing children's lexical abilities. For example, as highlighted above classrooms with higher proportions of children with high lexical abilities receive higher levels of Concept Development upon entering preschool. These are the kinds of interactions that are rich with "wh-" questioning and higher-level metacognitive discourse. These kinds of interactions might provide teachers with a clear idea of each child's limits. That is to say that children, when in the process of explaining their understanding of a topic at hand through consistent lines of teacher inquiry that probe children to keep elaborating, will run out of words that delineate their thinking and/or understanding of a topic. These opportunities provide teachers a clear idea of what lexical items are needed on the part of children to understand a topic. Teachers can provide these lexical items to children, who already provided much of the context underlying the meaning of the word, and more easily incorporate new words into their lexicons. Consequently, children who have higher levels of lexical ability might consistently find themselves in rich interactions with children that are conducive to acquiring new words. Alternatively, children with lower lexical abilities experience higher Quality of Feedback. These kinds of teacher/child interactions are more about simple feedback loops and conversational exchanges between teachers and children in the classroom. As children struggle with lexical development teachers might find that consistently engaging children with simple feedback loops, marked by exchanges of encouragement, help to build academic esteem and motivation in children. For teachers this might provide the best means with which to help these children access the classroom curriculum. To investigate this more clearly more work would need to be done within the motivational literature to better understand how academic motivation might be linked to children's language acquisition.

Everything outlined in the preceding paragraph are hypothesized theories of change for children's lexical development, and the present study found no change in children's lexical abilities across time. This does not, however, rule out any of the aforementioned hypotheses. Lexical development was measured by the PPVT-III, which might not tap into the rich lexical items children with high lexical abilities might be picking up across school years. Different measures of lexical development should be utilized in future research. Additionally, changes in children's lexical abilities with those who exhibit lower levels of lexical development might need to be examined deeper into the first formative years of education, as the building of children's motivational levels might catalyze later word learning. In future research path analyses could be used with longitudinal data to investigate these causal processes. The results for the present study might also have been impacted by a consistent measurement plan for the CLASS across preschool and kindergarten. The pooling of estimates from the CLASS in kindergarten might have artificially decreased the variance in the subscale scores, masking any potential change in lexical abilities across time. It would be interesting to examine whether or not multiple measures of the CLASS in kindergarten showed a better picture of language development within the window of this study, and if reentering time at the fall of kindergarten would show the same patterns of teachers' use of the Quality of Feedback and Concept Development components of the CLASS. This would further support the idea of an evocative effect with a new set of teachers. Of course, it should also be re-emphasized that the CLASS is an aggregate measure of a classroom environment experienced by all children. Many of the hypotheses above might be better explored with dyadic data between teachers and children. The inCLASS (Downer et. al., 2010) is an exciting new tool that utilizes many of the construct ideas from the CLASS to understand the nuance instructional exchanges between a child and his/her teacher in close dyadic exchanges. Additionally, micro-genetic analyses (Schoenfeld, Smith & Arcavi, 1993) might allow researchers to understand changes in the dynamics of interactions between a child and a teacher across time without imposing a preconceived construct structure onto the interaction, as is provided by the inCLASS. Both methods call for a more person-centered approach to data analysis. Lastly, it will be important for future research to triangulate these findings with data that includes teachers' perceptions of children's academic competencies. This might better elucidate the intentionality behind differences in how teachers initially structure their exchanges with children in the classroom.

Finally, this study found no support for interactions between the SES and CLASS measures in relation to children's lexical development. This is a finding that is not particularly surprising, as the interaction effects would need to be quite large to be detected with this sample size. This leads to the final conclusion, which was that, the effect sizes for all the significant results were in the range of null to small (Selya, et. al., 2012). This is a finding that fits with past research (Cassidy, et. al., 2005; Duncan & Gibson-Davis, 2006). As Weiland & Yoshikawa (2013) suggest, more domain specific measures of classroom environment might better assist practitioners in the classroom.

Limitations

Limitations for this study mostly involved the quality of the data. First, the measurement occasions were spaced close together over a relatively short developmental period, which might have masked the true trend of lexical development at this age. Second, the CLASS was not truly time-varying in kindergarten because an aggregate score was reported in the dataset. This might have impacted the subscale interpretation in relation to parameter estimates. Third, the measures of SES were highly decontextualized, and while proven to be predictive of developmental outcomes in the research, these measures might not have been adequate proxies for the proximal processes that influence lexical development within this developmental period. Lastly, because of a limitation of SAS PROC MIXED analyses were conducted without sample weights, which might have produced biased parameter estimates.

References

Baltes, P. B. (1987). Theoretical propositions of life-span developmental psychology: On the dynamics between growth and decline. *Developmental Psychology*, *23*(5), 611.

Baltes, P. B. & Nesselroade, J. R. (1979). History and Rationale of Longitudinal Research. In J. R. Nesselroade & P. B. Baltes (eds.), Longitudinal research in the study of behavior and development (pp. 1–39). New York: Academic Press.

Barnett, W. S., & Yarosz, D. J. (2004). Who goes to preschool and why does it matter? *Preschool Policy Matters*, *8*(3), 2–16.

Barnett, M. A., Gustafsson, H., Deng, M., Mills‐Koonce, W. R., & Cox, M. (2012). Bidirectional Associations Among Sensitive Parenting, Language Development, and Social Competence. *Infant and Child Development*, *21*(4), 374-393.

Bettes, B. A. (1988). Maternal depression and motherese: Temporal and intonational features. *Child Development*, 1089-1096.

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 models. *Psychological Methods*, *9*(1), 30-52.

Bornstein, M. H., & Putnick, D. L. (2012). Stability of language in childhood: A multiage, multidomain, multimeasure, and multisource study. *Developmental Psychology*, *48*(2), 477.

Bowers, E. P., & Vasilyeva, M. (2011). The relation between teacher input and lexical growth of preschoolers. *Applied Psycholinguistics*, *32*(01), 221-241.

Brett, A., Rothlein, L., & Hurley, M. (1996). Vocabulary acquisition from listening to stories and explanations of target words. *The Elementary School Journal*, 415-422.

Brent, M. R. (1997). Toward a unified model of lexical acquisition and lexical access. *Journal of Psycholinguistic Research*, *26*(3), 363-375.

Bronfenbrenner, U., & Evans, G. W. (2000). Developmental science in the 21st century: Emerging questions, theoretical models, research designs and empirical findings. *Social Development*, *9*(1), 115-125.

Bronfenbrenner, U., & Morris, P. A. (2006). The Bioecological Model of Human Development. In: Lerner RM, Damon W, editors. Handbook of Child Psychology: Vol. 1. Theoretical models of human development. 5th ed.

Brooks-Gunn, J., Duncan, G. J., & Britto, P. R. (1999). Are socioeconomic gradients for children similar to those for adults. *Developmental Health and the Wealth of Nations*, 94-124.

Bruner, J. S. (1975). From communication to language—A psychological perspective. *Cognition*, *3*(3), 255-287.

Bruner J (2002) Making Stories: Law, Literature, Life. New York: Farrar, Straus, and Giroux.

Bureau of the Census, Income, Poverty, and Health Insurance Coverage in the United States. *Report,* 60-239.

Cassidy, D. J., Hestenes, L. L., Hegde, A., Hestenes, S., & Mims, S. (2005). Measurement of quality in preschool child care classrooms: An exploratory and confirmatory factor analysis of the early childhood environment rating scale-revised. *Early Childhood Research Quarterly*, *20*(3), 345-360.

Chall, J. (1987). Two Vocabularies for Reading: Recognition and Meaning. In M. G. McKeown & M. E. Curtis (Eds.), The Nature of Vocabulary Acquisition. Hillsdale, NJ: Erlbaum.

Chapman, R. S. (2000). Children's language learning: An interactionist perspective. *Journal of Child Psychology and Psychiatry*, *41*(1), 33-54.

Chomsky, N. (1965). *Aspects of the Theory of Syntax* (Vol. 119). The MIT press.

Chomsky, N. (1986). *Knowledge of Language: Its nature, origin, and use*. Praeger Publishers.

Clark, E. V. (2010). Adult offer, word-class, and child uptake in early lexical acquisition. *First Language*, *30*(3-4), 250-269.

Clifford, D., Bryant, D., Burchinal, M., Barbarin, O., Early, D., Howes, C., Pianta, R. & Winton, P. (2001). National Center for Early Development and Learning; Multistate Study of Pre-Kindergarten, 2001-2003. [Computer File] ICPSR04283. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2012-01-30.

Connell, J. P., & Wellborn, J. G. (1991). Competence, autonomy, and relatedness: A motivational analysis of self-system processes. In M. Gunnar & A. Sroufe (Eds.), Minnesota Symposium on Child Psychology (Vol. 23, pp. 43-77). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Cristofaro, T. N., & Tamis-LeMonda, C. S. (2012). Mother-child conversations at 36 months and at pre-kindergarten: Relations to children's school readiness. *Journal of Early Childhood Literacy, 12*(1), 68-97.

Cronsoe, R., Johnson, M. K., and Elder, G. (2004). Intergenerational Bonding in School: The Behavioral and Contextual Correlates of Student-Teacher Relationships. *Sociology of Education*. 77 (1) 60-80

Curby, T. W., Rimm-Kaufman, S. E., & Ponitz, C. C. (2009). Teacher-child interactions and children's achievement trajectories across kindergarten and first grade. *Journal of Educational Psychology*, *101*(4), 912.

Curran, P. J., Obeidat, K., & Losardo, D. (2010). Twelve frequently asked questions about growth curve modeling. *Journal of Cognition and Development*, *11*(2), 121-136.

Deci, E. L., & Ryan, R. M. (1985). *Self‐Determination*. John Wiley & Sons, Inc..

Dollaghan, C. A., Campbell, T. F., Paradise, J. L., Feldman, H. M., Janosky, J. E., Pitcairn, D. N., & Kurs-Lasky, M. (1999). Maternal education and measures of early speech and language. *Journal of Speech, Language and Hearing Research*, *42*(6), 1432.

Downer, J. T., Booren, L. M., Lima, O. K., Luckner, A. E., & Pianta, R. C. (2010). The Individualized Classroom Assessment Scoring System (inCLASS): Preliminary reliability and validity of a system for observing preschoolers' competence in classroom interaction. *Early Childhood Research Quarterly, 25* (1), 1-16.

Duncan, G. J., Brooks‐Gunn, J., & Klebanov, P. K. (1994). Economic deprivation and early childhood development. *Child Development*, *65*(2), 296-318.

Duncan, G. J., & Brooks‐Gunn, J. (2000). Family poverty, welfare reform, and child development. *Child Development*, *71*(1), 188-196.

Duncan, G. J., Dowsett, C. J., Claessens, A., Magnuson, K., Huston, A. C., Klebanov, P. & Japel, C. (2007). School readiness and later achievement. *Developmental Psychology*, *43*(6), 1428-1446.

Duncan, G. J., & Gibson-Davis, C. M. (2006). Connecting Child Care Quality to Child Outcomes Drawing Policy Lessons from Nonexperimental Data. *Evaluation Review*, *30*(5), 611-630.

Dunn, L.M., & Dunn, L.M. (1997). *Peabody Picture Cocabulary Test-revised.* Circle Pines MN.

Early, D. M., Maxwell, K. L., Burchinal, M., Alva, S., Bender, R. H., Bryant, D. & Zill, N. (2007). Teachers' education, classroom quality, and young children's academic skills: Results from seven studies of preschool programs. *Child Development*, *78*(2), 558-580.

Eccles, J. S. (1993, October). School and family effects on the ontogeny of children's interests, self-perceptions, and activity choices. In *Nebraska Symposium on Motivation* (Vol. 40, pp. 145-208). Lincoln, NE: U. Nebraska Press.

Elley, W. B. (1989). Vocabulary acquisition from listening to stories. *Reading Research Quarterly*, 174-187.

Ertel, K. A., Rich-Edwards, J. W., & Koenen, K. C. (2011). Maternal depression in the United States: nationally representative rates and risks. *Journal of Women's Health*, *20*(11), 1609-1617.

Estigarribia, B., & Clark, E. V. (2007). Getting and maintaining attention in talk to young children. *Journal of Child Language*, *34*(04), 799-814.

Feitelson, D., Goldstein, Z., Iraqi, J., & Share, D. L. (1993). Effects of listening to story reading on aspects of literacy acquisition in a diglossic situation. *Reading Research Quarterly*, 71-79.

Felner, R. D., Brand, S., DuBois, D. L., Adan, A. M., Mulhall, P. F., & Evans, E. G. (1995). Socioeconomic disadvantage, proximal environmental experiences, and socioemotional and academic adjustment in early adolescence: Investigation of a mediated effects model. *Child Development*, *66*(3), 774-792.

Fenson, L., Dale, P. S., Reznick, J. S., Bates, E., Thai, D. J., & Pethick, S. J. (1994). Variability in early communicative development. *Monographs of the Society for Research in Child Development,* 59(5), I-185.

Goldfield, B. A., & Reznick, J. S. (1990). Early lexical acquisition: Rate, content, and the vocabulary spurt. *Journal of Child Language*, *17*(1), 171-183.

Goodman, J. C., Dale, P. S., & Li, P. (2008). Does frequency count? Parental input and the acquisition of vocabulary. *Journal of Child Language*, *35*(3), 515.

Gottlieb, G. (1992). *Individual Development and Evolution: The genesis of novel behavior*. Psychology Press.

Hamilton, D. (1987). Sometimes R 2> r 2 yx 1+ r 2 yx 2: Correlated Variables are Not Always Redundant. *The American Statistician*, *41*(2), 129-132.

Hamre, B. K., Pianta, R. C., Mashburn, A. J., & Downer, J. T. (2007). Building a science of classrooms: Application of the CLASS framework in over 4,000 US early childhood and elementary classrooms. *New York, NY, Foundation for Child Development*.

Hart, B., & Risley, T. R. (1995). *Meaningful Differences in the Everyday Experience of Young American Children*. Brookes Publishing Company, Inc., PO Box 10614, Baltimore, MD 21285-0624.

Hart, B., & Risley, T. R. (2003). The early catastrophe: The 30 million word gap by age 3. *American Educator*, *27*(1), 4-9.

Hoff, E., & Tian, C. (2005). Socioeconomic status and cultural influences on language. *Journal of Communication Disorders*, *38*(4), 271-278.

Howes, C., Burchinal, M., Pianta, R., Bryant, D., Early, D., Clifford, R., & Barbarin, O. (2008). Ready to learn? Children's pre-academic achievement in pre-kindergarten programs. *Early Childhood Research Quarterly*, *23*(1), 27-50.

Huttenlocher, J., Haight, W., Bryk, A., Seltzer, M., & Lyons, T. (1991). Early vocabulary growth: Relation to language input and gender. *Developmental Psychology*, *27*(2), 236.

Kit, C. (2003). How does lexical acquisition begin? A cognitive perspective. *Cognitive Science*, *1*(1), 1-50.

Kreft, I. G., & De Leeuw, J. (1998). *Introducing Multilevel Modeling*. SAGE Publications Limited.

Kuhl, P. K. (2004). Early language acquisition: cracking the speech code. *Nature Reviews Neuroscience*, *5*(11), 831-843.

La Paro, K. M., & Pianta, R. C. (2000). Predicting children's competence in the early school years: A meta-analytic review. *Review of Educational Research*, *70*(4), 443-484.

Lerner, R. M., & Kauffman, M. B. (1985). The concept of development in contextualism. *Developmental Review*, *5*(4), 309-333.

LoCasale-Crouch, J., Konold, T., Pianta, R., Howes, C., Burchinal, M., Bryant, D., ... & Barbarin, O. (2007). Observed classroom quality profiles in state-funded pre-kindergarten programs and associations with teacher, program, and classroom characteristics. *Early Childhood Research Quarterly*, *22*(1), 3-17.

Lovejoy, M. C., Graczyk, P. A., O'Hare, E., & Neuman, G. (2000). Maternal depression and parenting behavior: A meta-analytic review. *Clinical Psychology Review*, *20*(5), 561-592.

MacWhinney, B. (2000). *The CHILDES Project: Tools for Analyzing Talk. Transcription,* *format and programs* (Vol. 1). Lawrence Erlbaum.

MacWhinney, B. (2004). A multiple process solution to the logical problem of language acquisition. *Journal of Child Language*, *31*(04), 883-914.

McKee, G., Malvern, D., & Richards, B. (2000). Measuring vocabulary diversity using dedicated software. *Literary and Linguistic Computing*, *15*(3), 323-338.

Newland, R. P., Crnic, K. A., Cox, M. J., & Mills-Koonce, W. R. (2013). The family model stress and maternal psychological symptoms: Mediated pathways from economic hardship to parenting. *Journal of family psychology: JFP: journal of the Division of Family Psychology of the American Psychological Association (Division 43)*, *27*(1), 96-105.

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 and Youth Development. American Educational Research Journal, 39, 133–164.

NICHD Early Childcare Research Network & Duncan, G. J. (2003). Modeling the impacts of child care quality on children's preschool cognitive development. *Child Development*, *74*(5), 1454-1475.

NICHD Chilad-care effect sizes for the NICHD Study of Early Child Care and Youth Development. (2006). *The American Psychologist, 61*(2), 99-116.

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*(4), 763-782.

Pianta, R. C., La Paro, K. M., & Hamre, B. K. (2004). Classroom Assessment Scoring System [CLASS] manual: Pre-K. Baltimore, MD: Brookes Publishing.

Pianta, R. C., Belsky, J., Houts, R., & Morrison, F. (2007). Opportunities to learn in America's elementary classrooms. *Science (New York, NY)*, *315*(5820), 1795.

Pianta, R. C., Mashburn, A. J., Downer, J. T., Hamre, B. K., & Justice, L. (2008). Effects of web-mediated professional development resources on teacher–child interactions in pre-kindergarten classrooms. *Early Childhood Research Quarterly*, *23*(4), 431-451.

Poll, G. H. (2011). Increasing the odds: Applying emergentist theory in language intervention. *Language, Speech, and Hearing Services in Schools*, *42*(4), 580.

QI Huaqing, C., Kaiser, A.P., Milan, S., & Hancock, T. (2006). Language Performance of Low-Income African American and European American Preschool Children on the PPVT-III. *Language, Speech, and Hearing Services in Schools*, *37*, 5-16.

Raver, C. C. (2002). Emotions matter: Making the case for the role of young children's emotional development for early school readiness. Social Policy Report, 16(3), 3-19.

Ram, N., & Grimm, K. J. (2009). Methods and measures: growth mixture modeling: a method for identifying differences in longitudinal change among unobserved groups. *International Journal of Behavioral Development*, *33*(6), 565-576.

Raviv, T., Kessenich, M., & Morrison, F. J. (2004). A mediational model of the association between socioeconomic status and three-year-old language abilities: The role of parenting factors. *Early Childhood Research Quarterly*, *19*(4), 528-547.

Resnick, L. (1994). Situated Rationalism: Biological and social preparation for learning. In L. A. Hirschfeld & S. A. Gelman (Eds.), Mapping the Mind: Domain specificity in cognition and culture (pp. 474 – 493). New York: Cambridge University Press.

Robinson, C., & Schumakcer, R.E. (2009). Interaction Effects: Centering, Variance, Inflation Factor, and Interpretation Issues. *Multiple Regression Viewpoints, 35,* 1, 6-11.

Rodriguez, E. T., & Tamis‐LeMonda, C. S. (2011). Trajectories of the home learning environment across the first 5 years: Associations with children's vocabulary and literacy skills at prekindergarten. *Child Development*, *82*(4), 1058-1075.

Rowe, M. L., Coker, D., & Pan, B. A. (2004). A Comparison of Fathers' and Mothers' Talk to Toddlers in Low‐income Families. *Social Development*, *13*(2), 278-291.

Rowe, M. L., & Goldin-Meadow, S. (2009). Differences in early gesture explain SES disparities in child vocabulary size at school entry. *Science*, *323*(5916), 951-953.

Rudd, L. C., Cain, D. W., & Saxon, T. F. (2008). Does improving joint attention in low‐quality child‐care enhance language development?. *Early Child Development and Care*, *178*(3), 315-338.

Schoenfeld, A. H., Smith, J. P., & Arcavi, A. (1993). Learning: The microgenetic analysis of one student's evolving understanding of a complex subject matter domain. *Advances in instructional psychology*, *4*, 55-175.

Selya, A. S., Rose, J. S., Dierker, L. C., Hedeker, D., & Mermelstein, R. J. (2012). A Practical Guide to Calculating Cohen's f2, a Measure of Local Effect Size, from PROC MIXED. *Frontiers in Psychology*, *3*.

Singer, J. D. (1998). Using SAS PROC MIXED to fit multilevel models, hierarchical models, and individual growth models. *Journal of Educational and Behavioral Statistics*, *23*(4), 323-355.

Singer, J. D., & Willett, J. B. (2003). *Applied Longitudinal Data Analysis: Modeling change* *and event occurrence.* Oxford University Press, USA.

Sirin, S. R. (2005). Socioeconomic status and academic achievement: A meta-analytic review of research. *Review of Educational Research*, *75*(3), 417-453.

Snow, C. E. (1983). Literacy and language: Relationships during the preschool years. *Harvard Educational Review*, *53*(2), 165-189.

Snow, C. E., & Beals, D. E. (2006). Mealtime talk that supports literacy development. *New Directions for Child and Adolescent Development*, *2006*(111), 51-66.

Skinner, E. A., & Belmont, M. J. (1993). Motivation in the classroom: Reciprocal effects of teacher behavior and student engagement acrossthe school year. *Journal of Educational Psychology*, 85, 571–581.

Stevenson, H. W., Lee, S. Y., Chen, C., Stigler, J. W., Hsu, C. C., Kitamura, S., & Hatano, G. (1990). Contexts of achievement: A study of American, Chinese, and Japanese children. *Monographs of the Society for Research in Child Development*, i-119.

Tabachnick, B.G., & Fidell, L.S. (2006). *Using Multivariate Statistics* (5th ed.). New York, NY: Allyn & Bacon.

Thelen, E. (1995). Motor development: A new synthesis. *American psychologist*, *50*(2), 79.

Thelen, E., & Smith, L. B. (2006). Dynamic Systems Theories. *Handbook of Child Psychology*.

Tomasello, M., & Farrar, M. J. (1986). Joint attention and early language. *Child Development*, 1454-1463.

Tomasello, M. (2000). The social-pragmatic theory of word learning. *Pragmatics*, *10*(4).

Tzelgov, J., & Henik, A. (1991). Suppression situations in psychological research: Definitions, implications, and applications. *Psychological Bulletin*, *109*(3), 524-536.

Truxillo, C. (2005, April). Maximum likelihood parameter estimation with incomplete data. In *SAS Users Group International Conference, Philadelphia, PA*.

Vygotsky L (1986) Thought and Language. Cambridge, MA: The MIT Press.

Vygotsky, L. (1978). Mind in Society. Harvard University Press.

Walker, D., Greenwood, C., Hart, B., & Carta, J. (1994). Prediction of school outcomes based on early language production and socioeconomic factors. *Child Development*, *65*(2), 606-621.

Weiland, C., Ulvestad, K., Sachs, J., & Yoshikawa, H. (2013). Associations between classroom quality and children's vocabulary and executive function skills in an urban public prekindergarten program. *Early Childhood Research Quarterly, 28*, 199-209.

Weizman, Z. O., & Snow, C. E. (2001). Lexical output as related to children's vocabulary acquisition: Effects of sophisticated exposure and support for meaning. *Developmental Psychology, 37*(2), 265-279.

Wentzel, K. R. (2002). Are effective teachers like good parents? Teaching styles and student adjustment in early adolescence. *Child Development*, *73*(1), 287-301.

Williams, K. T., & Wang, J. J. (1997). *Technical References to the Peabody Picture Vocabulary Test-(PPVT-III)*. American Guidance Service.

Zaslow, M., Anderson, R., Redd, Z., Wessel, J., Tarullo, L., & Burchinal, M. (2010). Quality dosage, thresholds, and features in early childhood settings: A review of the literature (OPRE 2011-5).

Zins, J., Bloodworth, M., Weissberg, R., & Walberg, H. (2004). The scientific base linking social and emotional learning to school success. In J. Zins, R. Weissberg, M. Wang, & H. J. Walberg (Eds.), Building academic success on social and emotional learning:

What does the research say? (pp. 1-22). New York: Teachers Press, Columbia University.