DOES BILINGUALISM IMPROVE ACADEMIC PERFORMANCE? ESTIMATING THE RELATIONSHIP BETWEEN FOREIGN LANGUAGES SPOKEN AT HOME AND STUDENT TEST SCORES

A Thesis
Submitted to the Faculty of the
Graduate School of Arts and Sciences
of Georgetown University
in partial fulfillment of the requirements for the
degree of
Master of Public Policy
in Policy

By

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Washington, DC
April 15, 2016

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ABSTRACT

During the 2013-14 school year, nearly 10 percent of students in U.S. public elementary and secondary schools are English-learners. Limitation in the scope of previous research prevents researchers from understanding whether a non-English language spoken at home has an effect on student test scores. Using the Early Childhood Longitudinal Study, Kindergarten 1998-99, this study examines the role of bilingualism – when a non-English language is spoken at home – plays in students' academic performance and their developmental trajectories in early school years. Ordinary Least Square results show that despite starting with lower math and the reading scores in kindergarten, bilingual students fully close the math gap by 1st grade and reading gap by 5th grade. However, home and community factors, school factors, and student characteristics explain more of these differences than bilingualism.

ACKNOWLEDGEMENTS

I would like to give a special thanks to my advisor, Thomas Wei, for providing enormous helpful feedback and guidance throughout this process. I also want to thank my statistics professors at Georgetown, Carolyn Hill, James Habyarimana, and Adam Thomas, who prepared me for this process. Finally, a special thanks to Eric Gardner for the valuable feedback and all the help on acquiring, mining and handling the raw data.

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INTRODUCTION

Ever since the 1965 Immigration Reform Act and the new era of globalization, the world's demand is not only for technology, economic views or products integration, but also for new strategy to cope the interface of international migrants and the native population. The U.S. Census Bureau has estimated that immigrant population was about 13 percent whereas immigrant's children (born in the United States) were about 26 percent of the total U.S. population in 2014 (Zong & Batalova, 2016). An essential component of movement is the utilization of language or dialects when parents interact with their children (Paret, 2006). During the 2013-14 school year, English-learners comprised more than 10 percent of enrollment in U.S. public elementary schools and secondary schools (Mitchell, 2016). The shifting of the U.S. population and predominance of foreign language use indicates that examining the educational experiences of the immigrants' children – those that speaks a non-English language at home – is essential for education reform and to meet globalization demand (Paret, 2006).

A recent study of academic achievement reveals the importance of language-based skills in early childhood (Kastner, May, & Hildman, 2001). The authors argue that mastery of language-based skills correlates positively with later performance in school. However, because language-minority students usually grow up learning a non-English language at home and English at school, they must to distribute resources in acquiring and mastering two or more languages. Therefore, their English proficiency might lag behind monolingual English speakers. This early difference in oral English language skill constitutes a deficit for immigrant children about to enter school in the United States (Hoff, 2013).

However, bilingualism appears to have benefits as well as liabilities. Bailystok and Craik (2010) found that bilinguals have better performance in nonverbal tasks that involve conflict resolution (e.g., Stroop and Simon tasks). However, the trade-off is that bilinguals may know fewer words and are less capable than monolinguals in forming sentences or speech.

In the past decade, because of the cost and benefits associated with bilingualism, bilingual education policy in the United States has been a subject of intense debate. Those who disagree with bilingual education argue with data that there are negative consequences associated with the use of non-English language when instructing or lecturing students (Wiley & Wright, 2004; Baker, 2011; and Mariam et al., 2013). Conversely, those who support bilingual education cite evidence of students improving executive control in nonverbal tasks. Should we formally promote bilingual education in the United States? Would just the oral form of bilingualism be enough to promote academic achievement (as opposed to reading and writing as well)? To answer these policy questions, we need to understand the costs and benefits associated with it. One essential piece of information needed is the effect bilingualism has on student's academic performance and how does this effect evolve over time.

My study examines the relationship between bilingualism and academic achievement both at kindergarten entry, during the years at primary school and the year at eight grades. Past research has highlighted few reasons why early grades and progress through primary school are particularly important for students. First, because of the cumulative curriculums, what students learn in school in the early years act as building blocks to prepare them for later challenges; though the early performances is critical to measure and to predict the overall academic accomplishments and educational attainment (Ensminger & Slusarcock, 1992; Entwisle & Alexander, 1993; and Farkas, 2003). Second, prior entering school, student knowledge is limited to what they learnt at home, what they learn in the first few years in school are quantifiable instantaneously. Sylva & Wiltshire (1997) found that the quality of preschool programs is highly positive correlated with later academic achievements and success in the labor market. Third, humans' ability to learn language(s) diminishes with age. Specialists agree that there is a decline in the ability to learn a second language after the age of six or seven (Asher & Garcia, 1969). Though examining academic achievement in the early grades allow us to attribute the effect of language in students' performance more precisely.

Research Questions

My thesis attempts to answer two sets of questions regarding the academic achievement of primary school students:

1. What is the relationship between non-English language spoken at home and academic achievement at kindergarten entry and as student's progress through primary school and to eight grades?
2. How does academic trajectories differ between math and reading?

LITERATURE REVEW

Most of the research on bilingual student performance has been conducted on compound bilinguals. This is when students acquired their second language through formal language classes in school or language institutions. Studies of bilingual students' performance, where student acquired the second language via parents and the home environment are very limited. For those limited studies that do, researchers tend to focus on a single ethnic minority group and/or a single school grade. These studies compare the academic performance of ethnic minority students (i.e., Asian, Hispanic, etc.) who spoke a non-English language at home to English monolingual students (EMS) who spoke English only at home (Funligni, 1997; Mouw, & Xie, 1999; and

Buriel & Cardoza, 1988). Because these studies are limited to one or two ethnic minorities, they may not capture the overall average effect of non-English language spoken at home on student achievement. For example, Buriel and Cardoza (1988) examined the relationship between Spanish language background and achievement among high school Mexican-Americans. They found that students' aspirations showed the strongest positive relationship to achievement and Spanish language background showed practically no relationship to achievement. Despite the strong findings, the study only accounted for Mexican-American students from the U.S. Pacific Region, which might not apply to ethnic minority students nationally. Furthermore, the study did not include controls for home environment/socioeconomic characteristics (i.e., family income, parent's education), which raises concerns about whether the study captured the true effect of language spoken at home on academic achievement, given that other research has pointed to the importance of socioeconomic status for academic achievement (Sirin, 2005).

Another study (Mouw & Xie, 1999) included socioeconomic characteristics in the analysis, and the results indicated little to no correlation that students who speak two or more languages get higher test score than students who only speak one language. The results of this study contradicts with the other researches, probably because this study only included a sample of just 832 Asian-American students in eighth grade, which is not necessarily representative of U.S. non-native English speakers.

The first analysis to look more broadly at all ethnic minority students who spoke non-English languages across the U.S. came in a Child Development Report (Fuligni, 1997). This study examined students with Latino, East Asian, Filipino, and European backgrounds and their academic achievements and behaviors. Results indicated that bilingual students scored higher in math and reading tests than monolingual students, and a large portion of this effect correspond to the value and motivation shared among group. However, despite including various ethnic groups, this study is limited by the fact that participating students came from just two middle schools in California.

Han (2012) brought new rigor to the analysis of non-English language spoken at home and academic trajectories during early school years. Using panel data from the Early Childhood Longitudinal Study's Kindergarten Cohort (ECLS-K), he ran a three-level growth curve model (level 1 as time, level 2 as individual and level 3 as schools). In comparing English monolingual's test scores to "mixed bilingual" (children who have good usage of non-English language at home and English language in other settings), "non-English-dominant bilinguals" (children who speak non-English and English language, but English language is not the dominant language) and "non-English monolinguals" (children who speak non-English language only), the author found that "mixed bilingual" is the only group that achieves comparable test scores to "English monolingual". Although this study employed a stronger empirical strategy, it suffered from two important limitations: (1) the author restricted the analysis only to children from Latino and Asian backgrounds; and (2) the author did not control for socioeconomic factors.

Though there has been extensive research on bilingual students' academic achievement and the relationship between language skills and academic performance, the effects of being a bilingual on academic achievement have not been fully explored, and many of them are limited in scope. For example, most existing studies did not use a nationally representative sample, and most did not examined the effect of non-English language spoken at home on academic achievement over time.

My thesis aims to fill this gap in the literature by expanding the scope of past research (including all non-English minorities and adding more years) and adding new controls. I examine the relationships between language spoken at home and academic achievement over time. Focusing on the early academic experiences of language minority students and modeled after Paret (2006) and Han (2012) papers; my research is meant to build off of it by using the same data from a nationally representative sample of students who were enrolled in a public or private kindergarten program in the 1998-99 school year (ECLS-K). Furthermore, I employ an improved research design, which includes all controls variables that were used in quite more recent studies and that showed statistical significant effect on predicting academic performance. These variables include: language proficiency, race-ethnicity, socioeconomic status, school-level factors, and students' characteristics (Paret, 2006; and Han, 2012).

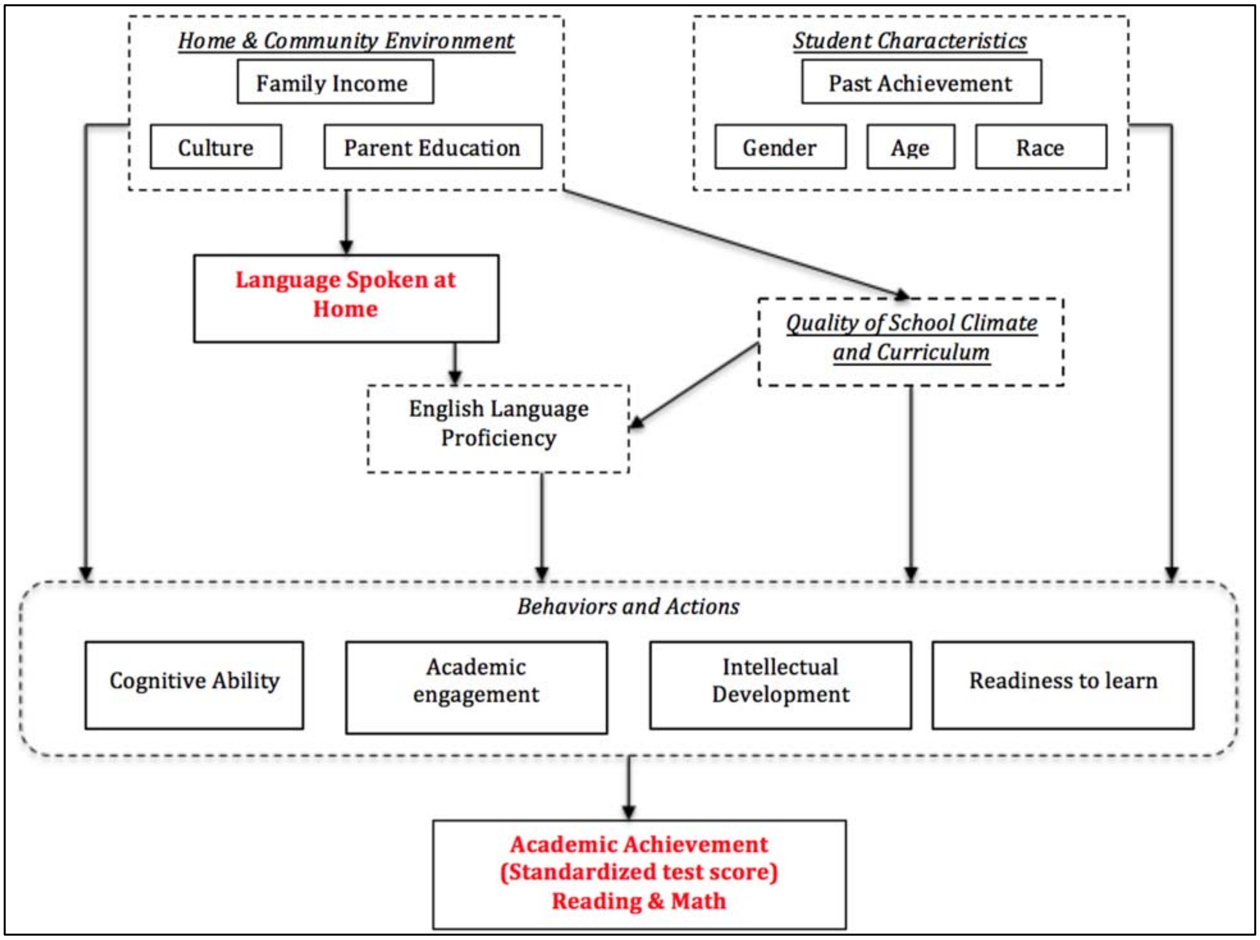
CONCEPTUAL MODEL AND HYPOTHESES

My study includes the factors that in recent studies have shown a statistically significant effect on academic achievement. For purposes of discussion, these variables are grouped into three major categories: (1) home and community environment, (2) quality of school climate and curriculum, and (3) students' characteristics. The only two variables that are not grouped into a major category are non-English Language Spoken at Home and English Language Proficiency. The conceptual model for examining the effects of these factors is presented in Figure 1 and discussed in the following paragraphs.

The model posits that Home and Community Environment, Quality of School Climate and Curriculum, Students' Characteristics and English Language Proficiency have a direct effect on Behaviors and Actions, which are related to academic achievement. In part, Language Spoken at Home and Quality of School Climate and Curriculum affect students' English Language

Proficiency. To fully understand the effects of each factor on academic achievement, I also discuss these factors' interacting and overlapping influences.

Figure 1. Conceptual Model



1. *Quality of School Climate and Curriculum*

Many authors have cited the importance of quality of education, school climate, and curriculum on the trajectory of students' academic achievement. Han (2012) suggests that about one third of the reductions in the differences in children's (white English monolingual vs. non-English dominant bilingual) academic outcomes are attributable to school-level factors. Among these factors, School Climate and Curriculum is especially important because it can promote student engagement. For instance, we would expect that a classroom with resources (e.g., computers and projectors) would make classes more interactive, which enhances students' learning experiences and increases their probability of succeeding in class. Indeed, Sbrocco (2009) found that more engaged students are more likely to obtain higher average test scores.

2. Home & Community Environment

Culture, family income, and parents' education are grouped under Home and Community factors. Language spoken at home by students largely depends on the race and ethnicity of parents since individuals who was born and/or grew up in a country where English is not the official or primary language used, are more likely to use the foreign language at home (Paret, 2006). This is important because by the time children reach school age; the non-English Language Spoken at Home factor will affect English acquisition (i.e., children who spoke a non-English language at home would have to learn a new language – English – when they get to school). From the sociocultural point of view, learning a non-English native language or dialect is seen as a way to preserve and practice a culture (Paret, 2006).

Culture and language are inseparable. A survey designed by Jiang (1999) examined how culture affects the choice of words and expression used by two different language groups participant. Jiang (1999) noted that food words listed by most native Chinese speaker include: 'steamed bread', 'noodle, meat', 'rice and dumpling', which are typical foods among in Chinese people; While words such as 'hamburgers', 'ice-cream', 'pizza', 'and dessert' are listed by the native English speaker. Jiang (1999) results not only suggests the choice of word differs, but that native Chinese speakers tend to express things in a more specific way, while native English speaker tend to be more general. Culture includes, but is not limited to, beliefs, morals, law, knowledge, practices, and parenting style. These factors influence student academic performance, through theirs effects on cognitive ability, intellectual development and values such as work ethic (Kao & Thompson, 2003).

The levels of parental and community resources may also influence students' academic achievement. Families with more resources (e.g., higher income) would have access to better health services, nutrition, and better schools for their children. Previous studies have cited the importance of nutrition to a child's cognitive development. Conversely, poor nutrition in early childhood could result to severe effect in the later stage of development. Children with poor nutrition could experience delayed physical growth and motor development (World Bank, 2011), which could impact their ability to learn, focus and in more extreme cases children could experience hard time interacting with their peers. In contrast, high academic accomplishment is in all likelihood when schools and teachers put students achievement in priority, and when home and community put enough resources and supports for students to grow in healthy environment (Bronfenbrenner, 1978).

Parents' educational attainment is also important in determining their child's academic achievement. Parents with higher education are more likely to earn higher income and to supervise their children on school assignments and in understanding course materials. Parenting behavior is shaped by background factors and context (e.g., education) and as parents express diverse values and opinions, children's manners and inspirations are then influenced (Grolnick et al., 2009). So when parents believe that academic accomplishment and intellectual capacity are something that can be altered or work to achieve, children would be instilled with such mentalities and so they will work hard in achieving high accomplishment (Dweck, 2010).

3. Student Characteristics

Student's gender, past achievement, age, and race factors are included under Student Characteristics, have a direct and indirect impact on academic achievement. Gender differences in test scores are an international phenomenon that emerges in different institutional settings. Researchers have cited biological, social, psychological, and institutional reasons to explain gender disparities in academic achievement (Mickelson, 1989; Esptein, 1998; and Hyde & Kling, 2001). Previous scholastic achievement is highly correlated with present achievement, not only because past performance indicates how well prepared students are for present or new materials, but also because it affects students aspirations, expectations, and cognitive abilities (Lemons et al. 2014). As the Lemons and his coauthors suggest, students' aspiration, expectations, and cognitive abilities are shaped by multiple variables, including: age, past performance, race, culture, and many others. These factors hold a simultaneous relationship, which will affect academic outcomes.

4. Language Spoken at Home and English Language Proficiency

Language proficiency has an indirect effect on academic achievement through a set of effects on psychological, behavioral, and physical brain development. For a student to understand school materials and succeed in the classroom, proficiency in the main language used in the classroom is required. For instance, in schools where English is the main language, students with high English proficiency will be able understand and interpret course materials effectively; but students with limited English proficiency may experience communication difficulties (Warren, 1996; and Schmid, 2001). In addition, language spoken at home affects proficiency in English. As discussed earlier, children who speak non-English languages at home have to learn a new language – English – when they get to school. Moreover, these students have to allocate their resources to learning/maintaining two languages.

In exploring the relationship between language spoken at home and English language proficiency, researchers have come to different conclusions. Ben-Zeex (1977) suggests that raising children to speak and understand more than one language is good for their cognitive development. Students with higher cognitive ability are usually higher academic achievers (Leeson et al., 2008). In other words, there could be a positive impact as bilingual students "have the English-language skills to function effectively in school without abandoning their [native] language and culture that enable them to maintain an identity and to function effectively in their families and communities" (Rumberger & Larson, 1998). However, there could also be a negative impact if the second language gradually replaces the first language. As explained by Lambert and Taylor (1981): "the hyphenated American child, like the French-Canadian child, may embark on a 'subtractive' bilingual route as soon as he/she enters a school where a high prestige, socially powerful, dominant language like English is introduced as the exclusive language of instruction" (p. 14).

5. Hypotheses

Based on the findings of previous studies, different factors influence the relationship of non-English language spoken at home and academic achievement positively and negatively; though the net effect is not clear. But in my opinion, I hypothesize that non-English language spoken at home (bilingualism) will have a negative effect on academic achievement (in both math and reading). I also hypothesize that all students' that speak a non-English language – regardless of their race – at home will score lower than native-English students in kindergarten and the first few years in primary school. But because cognition increases with age, this gap will diminish as students proceed to the last few years of primary school. Furthermore, the rate at which this gap closes will be faster for math than reading; and even faster for bilingual students who are proficient in English.

EMPIRICAL STRATEGY

In my study, the term monolingual refers to those students who speak only English at home; while bilingual refers to those students who speak a non-English language at home (language minorities). Model 1 is my base empirical Ordinary Least Square (OLS) model, derived from the conceptual framework in *Figure 1* and structured partially following the equation in Paret (2006).

Model 1 (Base): Regression Model
Test Score (R-reading and M-math)

$$TS_{s,g} = \propto + \beta_1 LSH + \beta_2 \mathrm{ELP}_g + \beta_3 \text{School Factors}_{\mathrm{g}} + \beta_4 \text{Home \& Community Factors} + \beta_5 \text{Student Factors}_{\mathrm{s,g}}{}^{*} + u_{s,g}$$

s: subject
g: grade
LSH: Language spoken at home
ELP: English language proficiency
***:** *Only past achievement will vary by grade and subject*

In this equation, my dependent variable is test scores (math and reading). Current year test scores are a function of language spoken at home, English language proficiency, home and community factors (race, family income, and parent education), school factors (school type), and student factors (gender, age, and previous year test scores). I apply sampling weights to ensure my results are nationally representative. I also conduct a secondary subgroup analysis by race. This allows me to see if there are differences in the effect of languages across various racial groups.

For robustness analyses, I employ five more regressions. In the first four of these regressions, I omit a factor from the base model and in the fifth regression I omit all control variables/factors. Model 2 omits the School Climate and Curriculum category; Model 3 omits Home and

Community category; Model 4 omits the Student Characteristics; Model 5 omits English Language Proficiency; and Model 6 omits all control variables/factors.

Model 2: Regression Model

$$TS_{s,g} = \propto + \beta_1 LSH + \beta_2 \mathrm{ELP}_g + \beta_3 \mathrm{Home\ \&\ Community\ Factors} + \beta_4 \mathrm{Student\ Factors}_{\mathrm{s,g}}{}^{*} + u_{s,g}$$

Model 3: Regression Model

$$TS_{s,g} = \propto + \beta_1 LSH + \beta_2 \mathrm{ELP}_g + \beta_3 \mathrm{School\ Factors}_{\mathrm{g}} + \beta_4 \mathrm{Student\ Factors}_{\mathrm{s,g}}{}^{*} + u_{s,g}$$

Model 4: Regression Model

$$TS_{s,g} = \propto + \beta_1 LSH + \beta_2 \mathrm{ELP}_g + \beta_3 \mathrm{School\ Factors}_{\mathrm{g}} + \beta_4 \mathrm{Home\ \&\ Community\ Factors} + u_{s,g}$$

Model 5: Regression Model

$$TS_{s,g} = \propto + \beta_1 LSH + \beta_2 \mathrm{School\ Factors}_{\mathrm{g}} + \beta_3 \mathrm{Home\ \&\ Community\ Factors} + \beta_4 \mathrm{Student\ Factors}_{\mathrm{s,g}}{}^{*} + u_{s,g}$$

Model 6: Regression Model

$$TS_{s,g} = \propto + \beta_1 LSH + u_{s,g}$$

s: subject
g: grade
LSH: Language spoken at home
ELP: English language proficiency
***:** *Only past achievement will vary by grade and subject*

1. Dependent Variables

My dependent variables are the student-level test scores for each subject and grade. The reading assessments were designed to measure basic skills such as letter sounds and recognition, vocabulary, and comprehension. The math assessments were designed to measure conceptual knowledge, procedural knowledge, and problem solving. Direct assessments of reading and mathematics competency were collected using an item response theory (IRT) approach. IRT procedures yield an overall scale score of children’s knowledge and skills estimates at any given point in time and can be used to look at knowledge and skill over time. My models include ten continuous variables; five corresponding to reading test scores and five corresponding to math test scores in kindergarten, and first, third, fifth and eighth grades.

2. Independent Variables of Interest – Language Spoken at Home

My main independent variable of interest is language spoken at home. The ECLS-K measured this by asking parents what languages were spoken at home, and which of these languages was primary and secondary in terms of use in the base year (Kindergarten). Based on the responses students are organized into two categories: (1) English is the only language spoken at home; (2) a non-English language is spoken at home.

3. Control Variables

My control variables account for other factors that influences test scores and may also be related to whether a non-English language is spoken at home. The control variables include English Language Proficiency and other variables that are grouped in three categories: home and community factors (culture, family income, and parent educational attainment); school factors (school type); and student factors (gender, race, and previous year test scores).

With respect to English Language Proficiency, the ECLS-K collected detailed information at school entry. In the kindergarten and first-grade data collections, a brief language screener, the Oral Language Development Scale (OLDS) was given to 15% of children who were identified by teachers or school records as having a non-English language background, and those that did not understood English well enough to receive the direct child assessment from the screener. Whether a child achieved at least the cut-off score on the OLDS and was assessed in English can be used as an indicator of the child's Basic English proficiency. In kindergarten, about 1,400 children (9% of the overall sample) scored below the cut-off point, and by first grade the number was down to 2% of the overall sample. The OLDS was not administered beyond first grade because most children had passed the OLDS by the spring first-grade data collection.

Control variables under Home and Community Factors include culture, family income, and parent educational attainment. ECLS-K does not have a direct assessment of culture, but the race variable captures some cultural characteristics. Since race is also included as a student factor, I use a student's race recorded at the beginning of the ECLS-K study as control variable. Family income is measured through parent interviews in each round. My study uses the average income of each household over all the rounds I am studying. The ECLS-K also recorded parents' highest education level in the base year (kindergarten). The record shows nine levels of educational attainment. I take this information and collapse it into four categories: some high school, completed high school, completed college, and some master's classes.

Student gender and race are composite variables that are measured at the beginning of the study (kindergarten); I use these same variables as my controls. In addition, I include the scores of the previous round as my past achievement measure. For instance, when predicting third grade reading test scores, I include first grade reading test score as a control variable. Since kindergarten is the base year, previous round test scores are not included in that case. Student age, discussed in the conceptual model, will not be included in the regression model because students are required to be in a certain age range to attend a grade (e.g., 6 or 7 years of age to attend first grade). So age is already mostly captured in grade-level test scores.

DATA AND DESCRIPTIVE STATISTICS

The Early Childhood Longitudinal Study, Kindergarten Class of 1998-99 (ECLS-K) program sponsored by the National Center for Education Statistics at the U.S Department of

Education, is a longitudinal study that examines child development, school readiness, and early school experiences. To ensure that the sample is nationally representative, children in the study were drawn randomly using a dual-frame, multi-stage sample design. The primary-sampling units (PSUs) – counties and country groups – were selected from a national framework. After obtaining the counties, researchers selected about 46 students from public and private schools (23 students each) within each county. Through this process, a sample of 21,356 students from 1,280 schools was selected for the study in the fall of their kindergarten year. This sample contained children from diverse socioeconomic and racial/ethnic backgrounds. Also participating in the study were the children's parents, teachers, and schools. Students who were selected in the study were followed longitudinally from kindergarten through eighth grade. Apart from being a national representative sample, the ECLS-K also included detailed information on language spoken at home upon school entry. This makes it the only dataset with the capacity to evaluate the relationship between children's language spoken at home and academic development trajectories.

As for my research, I have collected student-level panel data and their parents' responses from the ECLS-K. These data include: reading test score, math test score, language spoken at home, English language proficiency, parent's education, family income, race, gender, and school type attended (public, private or catholic). The students in my sample are a subsample of the ECLS-K, entered kindergarten in spring 1999 and were present in the study up until 8th grade. By using a consistent sample over time, more credible results are possible for comparisons across years. Appendix Table 1, compares the full sample, my analysis sample, and the dropped sample (the share if the full population not used in my study) in term of sizes and means across the various covariates in my analysis. My overall sample consists of 8,292 students. About 65% of these students are White. The rest were distributed in the following manner: Black (10.1%), Hispanic (17%), Asian & Pacific Islander (6.9%) and others races (4.1%). The proportion of females and males in my sample is about the same. Most students were attending public schools. Only 11% of my sample was administered the OLDS; and only 9.7% and 2.8% of the students administered the OLDS passed the assessment in kindergarten and first grade.

Although my sample comprises about 40% of the national representative sample (ECLS-K 1998-99 study), the students in my sample are statistically significantly different in many ways from the remaining 60% that were not selected. Although attrition is very common in longitudinal research, these differences do raise some concerns about attrition in my study. The attrition problem in my sample poses two threats of bias, which will be discussed below in my Discussion and Limitation section.

Appendix Table 2 shows a simple breakdown of the sample in my study by language status. Monolinguals are those students who only spoke English at home, while Bilinguals are student who spoke a non-English language at home. The percentages in Part I, shows that there are more monolingual students than bilingual students, but I still have a good number of students in each category. Before running OLS models and controlling for variables, it may be useful to see how test score performance differs between monolinguals and bilinguals. Part II reports the average standardized test scores based on the samples of children assessed in a given grade level. The differences between monolingual and bilinguals are all statistically significant, but reading test score differences are especially large when compared to math test scores. Difference in reading test scores range from 0.45 to 1 standard deviation, while differences in math scores range from 0.3 to 0.66 standard deviation units. Since the test scores in Table 2 Part II are computed as averages, it may also help to get a sense of the total distribution of test scores between monolinguals and bilinguals. Appendix Figure 2 and Figure 3 display the distribution of monolingual and bilingual student math IRT scale scores and reading IRT scale scores in standardized value by grade. The graphs show that both monolingual and bilingual student follow similar trajectories for Math and Reading. Student's IRT scores in kindergarten are skewed to the right, then cluster around the mean by 3rd grade, and end up skewing to the left by 8th grade.

RESULTS

The descriptive statistics show that monolingual and bilingual students vary in their observable characteristics and that their baseline average standardized test scores are significantly different (Table 2). After limiting my sample to students that were present throughout the study (kindergarten to 8th grade), I estimated the six OLS models outlined in my Empirical Strategy section (above). Appendix Tables 3 to 5 present the results. All regressions took into account any missing independent variable observations using the dummy variable adjustment. Less than three percent of observations were missing for the race control and the parent education control.

1. *Primary Results*

Some variables of interest yielded statistically significant results, though this was not consistent across all dependent variables and models. When results are significant, the magnitudes are mostly small. Table 3 displays regression results in standardized deviation units by subject and grade-level using the primary dependent variable of interest: test scores. The language spoken at home variable has only modest statistical significant and small effect on math test scores and almost no relationship to reading test scores. Four "Languages Spoken at Home" coefficients are statistically significant in predicting academic performance. Three are for math (kindergarten, 5th grade, and 8th grade), and one for reading (8th grade). For math test scores, the gap between monolingual and bilingual students although is small, but it is statistically significant (slightly less than 0.08 of a standard deviations).

The results suggest that bilingual students score lower than monolingual students at the beginning (kindergarten), but this gap gets smaller and reverses direction through time: bilinguals students eventually score higher than monolingual students on the math test. In 8th grade, being bilingual appears to be beneficial for math and reading achievement; it is associated with a 0.048 and 0.056 standard deviation increase in math and reading test scores respectively. In the other grades, being bilingual seems to be good for math (except in kindergarten) and neutral for reading. But overall, though statistically significant, the effect does not seem big – less than 0.1 of a standard deviation in test scores. In contrast, the control coefficients give more confidence that there are systematic and meaningful differences in math and reading test scores between monolingual and bilinguals.

a. English Language Proficiency

Among all control variables, English Language Proficiency has the strongest predictive power – in term of magnitude and statistical significance – for math and reading scores. The variable for students who were administered the ODLS and did not pass in the kindergarten round has a smaller impact in math and reading test scores when compared those that had to take the assessment in first grade. Having to take the assessment again in the first grade round is a future indication of lower English Language Proficiency. Students who passed in 1st grade round had scored 2.6 standard deviations lower in kindergarten reading than children who did not have to take the assessment. A similar story applies to those who did not pass OLDS at all.

b. Quality of School Climate and Curriculum

Most of the school coefficients are statically significant. Students in private and catholic schools score higher in reading tests relative to students in public schools in all years; and lower in 1st grade math. This finding is similar to Han (2012), who suggests that School-level factors could explain about one third of the reductions in the differences in children's academic performance.

c. Home and Community

Overall, Home and Community Factors (family income and parents' education) are statistically significant in all grade level. The higher the parents' educational attainment, the higher students score in math and reading, except that little or no difference was found between students whose parents' have a college degree and those whose parents have a graduate degree. Family income is also an important factor in student achievement. A dollar increase in family income is associated with test score increases ranging from 0.2 to 1.5 standard deviations.

d. Student Characteristics

Many of my time fixed variables are statistically significant. The effect of gender, past performance and race are smaller in magnitude and highly statically significant across all grades and subjects. On average, male students are likely to score higher than female students in math but lower in reading (kindergarten, 1st, 3rd and 5th grade). Past achievement is associated with a 0.7 to 0.8 standard deviation increase in both test scores. Race coefficients will require more attention as more coefficient in involved. The result in my analysis suggests that, on average, Whites score higher than other races in all grade level, except for Asian and Pacific Islander in later grades (after 3rd grade); but these differences are less than 0.5 standard deviations.

2. Secondary Results (Subgroup Analysis)

As race captures many cultural differences such as parental values and parenting styles and practices, which are very important in predicting academic achievement (Jiang, 1999), it is interesting to see if the relationship between language spoken at home and achievement varies for different racial groups. I conduct this analysis only for Hispanic and Asian & Pacific Islander subgroups since these groups have the most variation in whether a non-English language is spoken at home. Table 4 displays the regression results by subject and grade-level for my Hispanics and Asian & Pacific Islander subgroups. The results tell similar story as in Table 3 for the relationship between non-English language spoken at home and student test scores. For Hispanics, non-English language spoken at home does not seem to affect students' test score much, other than in kindergarten. In kindergarten, Hispanics who spoke a non-English language at home scored 0.2 and 0.01 standard deviations lower on math and reading tests than those who only spoke English at home. Students' past performance, gender, and achieving the OLDS minimum cut score had a stronger effect on test scores.

On the other hand, non-English language spoken at home only affects Asian & Pacific Islander math and reading test scores in 8th grade. In this sub-group, overall, students achieving the cut score of OLDS assessment by first grade, parent education, and student past achievement seem to have a larger effect on test scores than whether a non-English language was spoken at home.

3. Robustness Check

To ensure that my results are not being driven by model assumptions, I estimated the same regression, omitting different independent variables/factors. Table 5 displays language spoken at home coefficients by subject, grade, and model. In general, results from the original/baseline model and models omitting different variable(s) are similar with respect to statistical significance and the direction of relationship. The first column shows the original regression with all the control variables. The second to fifth columns show the original regression, but omitting school climate and curriculum factors, home and community factors, student characteristics factors or English language proficiency. Most of the OLS results are not sensitive to the elimination of variables relative to my baseline model, except the model eliminating the English proficiency variable (Table 5, column 5) and the model with no covariates (Table 5, column 6).

After eliminating the English proficiency variable (there is little sensitivity for 1st grade math) the language spoken at home variable becomes statistical significant at the 0.01 level and magnitudes increase in most of the grades for both subjects. The results on reading test scores are predominantly significant at most grade levels. This supports my earlier suggestion that, adding the English proficiency variable partially cancels out the effect of language spoken at home because they are strongly correlated. Student who spoke English only at home are expected to be proficient in English. On the other hand, student who spoke a non-English language at home are expected to be less proficient in English because they have to allocate their resource to learning two languages. English language proficiency is especially important for reading because it requires intensive knowledge and proficiency in English. Eliminating all covariates (Table 5, Column 6) from the original regression turns all language spoken at home coefficient to statistically significant at the 0.01 level for all grades. Control variables were added at the beginning because past studies had proved their effect on test scores. Removing them means excluding all alternative explanation that could be affecting test score outcomes. Also, the summary statistics in Table 2 show that monolingual and bilingual students differ significantly on many control variables. This suggests that their variables are different in important ways that may affect achievement. Therefore, not controlling for them likely will raise omitted variable bias.

DISCUSSION AND LIMITATIONS

Taken as a whole, my results indicate some relationship between language spoken at home and student test scores. This outcome confirms the previous literature that has found mixed differences between bilingual and monolingual student achievements trajectories. Though I was able to collect test scores and other observable characteristics from a nationally representative sample (original) of 21,409 students; to make comparable analysis, I restricted my sample to only consist of students that were present through the whole study (from kindergarten to 8th grade), so the sample in my test were restricted to only 40% of the original sample. The fact that the largest proportion of the original sample that was not selected in a way that met the requirements of my study poses threats to my conclusion because it differs on common baseline characteristics when compared to my sample. As a result, the conclusion drawn in my study may not be generalizable to the original population and is not nationally representative. Furthermore, selection bias may negatively affect the internal validity of my study; correlation between variables in my study could be different from the true correlations on the original sample.

Even in the case where attrition does not pose a threat in my study, the study has other important limitations. First, exclusion of observable or unobservable factors that are related to academic achievement and language spoken at home would lead me to overestimate the real relationship. For instance, although I have controlled for many important variables – and these controls might have explained a sizeable portion of the variation of test scores – I was not able to control for some variables. The main problem in estimating the effect of non-English language spoken at home on test score is unobservable factors. Bilingual student who speak a non-English language at home may have different habits at home from monolingual students due to the difference in culture. For instance, Asian culture puts more emphasizes on test scores and mastering skills, while Western culture puts more emphasizes on extra curricular activities and innovation. The degree to which Asians students focuses to achieve high test score largely depends on their parents' beliefs and values. As Paret (2006) indicates, these values and beliefs are affected by religion, the time being in America, and immigration status. Asians parents whose children are second-generation immigrants are less likely to urge their children to focus on achieving high-test scores than first-generation immigrants. These unobservable are not fully captured by race, which could bias my estimate of the true relationship.

Second, my outcome measures could be narrow in scope. My analysis can only make limited inferences, that is, inferences to the national population of the United States, since education systems and education policy vary from country to country. Bilingualism may exist in many different forms (e.g., students who attend bilingual school; or cases where the country/region official language consists of more than one language, as in Quebec, Canada). However, the scenario being studied in my research is specific to settings where English is the primary language used in school and where a non-English language is spoken at home.

Third, the other general limitation of my study is that even if my results had shown that speaking a non-English language at home makes students score differently than those who only speaks English at home, I can't differentiate bilingual students who spoke Chinese, Arabic, French, German or other non-English language at home, and to those who frequently spoke these non-English language at home to those who do not. Appendix Table 6 shows a simple distribution of the primary language spoken at home. As indicated in the table, ECLS-K only released half of the parents' responses and about 12,600 responses were suppressed. The "Sample" column reports a hypothetical distribution of students that will fall into each language category. Since I do not have a big enough sample, I cannot conduct further analysis of the type of non-English language spoken at home. This missing information is very important since there could be a relationship between the type of non-English language spoken at home and achievement on test score. For instance, a bilingual student who spoke Chinese (a language relatively different from English) could score at different level than a bilingual student who spoke Spanish (a language relatively similar to English). Also the racial categories don't necessarily fully capture this potential heterogeneity based on specific language spoken at home. Understanding if there are any differences in academic performances associated with bilingualism is important. While my study confirms that there are significant differences, it is not enough. The next item in the agenda is to explore the possibility of bilingual education program in primary school, and for such decision to be made, policy makers, educators and researchers need to identify the specific inputs and choices that yield better academic performance and to meet the demand of globalization.

CONCLUSION

My findings not only verify the crucial takeaway from the previous literature. To test the previous findings, I expanded the time frame and scope of past studies to find evidence about the relationship between non-English language spoken at home and academic achievement. My results suggest that even though bilingual students start with a lower math and reading tests scores, they fully close the math gap by 1st grade and the reading gap by 5th grade, which is consistent with my hypothesis and the part of Han's (2012) findings. Furthermore, non-English language spoken at home has negative effect on academic performances in the first few years of schools but this effect diminishes and eventually disappears. When students reach higher-grade levels, non-English language spoken at home has a to positive effect on academic performance (for both math and reading), which is a new finding; however, the effect is small in magnitude. For policymakers, the lesson may be to look into incorporating bilingual education as early as in primary school. It is possible that native-English students (who only speaks English at home) can enjoy the benefit that bilingualism brings, later in this academic experience.

As my research suffers from limitations, it leaves the door open for further research. Future researchers might consider using student-level panel data, like the data I have used here, but using more advanced research techniques such as propensity-score matching or regression discontinuity to draw more compelling conclusions. Researchers might also consider obtaining information on the specific non-English language spoken at home.

APPENDIX: TABLES AND FIGURES

Table 1. Sample Size and Percentage Distribution by Race, Gender, School Type and English Language Proficiency (based on: Kindergarten, 1999)

	Population (N= 21,409) *(ECLS-K Sample)*	**Sample (N= 8,036)**	**Dropped Sample (N= 13,117)**
Race			
White	55.1%	63.8%	51.3%***
Black	15.1%	9.7%	18.0%***
Hispanic	17.9%	16.4%	18.6%***
Asian & Pacific Islander	7.4%	6.2%	7.3%***
Other	4.3%	4.0%	4.8%**
Gender			
Female	48.8%	50.5%	48.0%***
Male	51.1%	49.6%	52.1%***
School Type			
Catholic	11.0%	14.0%	9.6%***
Private	10.4%	8.5%	11.9%***
Public	78.6%	77.5%	78.6%***
English Proficiency			
Not Identified Needing OLDS	85.9%	86.7%	85.1%***
Passed OLDS in Kindergarten	9.5%	9.1%	9.8%
Passed OLDS in 1st Grade	2.7%	2.5%	2.8%
Did not Pass OLDS by 1st Grade	2.0%	1.7%	2.3%***

***** p<0.01, ** p<0.05, *p<0.1**

Note: English Language Proficiency is measured with an Oral Language Development Scale (OLDS). The OLDS was administered to children in kindergarten and first grade. Children identified as not needing OLDS were children who were proficient in English and those needing the test had to achieve the cut score, otherwise were reassessed in first grade. The OLDS was not administered beyond first grade because most children had passed the OLDS by the spring first-grade data collection. The stars in the "Dropped Sample" column indicate the statistical significance of the differences between my analytic sample and the dropped sample.

Table 2. Distribution of Sampled Students by Language Status – Language Spoken at Home (N=8,036)

	Monolingual (N=7017)	**Bilingual** (N=1019)
PART I		
Race		
White	72.03%	6.97%***
Black	10.90%	1.08%***
Hispanic	9.18%	66.34%***
Asian & Pacific Islander	3.52%	24.53%***
Other	4.38%	1.08%***
Gender		
Female	50.38%	51.23%
Male	49.67%	48.97%
School Type		
Catholic	14.86%	8.24%***
Private	9.16%	4.22%***
Public	76.02%	87.73%***
English Proficiency		
Not Identified Needing OLDS	96.42%	20.12%***
Passed OLDS in Kindergarten	3.28%	49.26%***
Passed OLDS in 1st Grade	0.20%	18.45%***
Did not Pass OLDS by 1st Grade	0.14%	12.37%***
PART II		
Standardized Mean Test Score: Math		
Kindergarten	0.27	-0.39***
1st Grade	0.22	-0.25***
3rd Grade	0.20	-0.20***
5th Grade	0.16	-0.14***
8th Grade	0.10	-0.22***
Standardized Mean Test Score: Reading		
Kindergarten	0.23	-0.72***
1st Grade	0.22	-0.43***
3rd Grade	0.23	-0.35***
5th Grade	0.21	-0.33***
8th Grade	0.11	-0.34***

***** p<0.01, ** p<0.05, *p<0.1**

Note: Monolinguals are those students who only spoke English language at home, while Bilinguals are student who spoke a non-English language at home. English Language Proficiency is measured with an Oral Language Development Scale (OLDS). The OLDS was administered to children in kindergarten and first grade. Children were identified not needing OLDS were children who were proficient in English and those needing the test has to achieved cut score, otherwise will have to be reassessed in first grade round. The OLDS were not administered beyond first grade because most children had passes the OLDS by the spring first-grade data collection. The stars in the "Bilingual" column indicate the statistical significance of the differences between the average standardized test score between monolingual and bilingual students.

Table 3. Estimated Effect of Language Spoken at Home on Grade-Level Average Scale Score

	MATH				
	Kindergarten	**1st Grade**	**3rd Grade**	**5th Grade**	**8th Grade**
Non-English Language Spoken at Home	-0.083*	0.041	0.020	0.045*	0.048*
	(0.048)	(0.034)	(0.033)	(0.027)	(0.028)
Passed OLDS in Kindergarten	-0.124***	-0.004	0.027	0.030	-0.060**
	(0.046)	(0.034)	(0.034)	(0.027)	(0.029)
Passed OLDS in 1st Grade	-1.015***	0.286***	-0.054	-0.002	-0.102**
	(0.096)	(0.072)	(0.054)	(0.046)	(0.050)
Did not Pass OLDS by 1st Grade	-0.757***	0.017	-0.254***	-0.065	-0.144**
	(0.088)	(0.071)	(0.064)	(0.058)	(0.063)
Hispanic	-0.139***	-0.112***	-0.059**	-0.027	-0.016
	(0.034)	(0.026)	(0.025)	(0.020)	(0.022)
Asian & Pacific Islander	-0.154***	-0.028	0.062*	0.073***	0.025
	(0.053)	(0.036)	(0.033)	(0.024)	(0.028)
Family Income (thousands of dollars)	0.002***	0.0003**	0.001***	0.0003***	0.0002*
	(0.0003)	(0.0002)	(0.0001)	(0.0001)	(0.0001)
Parent Education - Some High School	-0.720***	-0.242***	-0.380***	-0.185***	-0.175***
	(0.052)	(0.037)	(0.036)	(0.030)	(0.033)
Parent Education - Some College	-0.517***	-0.142***	-0.207***	-0.070***	-0.020***
	(0.037)	(0.025)	(0.023)	(0.017)	(0.017)
Gender (Male)	0.088***	0.087***	0.119***	0.044***	-0.060***
	(0.020)	(0.014)	(0.013)	(0.011)	(0.012)
Previous Year Test Score		0.717***	0.686***	0.807***	0.815***
		(0.010)	(0.008)	(0.007)	(0.008)
School Type - Catholic	0.153***	-0.071***	-0.117***	0.010	0.098***
	(0.030)	(0.021)	(0.020)	(0.015)	(0.016)
Observations	8,036	8,036	8,036	8,036	8,036
R-squared	0.209	0.585	0.619	0.754	0.720

***** p<0.01, ** p<0.05, *p<0.1**

Note: Sample is weighted and it consists of all students that were present in the study from kindergarten to 8th grade. Dependent variable is the grade-by-subject level standardized test score (so the coefficient should be interpreted as standard deviation unit change). The independent variables are the language spoken at home dummy; dummies for each English Proficiency, Race, Parent Education and School Type; Family Income and dummy for Gender. The baseline category (constant) is white female monolingual students that were deemed not necessary for the OLDS assessment, attending public school and whose parent's highest education are at least graduate school. Some of the terms/categories were not reported on the table for simplicity, including: the constant, Black dummy, Other Race dummy, Parent Education – Some Masters dummy, Parent Education – Some Masters dummy, and School Type – Public dummy. Robust standard errors are reported in parentheses below the coefficients.

Table 3. Continued

READING					
	Kindergarten	**1st Grade**	**3rd Grade**	**5th Grade**	**8th Grade**
Non-English Language Spoken at Home	-0.032	-0.009	-0.020	0.005	0.056*
	(0.045)	(0.030)	(0.034)	(0.027)	(0.033)
Passed OLDS in Kindergarten	-0.064	-0.056*	-0.0005	-0.002	0.070**
	(0.047)	(0.030)	(0.033)	(0.027)	(0.033)
Passed OLDS in 1st Grade	-2.596***	1.594***	-0.196***	-0.145***	-0.099
	(0.051)	(0.066)	(0.055)	(0.047)	(0.061)
Did not Pass OLDS by 1st Grade	-2.469***	-0.742***	0.805***	-0.156***	-0.109
	(0.065)	(0.046)	(0.071)	(0.059)	(0.076)
Hispanic	-0.060**	-0.054**	-0.122***	-0.017	-0.113***
	(0.028)	(0.023)	(0.026)	(0.020)	(0.025)
Asian & Pacific Islander	0.233***	0.037	-0.235***	-0.027	-0.004
	(0.049)	(0.032)	(0.031)	(0.027)	(0.030)
Family Income (thousands of dollars)	0.001***	0.0006***	0.0007***	0.0002	0.0002
	(0.0002)	(0.0002)	(0.0002)	(0.0001)	(0.0001)
Parent Education - Some High School	-0.652***	-0.258***	-0.439***	-0.222***	-0.366***
	(0.043)	(0.034)	(0.038)	(0.032)	(0.039)
Parent Education - Some College	-0.439***	-0.130***	-0.239***	-0.109***	-0.169***
	(0.035)	(0.024)	(0.024)	(0.018)	(0.019)
Gender (Male)	-0.115***	-0.046***	-0.061***	0.014	-0.093***
	(0.017)	(0.013)	(0.014)	(0.011)	(0.013)
Previous Year Test Score		0.772***	0.668***	0.778***	0.708***
		(0.012)	(0.009)	(0.007)	(0.009)
School Type - Catholic	0.096***	0.005	0.072***	0.038**	0.096***
	(0.026)	(0.020)	(0.021)	(0.016)	(0.018)
Observations	8,036	8,036	8,036	8,036	8,036
R-squared	0.404	0.654	0.572	0.721	0.630

***** p<0.01, ** p<0.05, *p<0.1**

Note: Sample is weighted and it consists of all students that were present in the study from kindergarten to 8th grade. Dependent variable is the grade-by-subject level standardized test score (so the coefficient should be interpreted as standard deviation unit change). The independent variables are the language spoken at home dummy; dummies for each English Proficiency, Race, Parent Education and School Type; Family Income and dummy for Gender. The baseline category (constant) is white female monolingual students that were deemed not necessary for the OLDS assessment, attending public school and whose parent's highest education are at least graduate school. Some of the terms/categories were not reported on the table for simplicity, including: the constant, Black dummy, Other Race dummy, Parent Education – Some Masters dummy, Parent Education – Some Masters dummy, and School Type – Public dummy. Robust standard errors are reported in parentheses below the coefficients.

Table 4. Estimated Effect of Language Spoken at Home on Grade-Level Average Scale Score, by Race

HISPANIC					
MATH					
	Kindergarten	**1st Grade**	**3rd Grade**	**5th Grade**	**8th Grade**
Non-English Language Spoken at Home	-0.152***	0.062	-0.023	0.046	0.024
	(0.058)	(0.045)	(0.046)	(0.040)	(0.041)
Passed OLDS in Kindergarten	-0.146***	-0.019	0.020	-0.023	-0.009
	(0.055)	(0.046)	(0.047)	(0.040)	(0.042)
Passed OLDS in 1st Grade	-0.446***	-0.053	-0.051	-0.048	-0.036
	(0.079)	(0.064)	(0.069)	(0.060)	(0.065)
Did not Pass OLDS by 1st Grade	-0.543***	0.050	-0.307***	-0.067	-0.065
	(0.087)	(0.076)	(0.075)	(0.067)	(0.072)
Family Income (thousands of dollars)	0.004***	0.0007	0.0003	0.0003	0.0008
	(0.0008)	(0.0009)	(0.0007)	(0.0004)	(0.0005)
Parent Education - Some High School	-0.314**	-0.174	-0.282***	-0.112	-0.139*
	(0.159)	(0.115)	(0.092)	(0.076)	(0.077)
Parent Education - Some College	-0.233	-0.109	-0.207**	-0.061	-0.068
	(0.152)	(0.108)	(0.083)	(0.069)	(0.067)
Gender (Male)	0.009	0.103***	0.090***	0.095***	-0.054*
	(0.041)	(0.033)	(0.034)	(0.029)	(0.032)
Previous Year Test Score		0.773***	0.744***	0.848***	0.861***
		(0.027)	(0.022)	(0.017)	(0.018)
School Type - Catholic	0.179**	-0.152***	-0.097*	0.020	0.052
	(0.070)	(0.053)	(0.059)	(0.044)	(0.049)
Observations	1,320	1,320	1,320	1,320	1,320
R-squared	0.230	0.548	0.572	0.715	0.699

***** p<0.01, ** p<0.05, *p<0.1**

Note: Sample is weighted and it consists of all Hispanic students that were present in the study from kindergarten to 8^{th} grade. Dependent variable is the grade-by-subject level standardized test score (so the coefficient should be interpreted as standard deviation unit change). The independent variables are the language spoken at home dummy; dummies for each English Proficiency, Parent Education and School Type; Family Income and dummy for Gender. The baseline category (constant) is non-Hispanic female monolingual students that were deemed not necessary for the OLDS assessment, attending public school and whose parent's highest education are at least graduate school. Some of the terms/categories were not reported on the table for simplicity, including: the constant, Parent Education – Some Masters dummy, Parent Education – Some Masters dummy, and School Type – Public dummy. Race was omitted from the regression because this is subgroup analysis that estimates the regression containing only Hispanics. Robust standard errors are reported in parentheses below the coefficients.

Table 4. Continued

HISPANIC					
READING					
	Kindergarten	**1st Grade**	**3rd Grade**	**5th Grade**	**8th Grade**
Non-English Language Spoken at Home	-0.086*	0.036	-0.043	0.015	0.042
	(0.049)	(0.040)	(0.047)	(0.039)	(0.051)
Passed OLDS in Kindergarten	-0.110**	-0.105***	0.021	-0.015	0.113**
	(0.049)	(0.040)	(0.048)	(0.040)	(0.051)
Passed OLDS in 1st Grade	-2.522***	1.740***	-0.111	-0.180***	-0.053
	(0.050)	(0.104)	(0.071)	(0.059)	(0.080)
Did not Pass OLDS by 1st Grade	-2.513***	-0.573***	1.126***	-0.166**	-0.037
	(0.051)	(0.088)	(0.106)	(0.070)	(0.089)
Family Income (thousands of dollars)	0.002***	0.001**	0.001**	0.00056	0.0003
	(0.0007)	(0.0005)	(0.0006)	(0.0004)	(0.0006)
Parent Education - Some High School	-0.233	-0.008	-0.501***	-0.197***	-0.238***
	(0.145)	(0.090)	(0.105)	(0.069)	(0.089)
Parent Education - Some College	-0.124	0.0603	-0.375***	-0.118*	-0.077
	(0.141)	(0.085)	(0.097)	(0.063)	(0.076)
Parent Education - Some Masters	-0.051	0.122	-0.252**	-0.061	0.031
	(0.137)	(0.088)	(0.102)	(0.067)	(0.080)
Gender (Male)	-0.113***	-0.019	-0.121***	0.049*	-0.036
	(0.031)	(0.028)	(0.035)	(0.029)	(0.037)
Previous Year Test Score		0.863***	0.765***	0.766***	0.788***
		(0.033)	(0.025)	(0.017)	(0.022)
School Type - Private	0.121	0.184**	-0.158**	0.074	0.111
	(0.107)	(0.085)	(0.08)	(0.079)	(0.078)
School Type - Catholic	0.151**	-0.012	0.096*	0.084*	0.069
	(0.063)	(0.048)	(0.057)	(0.044)	(0.054)
Observations	1,320	1,320	1,320	1,320	1,320
R-squared	0.794	0.798	0.584	0.709	0.592

***** p<0.01, ** p<0.05, *p<0.1**

Note: Sample is weighted and it consists of all Hispanic students that were present in the study from kindergarten to 8th grade. Dependent variable is the grade-by-subject level standardized test score (so the coefficient should be interpreted as standard deviation unit change). The independent variables are the language spoken at home dummy; dummies for each English Proficiency, Parent Education and School Type; Family Income and dummy for Gender. The baseline category (constant) is non-Hispanic female monolingual students that were deemed not necessary for the OLDS assessment, attending public school and whose parent's highest education are at least graduate school. Some of the terms/categories were not reported on the table for simplicity, including: the constant, Parent Education – Some Masters dummy, Parent Education – Some Masters dummy, and School Type – Public dummy. Race was omitted from the regression because this is subgroup analysis that estimates the regression containing only Hispanics. Robust standard errors are reported in parentheses below the coefficients.

Table 4. Continued

ASIAN & PACIFIC ISLANDER					
MATH					
	Kindergarten	**1st Grade**	**3rd Grade**	**5th Grade**	**8th Grade**
Non-English Language Spoken at Home	0.179	0.135*	0.078	0.063	0.080*
	(0.112)	(0.077)	(0.067)	(0.047)	(0.047)
Passed OLDS in Kindergarten	-0.172	-0.066	-0.078	0.045	-0.011
	(0.112)	(0.075)	(0.069)	(0.048)	(0.048)
Passed OLDS in 1st Grade	-3.125***	1.467***	-0.103	0.0081	-0.094
	(0.115)	(0.215)	(0.124)	(0.086)	(0.099)
Did not Pass OLDS by 1st Grade	-2.751***	-1.168***	0.468*	-0.497**	-0.222
	(0.274)	(0.196)	(0.274)	(0.247)	(0.263)
Family Income (thousands of dollars)	0.0008	-0.0002	0.001***	-0.0006**	-0.0005*
	(0.0009)	(0.0004)	(0.0004)	(0.0003)	(0.0003)
Parent Education - Some High School	-0.941***	-0.329**	-0.369***	-0.155	-0.135
	(0.239)	(0.141)	(0.139)	(0.099)	(0.114)
Parent Education - Some College	-0.919***	-0.221**	-0.328***	-0.00881	-0.102
	(0.136)	(0.104)	(0.087)	(0.061)	(0.063)
Gender (Male)	0.160*	0.057	0.090	0.032	-0.065
	(0.084)	(0.058)	(0.057)	(0.041)	(0.046)
Previous Year Test Score		0.721***	0.678***	0.810***	0.867***
		(0.042)	(0.035)	(0.027)	(0.033)
School Type - Catholic	0.230*	0.012	-0.031	-0.074	0.190***
	(0.133)	(0.098)	(0.096)	(0.059)	(0.060)
Observations	497	497	497	497	497
R-squared	0.553	0.661	0.643	0.786	0.755

***** p<0.01, ** p<0.05, *p<0.1**

Note: Sample consists of all Asian and Pacific Islander students that were present in the study from kindergarten to 8th grade. Dependent variable is the grade-by-subject level standardized test score (so the coefficient should be interpreted as standard deviation unit change). The independent variables are the language spoken at home dummy; dummies for each English Proficiency, Parent Education and School Type; Family Income and dummy for Gender. The baseline category (constant) is non-Asian and Pacific Islander female monolingual students that were deemed not necessary for the OLDS assessment, attending public school and whose parent's highest education are at least graduate school. Some of the terms/categories were not reported on the table for simplicity, including: the constant, Parent Education – Some Masters dummy, Parent Education – Some Masters dummy, and School Type – Public dummy. Race was omitted from the regression because this is subgroup analysis that estimates the regression containing only Asian and Pacific Islander. Robust standard errors are reported in parentheses below the coefficients.

Table 4. Continued

ASIAN & PACIFIC ISLANDER					
READING					
	Kindergarten	1st Grade	3rd Grade	5th Grade	8th Grade
Non-English Language Spoken at Home	0.186*	0.020	0.001	0.024	0.136**
	(0.112)	(0.065)	(0.061)	(0.057)	(0.054)
Passed OLDS in Kindergarten	-0.167	-0.104*	-0.036	-0.024	0.049
	(0.116)	(0.062)	(0.060)	(0.059)	(0.054)
Passed OLDS in 1st Grade	-3.015***	1.232***	-0.329***	-0.112	-0.033
	(0.120)	(0.175)	(0.094)	(0.110)	(0.112)
Did not Pass OLDS by 1st Grade	-2.758***	-1.200***	0.373	-0.545***	0.105
	(0.284)	(0.165)	(0.234)	(0.143)	(0.323)
Family Income (thousands of dollars)	-1.65e-05	0.0006*	0.0003	0.0002	-0.0005*
	(0.001)	(0.0003)	(0.0003)	(0.0004)	(0.0003)
Parent Education - Some High School	-1.084***	-0.511***	-0.410***	-0.222**	-0.361***
	(0.225)	(0.132)	(0.120)	(0.109)	(0.114)
Parent Education - Some College	-1.003***	-0.439***	-0.284***	-0.137*	-0.281***
	(0.162)	(0.096)	(0.082)	(0.075)	(0.070)
Gender (Male)	-0.184**	-0.002	-0.055	-0.085*	-0.021
	(0.088)	(0.056)	(0.052)	(0.048)	(0.049)
Previous Year Test Score		0.624***	0.605***	0.789***	0.732***
		(0.028)	(0.028)	(0.031)	(0.031)
School Type - Catholic	0.172	0.155*	0.097	0.030	0.035
	(0.135)	(0.088)	(0.081)	(0.064)	(0.067)
Observations	497	497	497	497	497
R-squared	0.524	0.690	0.645	0.706	0.671

***** p<0.01, ** p<0.05, *p<0.1**

Note: Sample consists of all Asian and Pacific Islander students that were present in the study from kindergarten to 8th grade. Dependent variable is the grade-by-subject level standardized test score (so the coefficient should be interpreted as standard deviation unit change). The independent variables are the language spoken at home dummy; dummies for each English Proficiency, Parent Education and School Type; Family Income and dummy for Gender. The baseline category (constant) is non-Asian and Pacific Islander female monolingual students that were deemed not necessary for the OLDS assessment, attending public school and whose parent's highest education are at least graduate school. Some of the terms/categories were not reported on the table for simplicity, including: the constant, Parent Education – Some Masters dummy, Parent Education – Some Masters dummy, and School Type – Public dummy. Race was omitted from the regression because this is subgroup analysis that estimates the regression containing only Asian and Pacific Islander. Robust standard errors are reported in parentheses below the coefficients.

Table 5. Estimated Effect of Non-English Language Spoken at Home on Grade-Level Average Scale Score by Omitting Categories or Variables

LANGUAGE SPOKEN AT HOME COEFFICIENTS						
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
MATH						
Kindergarten	-0.083*	-0.087*	-0.167***	-0.084*	-0.343***	-0.658***
	-0.048	-0.048	-0.048	-0.048	-0.041	-0.034
1st Grade	0.041	0.043	0.012	-0.021	0.081***	-0.473***
	-0.034	-0.034	-0.033	-0.047	-0.028	-0.032
3rd Grade	0.02	0.023	0.009	0.004	-0.002	-0.398***
	-0.031	-0.033	-0.032	-0.048	-0.027	-0.033
5th Grade	0.045*	0.045	0.045*	0.048	0.049**	-0.307***
	-0.027	-0.027	-0.026	-0.049	-0.022	-0.034
8th Grade	0.048*	0.045	0.034	0.038	-0.0001	-0.311***
	-0.028	-0.03	-0.027	-0.047	-0.025	-0.036
READING						
Kindergarten	-0.032	-0.034	-0.034	-0.031	-0.661***	-0.951***
	-0.045	-0.045	-0.049	-0.045	-0.049	-0.048
1st Grade	-0.009	-0.008	-0.033	-0.032	0.091***	-0.649***
	-0.03	-0.03	-0.029	-0.044	-0.031	-0.041
3rd Grade	-0.02	-0.022	-0.102***	-0.04	0.014	-0.574***
	-0.034	-0.034	-0.033	-0.046	-0.028	-0.033
5th Grade	0.005	0.004	-0.01	-0.027	-0.031	-0.543***
	-0.027	-0.027	-0.026	-0.045	-0.023	-0.033
8th Grade	0.056*	0.053	0.018	0.038	0.056**	-0.458***
	-0.033	-0.033	-0.031	-0.047	-0.028	-0.036

***** p<0.01, ** p<0.05, *p<0.1**

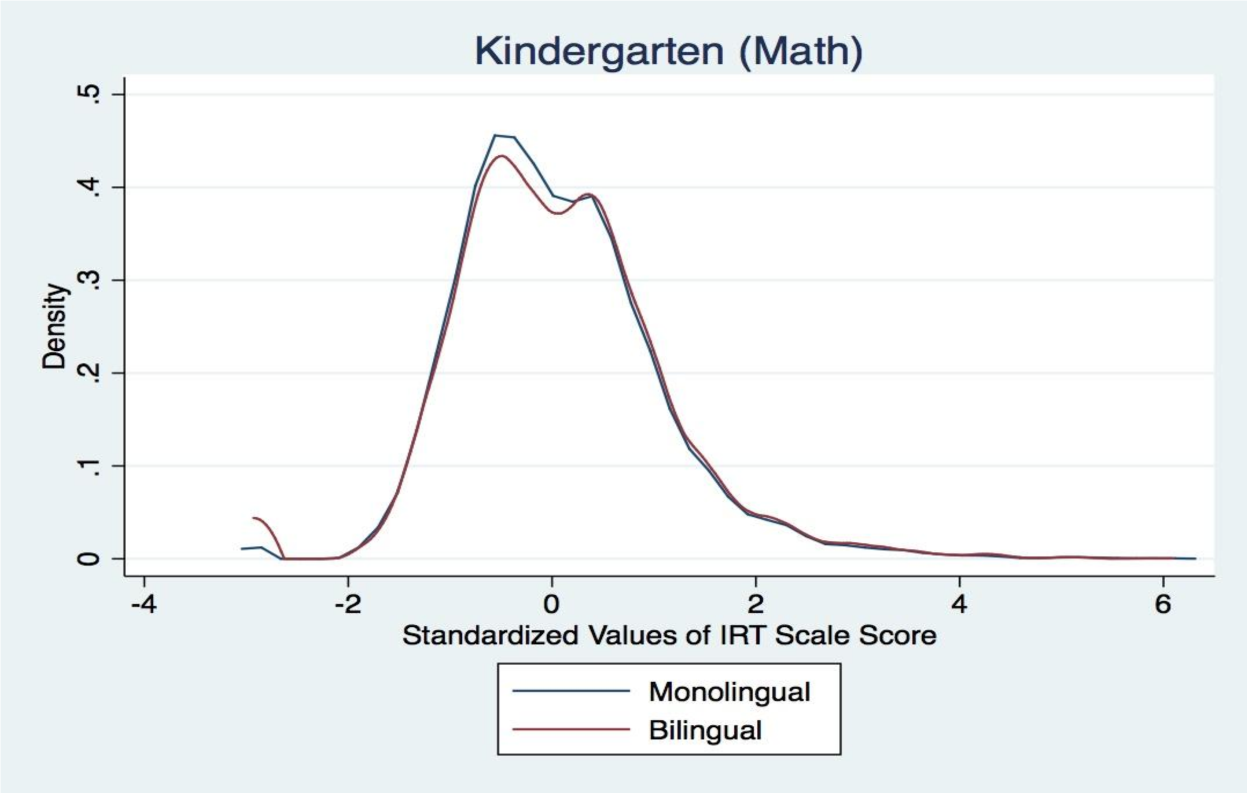
(1) Original Model
(2) Omitting School Climate and Curriculum Factors
(3) Omitting Home & Community Factors
(4) Omitting Student Characteristics
(5) Omitting English Language Proficiency
(6) Omitting all Control Variables

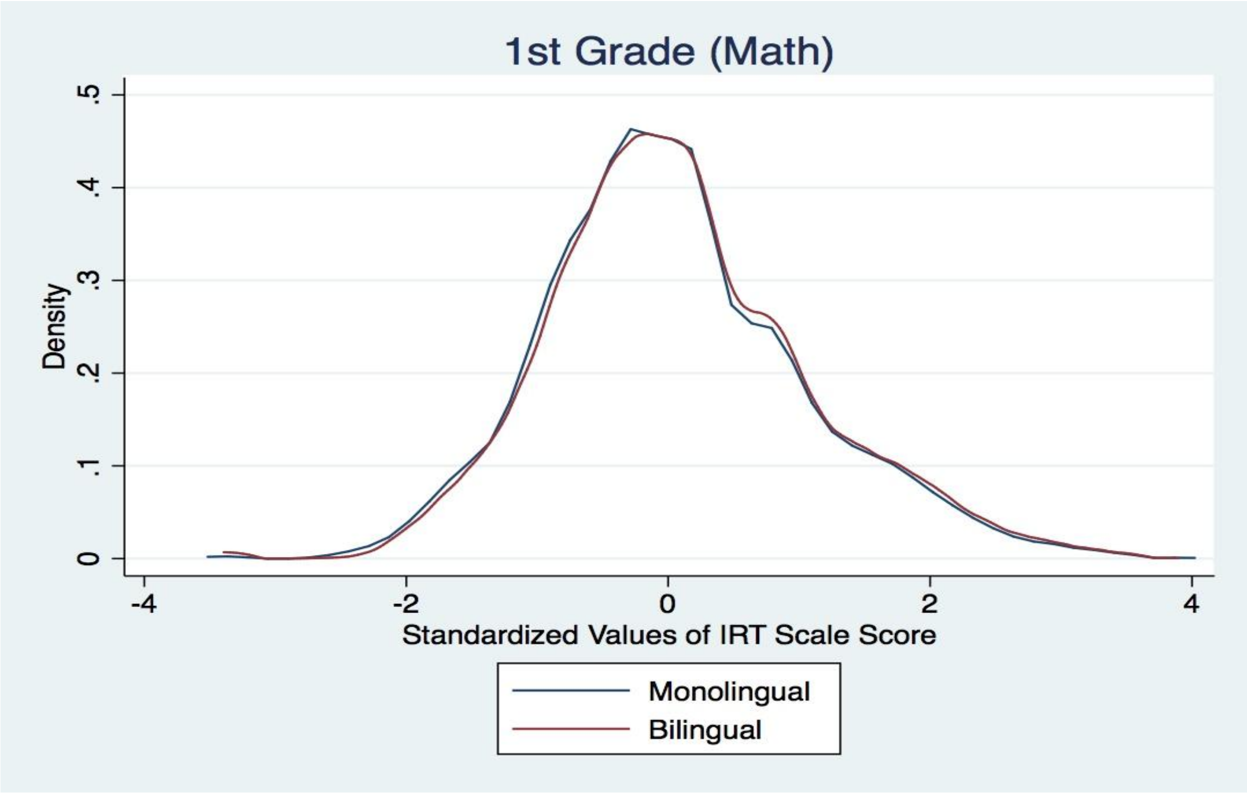
Table 6. Distribution of Primary Languages Spoken at Home

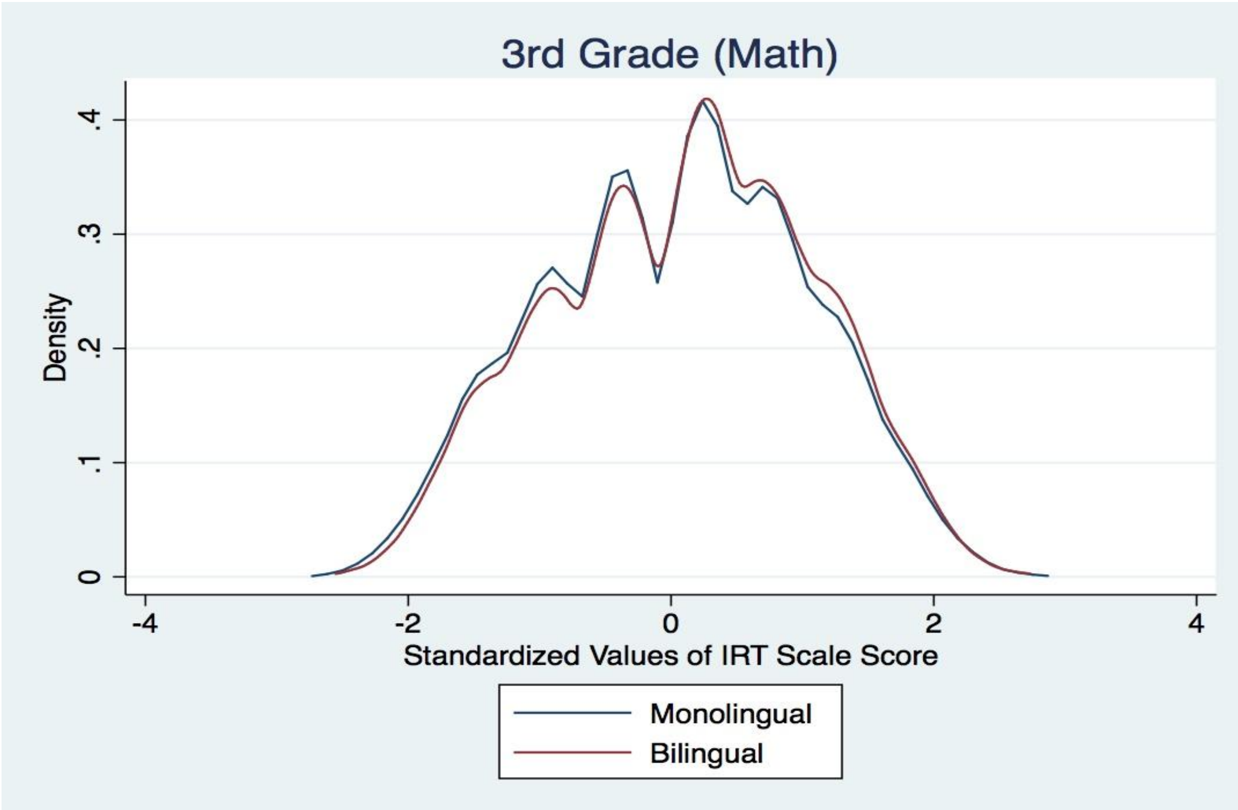
PRIMARY LANGUAGE SPOKEN AT HOME		
	Total Population: 21,409 Suppressed: 12,600	
	ECLS-K (N=8,809)	Sample (N=7,508)
English	8.71%	8.18%
Arabic	0.20%	0.17%
Chinese	0.44%	0.47%
Filipino	0.22%	0.19%
French	0.02%	0.03%
German	0.01%	0.01%
Greek	0.01%	0.01%
Italian	0.00%	0.00%
Japanese	0.02%	0.00%
Korean	0.07%	0.07%
Polish	0.11%	0.13%
Portuguese	0.06%	0.04%
Spanish	6.63%	6.10%
Vietnamese	0.19%	0.17%
Other Languages	0.08%	0.08%
African Languages	0.43%	0.43%
Eastern European Languages	0.18%	0.08%
Native American Languages	0.01%	0.01%
Sign Languages	0.00%	0.00%
Middle Eastern Languages	0.10%	0.11%
Western European	0.01%	0.01%
Indian Sub continental Languages	0.24%	0.24%
South East Asian Languages	0.49%	0.43%
Pacific Islander Languages	0.03%	0.03%
Not Applicable / Missing	81.72%	83.02%

NOTE: Missing variable is more than 80%. Only 8,809 responses were available publicly, the other 12,000 were suppressed. The percentages reported in each column are based on the population/sample size indicated in parenthesis. The “Sample” column is to simply show a hypothetical distribution of primary language used at home if same restriction were applied in choosing my sample.

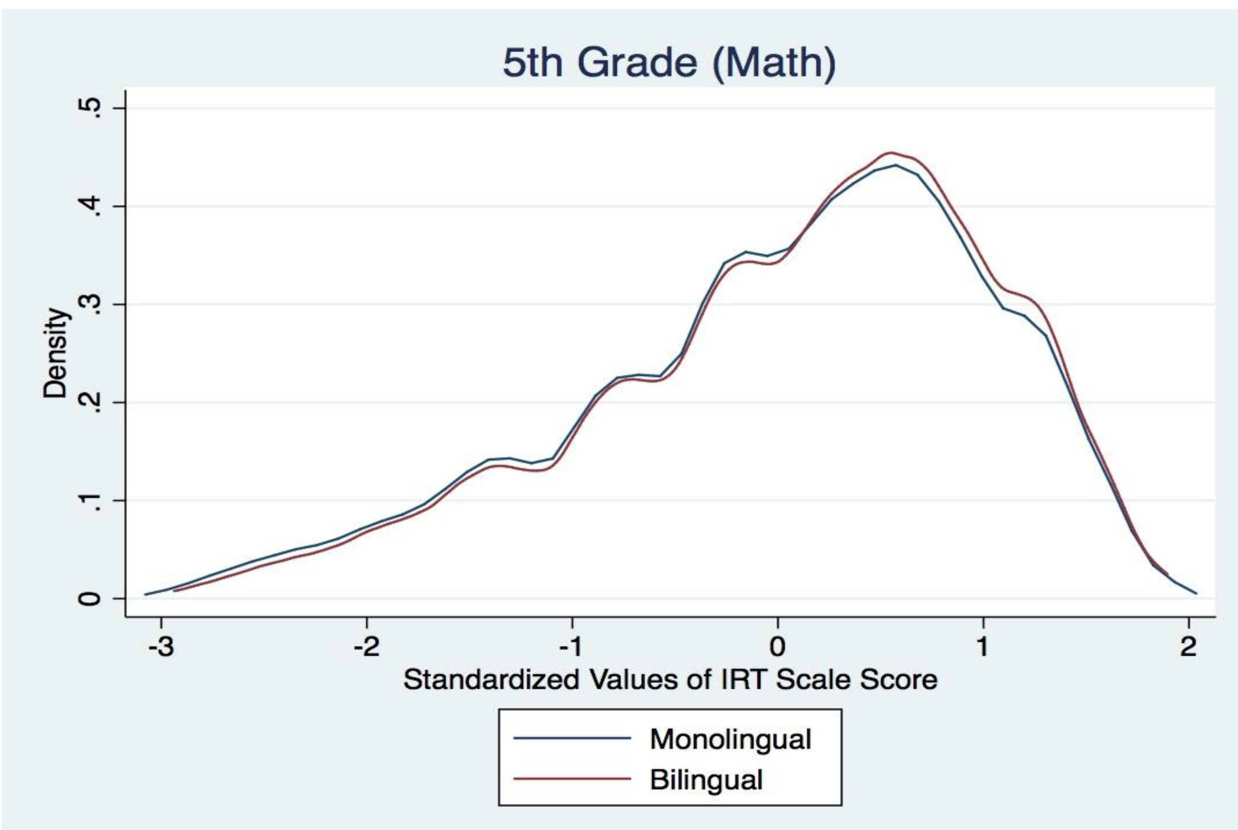
Figure 2. Distribution of Monolingual and Bilingual Math IRT Scale Scores, by Grade







3rd Grade (Math)
Density
0
.1
.2
.3
.4
-4
-2
0
2
4
Standardized Values of IRT Scale Score
Monolingual
Bilingual



5th Grade (Math)
Density
0
.1
.2
.3
.4
.5
-3
-2
-1
0
1
2
Standardized Values of IRT Scale Score
Monolingual
Bilingual

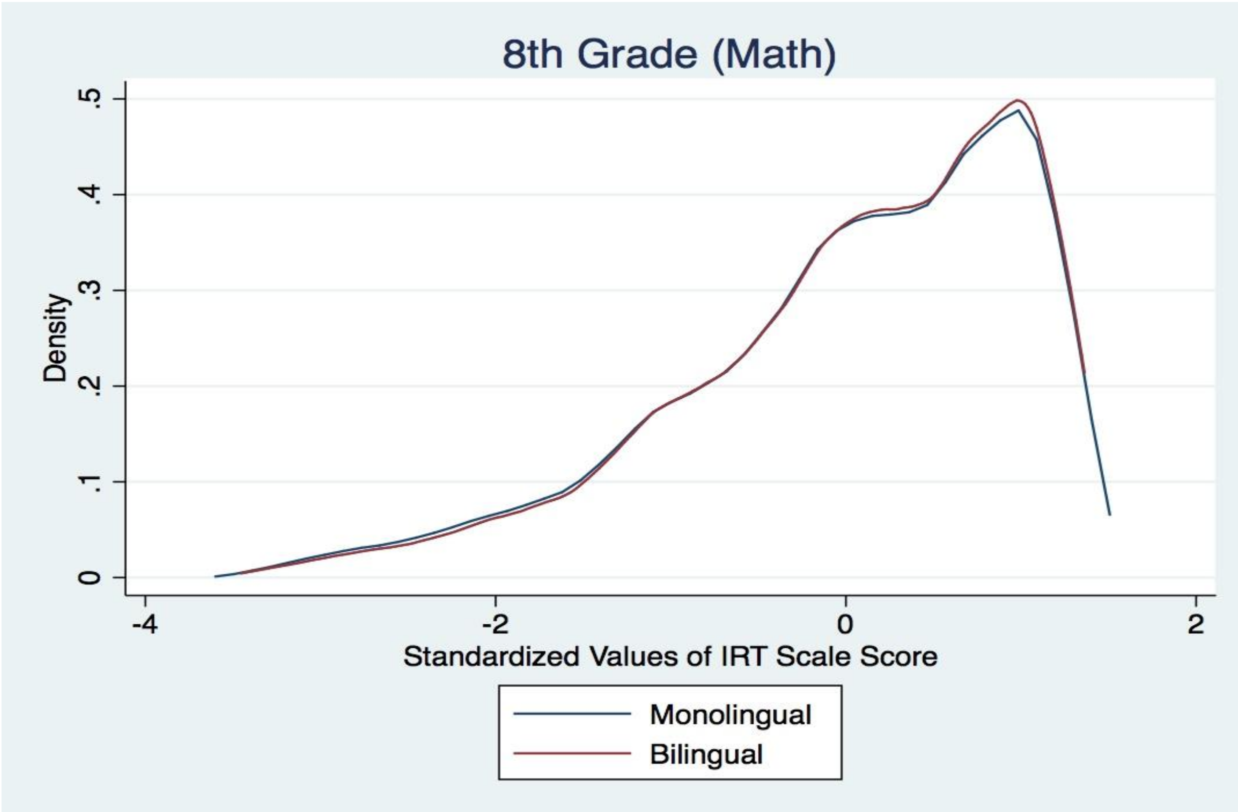
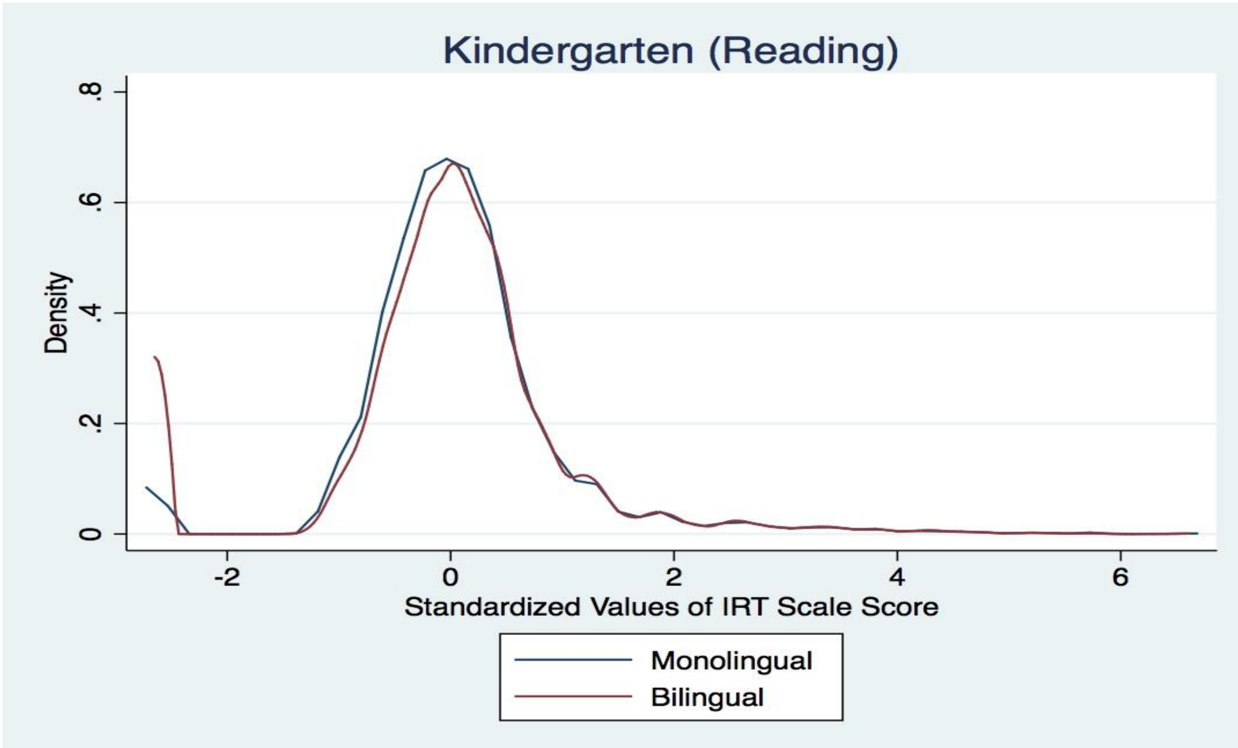
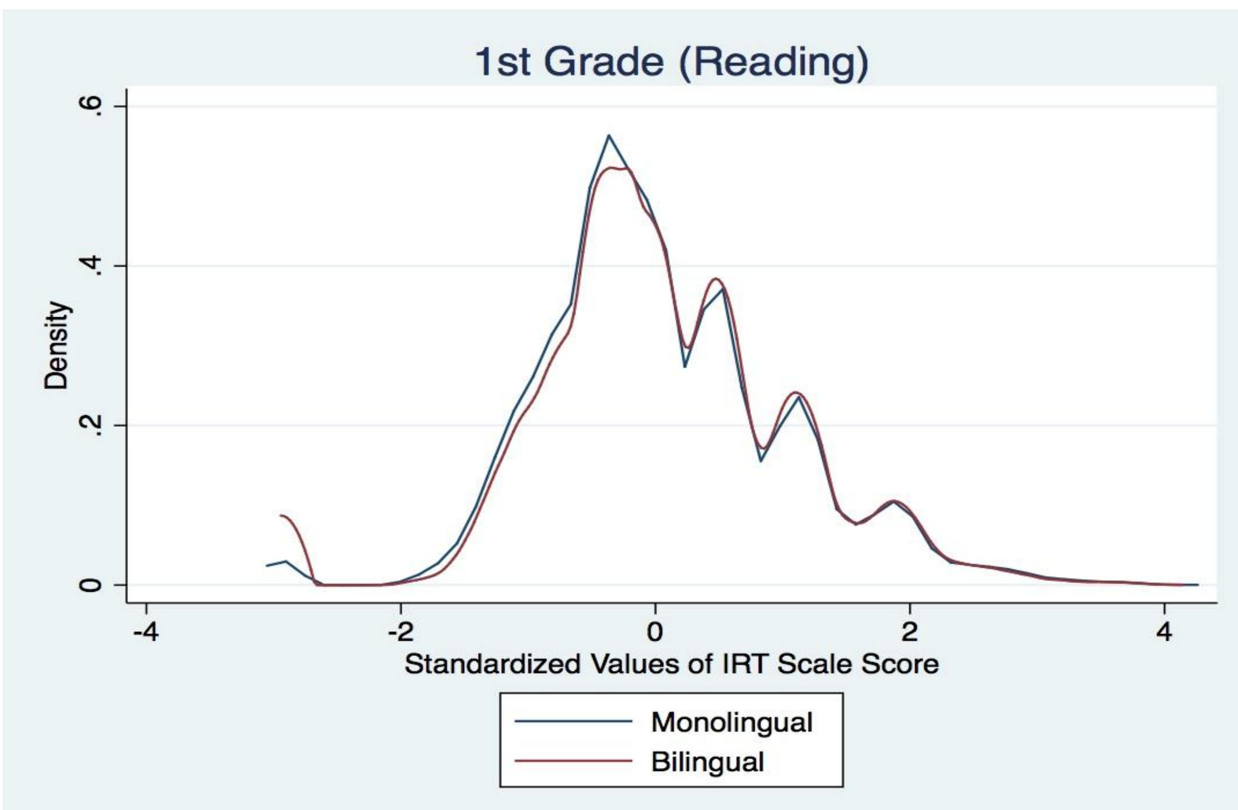
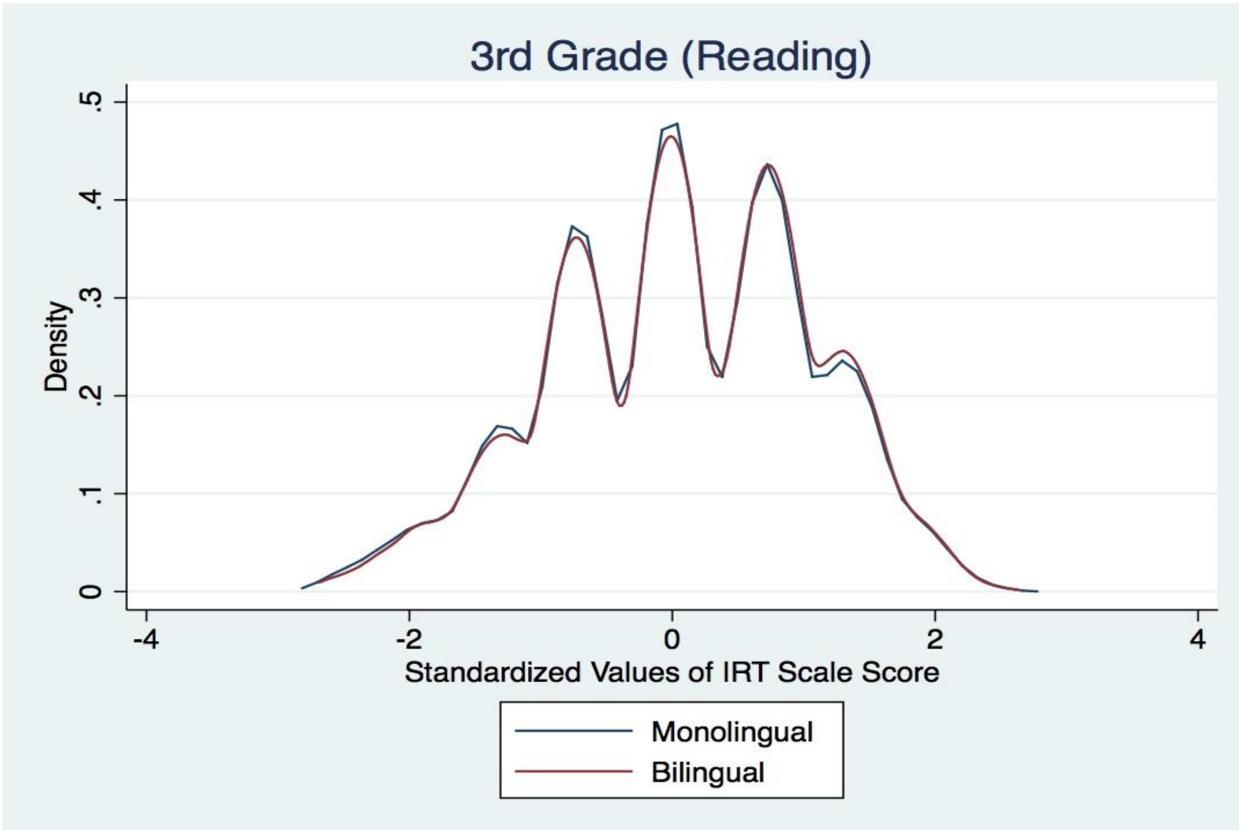
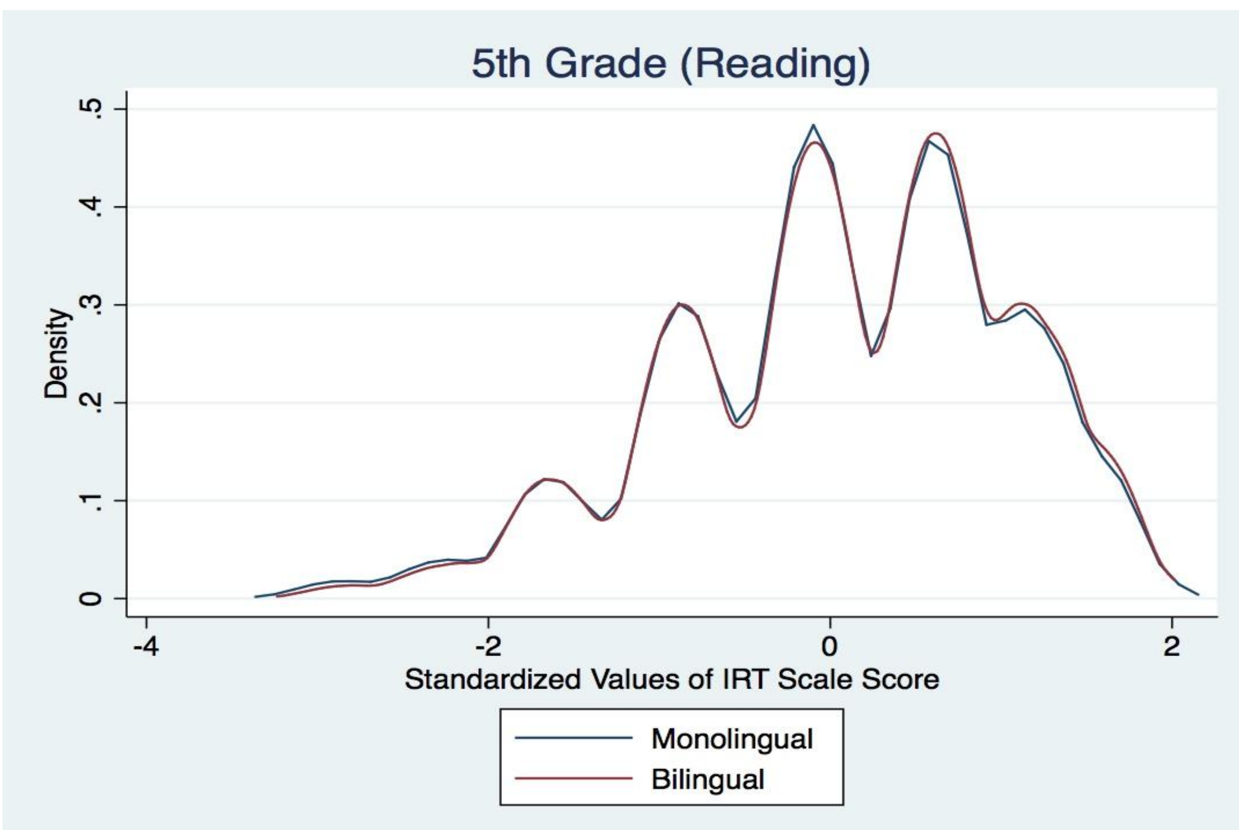

8th Grade (Math)
Density
0
.1
.2
.3
.4
.5
-4
-2
0
2
Standardized Values of IRT Scale Score
Monolingual
Bilingual

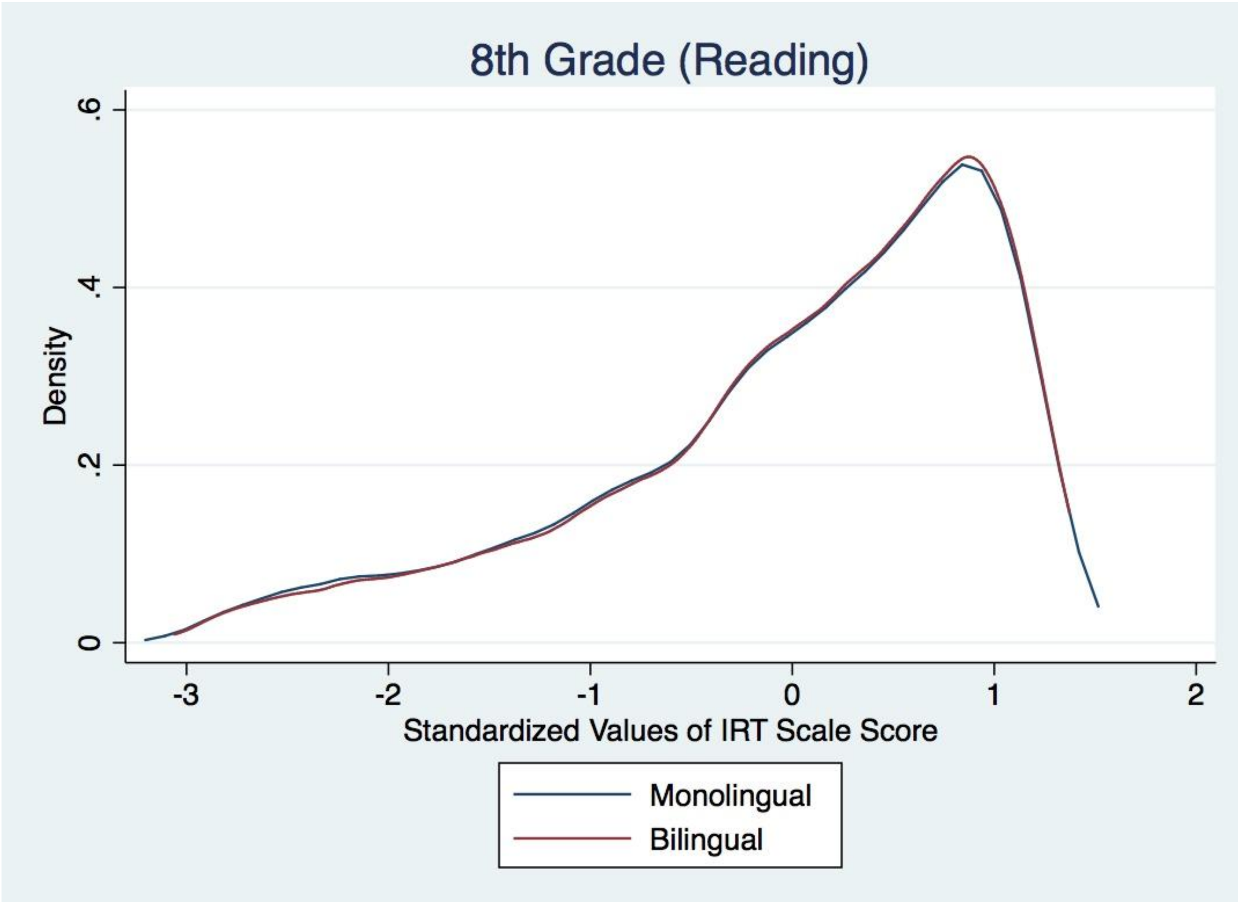
Figure 3. Distribution of Monolingual and Bilingual Reading IRT Scale Scores, by Grade






3rd Grade (Reading)
Density
0
.1
.2
.3
.4
.5
-4
-2
0
2
4
Standardized Values of IRT Scale Score
Monolingual
Bilingual


5th Grade (Reading)
Density
0
.1
.2
.3
.4
.5
-4
-2
0
2
Standardized Values of IRT Scale Score
Monolingual
Bilingual


8th Grade (Reading)
Density
0
.2
.4
.6
-3
-2
-1
0
1
2
Standardized Values of IRT Scale Score
Monolingual
Bilingual

REFERENCES

Asher, J.J., & Garcia R. (1969). T*he Optimal Age to Learn a Foreign Language*. The Modern Language Journal. Vol. 53, No. 5 (May, 1969), pp. 334-341. DOI: 10.2307/323026

Baker, C. (2011). *Foundations of Bilingual Education and Bilingualism (5th ed.).* Bristol, United Kingdom: Multilingual Matters.

Ben-Zcev, S. (1977). *The influence of bilingualism on cognitive strategy and cognitive development*. Child Development*.* Vol. 48, No. 3 (Sept., 1977), pp. 1009-1018

Buriel, R., & Cardoza, D. (1988). *Sociocultural Correlates of Achievement Among Three Generations of Mexican American High School Seniors.* American Educational Research Journal. Vol. 25, No. 2, pp. 177-192. DOI: 10.3102/00028312025002177

Bialystock, E. & Craik, F.I.M. (2010). *Cognitive and Linguistic Processing in the Bilingual Mind*. Ontario, Canada. Current Directions in Psychological Science. Vol. 19, No. 1, pp. 19-23. DOI: 10.1177/0963721409358571

Bronfenbrenner, U. (1978). "*The Social Role of the Child in Ecological Perspective*. Vol. *7*, No. 1, pp. 4–20. Retrieved from: http://www.zfs-online.org/index.php/zfs/article/viewFile/2344/1881

Dweck, C.S. (2010). "*Mindsets and Equitable Education"*. Principal Leadership*.* Vol. 10, No. 5, pp. 26-29. Retrieved from: http://www.epiconline.org/mind-sets-and-equitable-education/

Ensminger, M. E., & Slusarcick, A. L. (1992). *Paths to High-School Graduation or Dropout: a Longitudinal Study of a 1st-grade Cohort.* Sociology of Education. Vol. 65, No. 2, pp. 95-113. DOI: 10.2307/2112677

Entwisle, D. R., & Alexander, K. L. (1993). *Entry into School: The Beginning School Transition and Educational Stratification in the United States*. Annual Review of Sociology. Vol. 19, pp. 401-423. DOI: 10.1146/annurev.so.19.080193.002153

Esptein D. (1998). *Real boys don't work: Underachievement, Masculinity, and the Harassment of the "Sissies".* In: Epstein D, Elwood J, Hey V, Maw J, editors. *Failing Boys?: Issues in Gender and Achievement.* Philadelphia: Open University, 1998. pp. 177–200.

Farkas, G. (2003). *Racial disparities and discrimination in education: What do we know, how do we know it, and what do we need to know?.* Teachers College Record. Vol. 105, No. 6 (Aug., 2003), pp. 1119-1146. DOI: 10.1111/1467-9620.00279

Fulgini, A.J. (1997). *The Academic Achievement of Adolescents from Immigrant Families: The Roles of Family Background, Attitudes, and Behavior*. Child Development.Vol. 68, No. 2, (Apr., 1998). pp. 351-363. DOI: 10.1111/j.1467-8624.1997.tb01944.x

Grolnick, W. S., Friendly, R. W., & Bellas, V. M. (2009). *Parenting and Children's Motivation at School*. In K. R. Wentzel & A. Wigfield (Eds.), *Handbook of Motivation at School.* pp. 279-300. New York & London: Routledge.

Han, W. (2012). *Bilingualism and Academic Achievement*. Child Development. Vol. 83, No. 1, pp. 300-321. DOI: 10.1111/j.1467-8624.2011.01686.x

Hoff, E. (2013). *Interpreting the Early Language Trajectories of Children from Low-SES and Language Minority Homes: Implications of Closing Achievement Gaps.* Dev Psychol. Vol 49. No. 1 (Jan., 2013), pp 4-14. DOI: 10.1037/a0027238

Hyde J.S., & Kling, K.C. (2001). *Women, Motivation, and Achievement*. Psychology of Women Quarterly. Vol. 25, No. 4 (Dec., 2001). pp. 364–378. DOI: 10.1111/1471-6402.00035

Jiang, Wenying (1999). *The Relationship between Culture and Language*. ELT Journal Vol. 54, No. 4 (2000), pp. 328-334. DOI: 10.1093/elt/54.4.328

Kao, G., & Thompson, J. S. (2003). *Racial and Ethnic Stratification in Educational Achievement and Attainment.* Annual Review of Sociology. Vol. 29 (June, 2003), pp. 417-442. DOI: 10.1146/annurev.soc.29.010202.100019

Kastner J.W., May, W. & Hildman L. (2001), *Relationship Between Language Skills and Academic in First Grade*. Perceptual and Motor Skills. Vol. 92, No. 2 (Apr. 2001), pp. 381-390. DOI: 10.2466/pms.2001.92.2.381

Lambert, W.E. & Taylor, D. M. (1981). *Language in the Education of Ethnic Minority Immigrants: Issues, Problems and Methods.* Paper presented at the conference on The Education of Ethnic Minority Immigrants. Miami, FL

Leeson, P., Ciarrochi, J. & Heave, P.C.L. (2008). *Cognitive Ability, Personality and Academic Performance*. Personality and Individual Differences. Vol. 45, Issue 7 (Nov., 2008), pp. 630-635. DOI: doi:10.1016/j.paid.2008.07.006

Lemons, G.C., Abad, F.J., Almeida, L.S., and Colom, R. (2014). *Past and Future Academic Experiences are Related with Present Scholastic Achievement when Intelligence is Controlled.* Learning and Individual Differences**.** Vol. 32 (May, 2014), pp. 148–155. DOI:10.1016/j.lindif.2014.01.004

Mariam, V., Shook, A. & Schroeder, S.R. (2013). *Bilingual Two-Way Immersion Programs Benefit Academic Achievement.* Evanston, IL. Bilingual Research Journal. Vol. 36, pp.167–186. DOI: 10.1080/15235882.2013.818075

Mickelson R.A. (1989). *Why Does Jane Read and Write so Well? The Anomaly of Women's Achievement*. Sociology of Education. Vol. 62, No. 1 (Jan., 1989), pp. 47-63. DOI: 10.2307/2112823

Mitchel, C. (2016, February). *Spanish, Arabic, Chinese Are the Top Home Languages for ELL in U.S. Schools.* Education Week. Retrieved from http://blogs.edweek.org/edweek/learning-the-language/2016/02/spanish_arabic_chinese_top_lis.html

Mouw, T., and Xie. Y. (1999). *Bilingualism and the Academic Achievement of First- and Second-Generation Asian Americans: Accommodation with or Without Assimilation?.* American Sociological Review. Vol. 64, No. 2 (May, 1999), pp. 232-252. DOI: 10.2307/2657529

National Center for Education Statistics. *Early Childhood Longitudinal Program 1988-99 (ECLS-K 1988-99).* U.S. Department of Education – Institute of Education Sciences, NCES. Retrieved from: https://nces.ed.gov/ecls/

Paret, M. (2006). *Language Background and Early Academic Achievement: Disentangling Language-minority Status, Social Background and Academic Engagement*. Center for Study of Evaluation. Technical Report 679. Retrieved from http://files.eric.ed.gov/fulltext/ED518684.pdf

Rumberger, R.W., & Larson, K.A. (1998). *Toward Explaining Differences in Educational Achievement among Mexican American Language-minority Students.* Sociology of Education. Vol. 71, No. 1 (Jan., 1998), pp. 68-92. DOI: 10.2307/2673222

Saville-Troke, M. (1984). *What Really Matters in Second Language Learning for Academic Achievement?.* Tesol Quarterly. Vol. 18, No. 2 (June, 1984), pp. 199-219. DOI: 10.2307/3586690

Sbrocco, R. (2009). *Student Academic Engagement and the Academic Achievement Gap between Black and White Middle School Students: Does Engagement Increase Student Achievement?*. Minneapolis, MN: University of Minnesta. Retrieved from http://conservancy.umn.edu/handle/11299//57326

Schmid, C. L. (2001). *Educational Achievement, Language-minority Students, and the New Second Generation*. Sociology of Education. Vol. 74, pp. 71-87. DOI: 10.2307/2673254

Sirin, S.R. (2005). *Socioeconomic Status and Academic Achievement: A Meta-Analytic Review of Research.* Review of Educational Research. Vol 75, No. 3, pp. 417-453. Retrieved from http://steinhardt.nyu.edu/scmsAdmin/media/users/lec321/Sirin_Articles/Sirin_2005.pdf

Sylva K. & Wiltshire, J. (1993). *The Impact of Early Learning on Children's later Development a Review prepared for the RSA Inquiry 'Start Right'*. European Early Childhood Education Research Journal. Vol. 1, Issue 1, pp. 17-40. DOI: 10.1080/13502939385207331

The World Bank Group (2011). *Nutrition.* Early Child Development. The World Bank Group. Retrieved from http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTCY/EXTECD/0,,contentMDK:20207804~menuPK:528430~pagePK:148956~piPK:216618~theSitePK:344939,00.html

Warren, J. R. (1996). *Educational Inequality among White and Mexican-Origin Adolescents in the American southwest*: *1990*. Sociology of Education. Vol. 69, No. 2 (Apr. 1996), pp. 142-158

Wiley, T.G., & Wright, W.E. (2004). *Against the Undertow: Language-minority Education Policy and Politics in the "Age of Accountability".* Educational Policy. Vol. 18, No. 1, pp. 142-168. DOI: 10.1177/0895904803260030

Zong, J., and Batalova J. (2016). *Frequently Requested Statistics on Immigrants and Immigration in the United States.* Migration Policy Institute. Retrieved from: http://www.migrationpolicy.org/article/frequently-requested-statistics-immigrants-and-immigration-united-states