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Investigating the Status of Early Numeracy Skills in Bilingual Dual Language Learner Latino Children Attending Head Start and the Association with Parent Demographic Characteristics

Chavely Lissette Iglesias
University of South Florida, chavelyiglesias@gmail.com

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by

Chavely L. Iglesias

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Co-Major Professor: Lisa M. Lopez, Ph.D.
Co-Major Professor: Julia A. Ogg, Ph.D.
John Ferron, Ph.D.

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Dedication

This thesis is dedicated to myself. As the only person who did not believe I had it in me to complete what seemed like an absolutely impossible task, I was my own worst enemy through every single step of what has been a long, arduous, painful, and incredibly meaningful experience. Every single time I get to a place where I am about to give up, I will open the cover to this page, think of everything I sacrificed to make this happen, and be reminded that I in fact DO have what it takes. Shapiro!

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Abstract

Research on mathematics achievement has become increasingly important with today's technological advances and demand for specialized knowledge. Though there is much literature regarding mathematics achievement in monolingual speakers, little is known regarding the mathematical abilities of Dual Language Learner (DLL) Latino children. This study examined the early numeracy skills in English and Spanish of 132 DLL Latino children attending Head Start programs in five counties across Florida. Relationships and differences among their performance in both languages were examined, along with the contribution of specific parent demographic variables to math achievement. Findings indicated that DLL Latino Head Start children's performance on early numeracy tasks in both English and Spanish ranged from average to low average when compared to national normative samples of monolingual peers. Child participants' performance on early numeracy tasks in English and Spanish was related to some extent. In addition, multiple regression analyses revealed that combined demographic variables predicted math performance in English and Spanish, but only mothers' level of education uniquely predicted the child participants' math performance in Spanish. This study is an important contribution to the literature, as it provides data regarding the early numeracy skills of DLL Latino Head Start children, as well as implications for the field of school psychology. Future directions for research are also discussed.

Chapter One: Introduction

Statement of the Problem

Mathematics is more important now than ever. The rapidly growing technological advances of today's world are requiring a solid grasp of mathematical skills as a vital foundation for the job market in our society (Mazzocco & Thompson, 2005; Clarke & Shinn, 2004). Despite this fact, the literature has shown that students in the United States (U.S.) are struggling to achieve the necessary mathematical skills to experience successful outcomes within the school setting and beyond (National Research Council, 2001).

International comparison. The rationale for directing attention to mathematics, especially in earlier grades can be seen in statistics regarding how U.S. students' mathematical achievement compares to that of students in other countries, which is cause for concern. There are several ways in which the proficiency levels of our students' skills are assessed, both domestically and internationally. One example of an international assessment of mathematics performance is the Trends in International Mathematics and Science Study (TIMSS), a metric by which students' performance in the U.S. can be analyzed and compared to their international counterparts (National Center for Education Statistics, 2007). The TIMSS study has been conducted every four years since 1995 in over 70 countries and across six continents. This assessment measures the performance of students in fourth and eighth grades, specifically in math and science. The most recent data from 2007 showed that the U.S. was performing far below other countries in the world in terms of mathematics. Even though the U.S. is performing above the international average set for the world (i.e., at 529, while the TIMMS average is 500 on the fourth grade level), they are still behind other countries such as Japan (i.e., at 568), Chinese Tapei (i.e., at 576), and Singapore (i.e., at 599; National Center for Education Statistics, 2007).

Another comparison tool for measuring U.S. performance against other countries is the Programme for International Student Assessment (PISA; Organisation for Economic Cooperation and Development, 2009). The PISA is conducted every three years and assesses 15 year old students in over 65 countries to determine how their performance in reading, mathematics, and science compares internationally. Though the focus of the most recent PISA data collection in 2009 was reading, results in 2003 had an in-depth focus on mathematics performance of students around the world (National Center for Education Statistics, 2003). Results of this 2003 data collection showed that U.S. students' performance was lower than the average score of 500 (i.e., at 483), trailing various countries including Finland, Korea, and the Netherlands, and exceeding only five other participating countries (i.e., Portugal, Italy, Greece, Turkey, and Mexico; National Center for Education Statistics, 2003). These data demonstrate a need for the U.S. as a whole to improve efforts in order to reach mathematics achievement levels that will keep U.S. students competitive with students in the rest of the world.

National comparison. Though the previous data highlight the fact that students in the U.S. lag behind students in other parts of the world in terms of mathematical performance, U.S. students' performance also demonstrates that they are struggling when compared at the national level. A notable majority of U.S. students continue to struggle to meet expectations related to proficiency, particularly in mathematics. One way of acquiring this information is to look at data reported by The National Assessment of Educational Progress (NAEP; National Center for Education Statistics, 2009). This is an assessment which is administered nationally in order to obtain data showing the abilities and measure the progress of students in fourth, eighth, and twelfth grades within the U.S. in various subject areas, including math and reading. These data can be used to compare students' abilities at the state and national levels. The framework for this assessment includes cutoffs for the categories in which students can be placed in terms of their mathematical proficiency. The Basic proficiency is reached when the student has partially mastered the foundational skills which are required in order to demonstrate work on grade level. The Proficient category denotes performance which reflects competence and mastery of the skills necessary to understand, apply, and analyze what has been learned to practical situations. Lastly, the Advanced category is reserved for those whose performance in the subject area(s) exceeds that of the Proficient level.

According to the most recent NAEP data, 43% of U.S. fourth grade students are at a basic level of proficiency, while 18% of these students fall below the Basic level (National Center for Education Statistics, 2009). Eighth grade students performed worse than the fourth grade students, as the NAEP data for this group show that 39% of eighth grade students were at Basic proficiency, with 27% below the Basic level. It is also notable that the percentage of students at the Basic proficiency level has remained relatively constant since 1990, when the assessment began (i.e., from 37% to 39%; National Center for Education Statistics, 2009). In contrast, 33% of fourth grade students and only 27% of eighth grade students were at the proficient level in 2009.

In addition, the discrepancies in math achievement become more pronounced when children of disadvantaged and/or minority populations are compared to their middle-income peers (National Research Council, 2009). For example, the same national data for mathematics achievement of eighth grade students for 2009 shows that 43% of Hispanic/Latino children scored below the Basic proficiency level as compared to 17% of their Caucasian counterparts (National Center for Education Statistics, 2009). As the minority group with the fastest growth rate in the United States (United States Census Bureau, 2000), Latinos are an important population to examine, and it is critical to understand the factors which may be related to their mathematics achievement.

Theoretical Framework

The following section will discuss the theoretical framework for early numeracy and bilingualism that will be utilized in the current study.

Early numeracy. The alarming statistics just discussed provide a rationale for why it is vital to direct attention to early numeracy skills of children in the U.S. Numeracy skills begin to develop in early childhood through number sense, or the understanding of numbers and how they relate to mathematical concepts of the world (e.g., rote counting, sequence, quantity, size and identification; Gersten & Chard, 1999; Baker et al., 2002; Howell & Kemp, 2005). The framework for the current study, on which the concept of number sense was originally founded, is derived from William Brownell’s meaning theory. Brownell combines understanding mathematical relationships and their practical use in everyday situations as the basis of his theory. The key to meaning theory is that it describes the importance of teaching mathematics in such a way as to make sense to the learner. This is accomplished by pacing the instruction of mathematics according to the increasing complexity of mathematical concepts, making connections among the various numerical properties in a practical manner, and teaching relationships that numerical concepts share in order to foster a deeper understanding of those concepts (Brownell, 1935). In addition, Baroody, Eiland, and Thompson (2009) described number sense in three stages, which include counting strategies, reasoning about numerical relationships, and retrieval of learned mathematical concepts. Thus, Baroody et al.'s (2009) description will serve as the operational definition of number sense for the current study.

Studies have shown that number sense is built upon and later forms the foundation for learning higher order mathematical principles as children age (Baroody, Lai, & Mix, 2006). Number sense is therefore an essential area to focus on, in order to help children develop later mathematical skills more deeply. Jordan, Kaplan, Ramineni, & Locuniak (2009) found that having a strong foundation in number sense in kindergarten was predictive of growth rate for children's mathematics achievement from first through third grade. This foundation is especially crucial for low-income and minority children (e.g., Latinos) who may be entering early childhood education centers (e.g., Head Start) at a disadvantage because of their comparably weaker number sense skills (Starkey & Klein, 2000).

Bilingualism. Additionally, speaking two languages may have an impact on mathematics achievement. The seminal work by Cummins (1977, p. 8) describes his "threshold theory" in which bilingual individuals may reach differing levels of proficiency in each language. High proficiency in both languages results in better cognitive outcomes (i.e., better developed problem solving skills and more divergent thinking). Dominant bilinguals speak both languages, but the speaker is more dominant in one of his/her languages than the other. Finally, some bilinguals may experience semilingualism, or not demonstrating proficiency in either language. Given the potential cognitive benefits of bilingualism and the nature of cognitive effort involved in mathematical problem solving, the investigation of the relationship between bilingualism and mathematics achievement is merited.

The research on bilingualism and mathematics achievement is markedly scarce. Even more limited is the literature regarding Dual Language Learner (DLL) Latino children’s abilities, and instruments to assess the children which belong to this population are also quite scarce. As such, assessing bilingual DLL Latino children in both their native language and in English becomes important in order to understand their overall abilities (McCardle, McCarthy & Leos, 2005). Thus, the current study is both relevant and necessary to add to the current literature and provide insight into how speaking two languages relates to achievement in mathematics.

Parent Characteristics of Dual Language Learner Latino Children

In addition, an area which needs more research is the parent characteristics which may be related to DLL Latino children’s achievement in schools. There exists literature regarding parent involvement and its relationship to achievement of ethnic minority children (Rodriguez, Hines, & Montiel, 2009; Ryan, Casas, Kelly-Vance, Ryalls, & Nero, 2010; Mendez, 2010), but the literature is particularly limited when looking at the demographic variables that contribute to the status of DLL Latino children’s achievement in school, let alone to early numeracy skills. Thus, the need for investigating parent variables which may relate to DLL Latino children's academic achievement, particularly in mathematics, is warranted.

Purpose of the Study

Relatively little research has been conducted regarding Latino DLL children in general, so it is not surprising that the literature on these children's early numeracy skills is virtually nonexistent. Given the startling facts surrounding the underachievement of Latinos in this country, and the fact that mathematics abilities have such a profound impact on the availability of employment in a competitive job market of the future, understanding where bilingual DLL children stand regarding their proficiency in early numeracy skills is a significant area with scarce literature in which a contribution is highly useful. Additionally, understanding the relationship between parent demographic characteristics and bilingual DLL children's mathematical achievement has useful implications for informing school psychologists' interactions with and intervention strategies for this population. The purpose of this study was to ascertain the current status of early numeracy skills in bilingual DLL Latino children in Head Start programs within the state of Florida, examine relationships between their performance in English and Spanish, ascertain if cross-language differences in these children's skills exist, and examine whether parent demographic variables are related to these children's early numeracy skills.

Research Questions

As previously stated, the current issue regarding the early numeracy skills of bilingual DLL Latino children in the U.S. is that the status of these children's abilities is virtually unknown. Similarly, there is a gap in the literature concerning whether parental demographic variables regarding early numeracy skills are related to these children's achievement on measures designed to assess numeracy acquisition. Thus, the need for this information was ascertained by answering the following questions:

1. What is the status of early numeracy in Dual Language Learner Latino children attending Head Start Programs?
2. What is the relationship between early numeracy skills in English and Spanish for Dual Language Learner Latino children attending Head Start Programs?
3. Are there cross-language differences in early numeracy for Dual Language Learner Latino children attending Head Start Programs?
4. What parental demographic variables (i.e., mothers' level of education, mothers' years of residence in the U.S., mothers' proficiency in English, mothers' proficiency in Spanish) are related to early numeracy skills of Dual Language Learner Latino children attending Head Start programs?

Significance of the Study

Given the fact that numeracy begins to develop early and that DLL Latino children are at risk for poor academic outcomes, understanding these children's early numeracy skills is an area that merits investigation. The current study is an important contribution to the literature in terms of providing information regarding the status of early numeracy skills and mathematic achievement in bilingual DLL Latino children attending Head Start. In addition, this study contributes unique findings regarding parent demographic variables and their relationship to early numeracy skills in DLL Latino children attending Head Start, which has not previously been observed in the literature.

These data are significant because they provide information which can be used to enhance DLL Latino Head Start children's existing early numeracy skills.

Operational Definitions of Terms

Independent variables. The independent variables in this study include parent demographic variables, which are defined as follows:

Parent level of education. The highest level of education completed by the mothers of the child participants, ascertained from responses to the parent interview presented in a multiple choice response format.

Parent years of residence in the U.S. The number of years that mothers of the child participants have resided in the U.S., ascertained from responses to the parent interview presented in an open-ended response format.

Parent proficiency in English. The level of English proficiency reported for the mothers of the child participants, ascertained from responses to the parent interview in a multiple choice response format.

Parent proficiency in Spanish. The level of Spanish proficiency reported for the mothers of the child participants, ascertained from responses to the parent interview in a multiple choice response format.

Dependent variable.

Early numeracy skills. The dependent variable in the current study is early numeracy skills, defined as children's scores on two tests of the Woodcock Johnson III Tests of Achievement (Woodcock, McGrew, & Mather, 2001) and the Batería III Woodcock-Muñoz Pruebas de Aprovechamiento (Muñoz-Sandoval, McGrew, & Mather, 2004). These tests are the Applied Problems and Quantitative Concepts in English and

Problemas Aplicados and Conceptos Cuantitativos in Spanish. Additionally, a Math Reasoning cluster score and a Compuesto de Razonamiento en Matematicas score were also computed.

Additional terms.

Dual Language Learners. The term dual language learners is defined for the purpose of this study as children who are exposed to two languages (i.e., English and Spanish) at the same time, and who are acquiring the second language while their first language continues to develop.

Bilingual. The term bilingual for the purpose of this study refers to the ability to speak two languages (i.e., English and Spanish).

Preschool children. The term preschool children for the purpose of this study refers to children who are currently under the age of 5 and who are eligible to attend a pre-kindergarten setting for early education services.

Head Start. The term Head Start refers to the federally funded program for children of low income families between the ages of three and five, which provides preschool and nutritional services.

Chapter Two: Review of the Literature

Theoretical Framework for Math

Theoretical guidance for the current study is based on William Brownell's meaning theory. Within this framework, Brownell describes how learning about numerical concepts and their relationships occurs through an understanding of both "the practical and mathematical significance" of numbers (Brownell, 1935, p. 19). He conceptualized the theory as providing a means for understanding and learning mathematics in a way that makes sense to the learner by accounting for the difficulty of the number's abstract properties, matching instructional pacing to the complexity of the mathematical concept, and stressing relationships within the number system in order to foster development in the progression of young children's arithmetical learning.

First, Brownell's theory takes into account that numbers, and the relationships that represent their many uses, are very complex. Comprehending numerical representation is not simply acquired through sensing one's environment, since nothing in the natural world readily indicates a concept of number by virtue of existing. For example, young children can experience four cats through their senses, but the concept that there are four of them is not automatically understood (Brownell, 1935). Brownell further explains that even when young children are able to count objects, they may not fully understand the significance of what their counting means, nor is it clear if they understand what they have counted beyond discrete entities as opposed to groups or units. Additionally, meaning theory posits that pacing of arithmetical instruction should match the difficulty of the mathematical concept to be learned. For this reason, meaning theory advocates for instruction that uses a progression which flows from concrete methods (e.g., physical objects, pictures), to semi-concrete methods (e.g., markings on a paper), to abstract methods (e.g., numerical symbols) so that children's understanding of the particular skill being learned has been verified in successive levels of complexity. Lastly, Brownell discusses how placing an emphasis on the relationships that numbers can produce in combination with one another and through computational procedures (e.g., addition, subtraction) are vital to a child's understanding of mathematics. The main premise is that if children are taught the varying ways in which numbers can be manipulated to produce the same result, they will better understand the content of what they are learning and the purpose it serves. In other words, by learning the same concept in different ways, children will be able to make sense of what they are learning through exposure to varying methods (Brownell, 1935).

Brownell's ultimate goal for meaning theory and its implication in children's learning of mathematical principles is to get children to problem solve in situations which require quantitative concepts. In other words, comprehending what is actually happening with numbers and the way they relate to each other is not only a means for the child to obtain the correct answer, but to learn from each successive connection he/she makes by thinking about what is involved in the mathematical task (Baroody, 1985). Through experience, children learn mathematical relationships that assist them in completing progressively more difficult tasks and build on this knowledge through their understanding of the meaning of the numerical principles.

Research in the field of early numeracy acquisition has drawn from Brownell's theory and attributed it to the most common components of arithmetical cognition to explain how people develop an understanding of number. As a result, the term *number sense* has been adopted as a means to describe the way in which we learn the foundational skills of mathematics and operations used to manipulate numbers, as well as using these relationships in ways that allow us to problem solve about numerical situations flexibly (McIntosh, Reys, & Reys, 1992). There is some disagreement in the literature, however, as to what number sense actually entails, with several operational definitions containing a number components available for review. For example, Gersten and Chard (1999) described number sense as a child's ability to perform counting of objects and rote counting, determine which of two objects is larger, and comprehend the concept of counting on (i.e., when the child knows to count from the next number in a sequence and continue). Van De Walle (1990) and Van Luit (2000) agree that number sense involves principles of counting (e.g., cardinality, one-to-one correspondence) and add magnitude and an understanding that the direction of a sequence can be bidirectional. Case and Sandieson (1991) include counting principles, magnitude, knowledge of operations, and an understanding of why mathematical knowledge is both useful and meaningful. Howell and Kemp (2005) further contribute to a definition of number sense by including rote counting that exceeds 10, the ability to create equal groups among objects, being able to differentiate between how much and what size objects are, and the ability to compare numbers that are uttered verbally.

Though researchers have conceptually defined number sense in various ways, research exists on the factors which underlie number sense as a construct, thereby revealing the most common basic skills that one must possess in order to have an understanding of numerical relationships. Factor analyses from Aunio et al. (2004) and Jordan et al. (2006) reveal that a two-factor model best fits the construct of number sense, in each case including counting skills and some form of discrimination among quantities of items or verbal representations of numbers. Further, these factor analyses show that counting skills and quantity discrimination abilities hang well together and represent the most essential components of basic number sense.

Another issue that has made it difficult for researchers to agree on a solid and universal definition of number sense is the fact that descriptions of number sense differ between those who study the concept from a cognitive perspective and those who approach number sense from the realm of education research. For example, Berch (2005) described how some individuals whose schools of thought adhere to a cognitive-developmental view theorize that number sense originates from an innate capacity with which all humans are born, making it a universal phenomenon that appears before any experience—formal or informal—ever makes an impact on an individual's understanding of number. On the other hand, those who adhere to an educational perspective take number sense to be more of a set of skills that is learned through experiences in the natural world prior to formal instruction, which then undergoes a complex development through later school experiences (Berch, 2005). An example of a model which adheres to the former view of innate capacities for number was proposed by Klein and Starkey (1988) and suggests that both knowledge of counting skills and understanding how to differentiate among quantities are conceptual universals. Thus, these abilities transcend cultural contexts. In other words, the position that numbers are a naturally occurring and innate construct of human cognition is supported by evidence of children having knowledge of numerical concepts before any instruction in a school or other formal setting ever take place (Gelman & Gallistel, 1978; Saxe, Guberman, & Gearhart, 1987). Klein and Starkey (1988) propose within their model that counting abilities, knowledge of quantities as transformed by operations, and a propensity with the system of natural numbers (i.e., the whole numbers used for counting, beginning with the number 1) are the essential components that relate to number sense. In this model it is again observed that counting and quantity knowledge are considered basic necessities for number sense development (Klein & Starkey, 1988).

Given the fact that both sides of the argument regarding the origins of number sense contain key components that contribute to the understanding of number sense development in children and the complexity through which it advances mathematical knowledge, a view which includes a combined approach was chosen for this study. Thus, the stance of the theoretical origin of number sense that was utilized for this study stems from the combination of innate abilities that precede experience and are essential upon which to build both unstructured and structured learning experiences, outlined by Dehaene (2001). Baroody and Ginsburg (1986) called this the mutual-development view, whereby biological predisposition for understanding numerical relationships and properties is enhanced by acquiring new skills from experience with the environment and direct instruction. Taking the aforementioned research into account, the conceptual definition chosen to guide this study comes from McIntosh, Reys, and Reys (1992, p. 4), which states that "number sense is a propensity for and an ability to use numbers and quantitative methods as a means of communicating, processing and interpreting information.” The operational definition of number sense is presented in Baroody, Eiland, and Thompson (2009), and is a framework that delineates the progression of skills, which children develop over time. This course is conceptualized in three stages (Kilpatrick, Swafford, & Findell, 2001), the first of which involves counting strategies (many of which have been mentioned in previously presented literature). The second stage involves reasoning, or using what is already known to help figure out an unknown. The last stage relies on retrieval, or the ability to have fluency with problems based on the ability to pull knowledge from memory (Baroody, Eiland, & Thompson, 2009). Researchers also agree that a child needs the first two stages as a prerequisite to reaching the last stage (Bezuk & Cegelka, 1995), and the fact that many difficulties which are seen in children’s mathematical fluency are due to the fact that the foundation of the first two stages has not been properly internalized (Jordan, Kaplan, Locuniak, & Ramineni, 2007; Baroody, Lai, & Mix, 2006).

Using this three-stage model as a framework for explaining number sense and its development, the following discussion of what is known about children’s progression through the aforementioned basic components of number sense provides detailed descriptions of each piece and how they are used to build a capacity for understanding numerical concepts in early childhood.

Number Sense Development

Infant studies.

Quantity discrimination. The notion that children who do not yet possess the ability for speech may have mathematical abilities is a perspective that is quite new in the literature. Previous to the 1960’s, the view regarding preverbal infants’ abilities in relation to understanding numerical concepts held that recognition and processing skills for numbers did not exist and would not emerge until children were of an appropriate age for school (Baroody, 1992). However, more recent studies that have examined early numeracy in the infantile years have discovered that infants in fact do possess abilities related to number, and these studies have been based on an additive model. One common research method for assessing infants' numerical abilities was to conduct habituation trials with various set sizes. Habituation is a process by which infants are shown a particular array of items with a specific quantity for a predetermined amount of time, with the expectation that the infants will get used to or "habituate" to the type of array presented and look at the display(s) less, thereby shifting their gaze away from the familiar arrangement. When a new array is presented that contains an unfamiliar quantity or set size (e.g., two items vs. one item), the infant should gaze longer at the novel array. This indicates that the infant has dishabituated, or noticed the discrepancy in set size and has turned his/her attention to the new array (Mix, Huttenlocher, & Levine, 2002).

Using this method, studies from Starkey and Cooper (1980) have shown that infants as young as four months of age are able to discriminate between sets containing two and three items. Antel and Keating (1983) had similar findings when assessing habituation in infants less than 40 hours old for arrays containing fewer than four items. Still more evidence for infants' ability to differentiate between small sets of items comes from studies that contained objects that were moving (i.e., as opposed to stationary objects which were used in the aforementioned studies). VanLoosbroek and Smitsman (1990) used rectangular figures moving steadily across a computer screen in a predetermined quantity. Infants were habituated to the original number of items and then shown the unfamiliar set of figures, which increased or decreased from the original by one. Findings indicated that children as young as eight months of age were able to reliably pick out and gaze longer at the novel set (VanLoosbroek & Smitsman, 1990). Of note, however, is the fact that infants between four and six months of age are able to direct attention to novel stimuli when the ratio used to differentiate the sets is 2:1. Any ratio that exceeds this causes the infants in this age range to fail to dishabituate to the new set of items (Cross, Woods, & Schweingruber, 2009).

Another example of evidence for infants' awareness of set sizes is the fact that studies have shown that infants respond correctly to objects which match up to the number of sounds presented. A study by Mix, Levine, and Huttenlocher (1997) showed that infants were able to select the set of items that matched the number of drum beats presented, even when rate and duration of the sounds of the drum beats were controlled. This provides evidence that infants can make a determination regarding equivalence between sets as early as seven months of age. In addition, it should be noted that infants' abilities to discriminate among set sizes is based on their judgment of amount rather than number (Mix, Huttenlocher, & Levine, 2002). In other words, infants younger than 10 months of age may be able to note which set has changed from the previously habituated set in terms of the spatial capacity which the array takes up, but have no sense of whether there is equivalence of number (i.e., when shown two sets containing different numbers of items but which take up the same amount of space in the visual field, infants do not dishabituate to the new array; Cross, Woods, & Schweingruber, 2009).

Subitizing. The question of how infants, and subsequently, young children develop their capacity to understand and utilize numbers has been studied by researchers.

In so doing, researchers have found that there exist two separate processes for using and manipulating numbers, depending on their size. The first process is known as subitizing, “a perceptual process that operates accurately and very quickly in determining exactly how many objects are contained in a small set of objects” (Klein & Starkey, 1988, p. 9). This definition supports the idea that adults utilize two different processes in order to count sets of objects that vary in size. Namely, adults are said to use subitizing in order to rapidly determine the number of objects in a set that does not exceed four objects; for sets with a larger number of objects, a counting procedure is then enacted (Mix, Huttenlocher, & Levine, 2002).

Since infants have been shown to subitize sets that contain no more than three objects, researchers have posited that the underlying process for adults and children is theoretically the same. The way that it has been most often measured involves a measurement of reaction time. Adults cannot subitize more than four objects at a time, and the measured reaction time for exposure to four objects or less is relatively flat. When presented with more than four objects, adults will cease to subitize and begin counting, thus dramatically increasing the slope of measured reaction time. In other words, experiments which show that the slope of reaction time for allegedly subitized sets of less than four objects is much more shallow than the slope of sets containing more than four objects has been touted as evidence that the subitizing phenomenon exists (Trick & Pylyshyn, 1994). One explanation for this is that small sets tend to form shapes which are easily recognized by subjects (e.g., three points forming a triangular pattern; Mandler & Shebo, 1982).

However, subitizing as a concept has caused considerable debate among researchers in regard to its origin and development. Klahr and Wallace (1976) believe that subitizing actually develops prior to counting in infants, and is the preferred method of enumerating small set sizes, even when infants have begun to count. Similarly, Gelman and Gallistel (1978) claim that subitizing as a process must develop prior to a child reaching two years of age, at which time children are able to begin showing evidence of comprehending counting abilities (i.e., this is discussed further in a later section). Trick and Pylyshyn (1994) argue that subitizing develops as a resulting component of vision and the intricate complexity of the way computational information is obtained and processed by the visual field into the eye, concurrently with working memory. Yet another theory is posed by Cross, Woods, and Schweingruber (2009), which states that children from four years of age show a propensity for subitizing, but only after having developed counting skills. The age range for the development of subitizing that was chosen for this study comes from Starkey and Cooper (1988), who say that subitizing begins between infancy and three years of age, during which children can subitize no more than four items in a given set.

Preschool-age studies.

Counting. The previous discussion of infants' abilities to detect disparities in displays of numbered sets leads into the development of preschoolers' abilities and how these children demonstrate their skills over time. Unlike infants, children of preschool-age begin to demonstrate the ability to correctly identify the number of objects in a set without erroneously paying attention to the physical properties of these objects (e.g., length, width), which might otherwise cause these children to give an incorrect answer regarding the number of objects in a set (Gelman, 1972). As such, preschoolers have been shown to exhibit abilities related to numerosity that expand on those abilities that emerged in infancy. The number sense view posits that children utilize both counting strategies and quantity discrimination as two of the major factors which underlie their understanding of mathematical concepts (Jordan, et al, 2006; Aunio, et al., 2004; Gersten, Jordan, & Flojo, 2005). Also called enumerative processes, there are several counting strategies which exist and develop in the young school-age child. Gelman and Gallistel (1978) explained that children inherently possess what they called "skeletal principles" (p.100), which children hone through experiences with informal knowledge (e.g., experiences through their environment) and later formal knowledge (e.g., scholastic experiences).

The first of these principles is the one-to-one principle, which states that only one label is assigned to each countable item, and that label is unique to that item (Gelman & Gallistel, 1978). Gelman and Gallistel have found that children as young as two and one-half years of age were able to apply the one-to-one principle when counting. In addition to being able to recognize that one label belongs to one item, the child must also be able to recognize what has already been counted. Thus, a child utilizing the one-to-one principle must simultaneously keep track of assigning one word or mental note for each item that is to be counted and keep separate those items which have already been assigned labels. Though the literature is scarce regarding the differentiation among the ability of preschool-age children to perform separation and unique labeling, one study by Potter and Levy (1968) tested the ability of three-year-old children to complete the separation portion and found that the children were able to do so. Regarding the understanding required for assigning one unique label to each countable object, the research is ambiguous. The most frequently accepted theory regarding children's understanding of counting one object with an exclusive label is that children exhibit this ability without having a deeper awareness of what they are actually doing (Cross, Woods, & Schweingruber, 2009). Previous studies (Beckwith & Restle, 1966; Wagner & Walters, 1982) have shown that although children can employ the separation and exclusive labeling techniques for each object they are counting, some preschool-age children are not able to demonstrate the ability to stop counting objects when there are no longer objects to count. In other words, children under the age of three are prone to exhaust the list of number words they are familiar with on the objects they are counting, sometimes assigning more than one label for each object. Baroody and Price (1983) found that for children older than three, this did not occur, since these children seemed to posses what Wagner and Walters (1982) called a "stop rule" (p. 111). That is, children were able to stop assigning labels to objects when they had no more objects to count, regardless of how many number word labels they were able to produce.

Following the one-to-one principle, the stable-order principle begins to develop in preschoolers. The stable-order principle states that the unique labels used to describe each individual countable item should always be utilized in the same order and/or be able to be repeated (Gelman & Gallistel, 1978). In children as young as three, this does not necessarily mean that they will begin with one and count on, though this is common. Children could begin with the number five and go on to six and seven and so on, just so long as they can repeat this pattern when asked to count again. Evidence for the presence of the knowledge of this principle can be seen in children as young as two and one-half years of age in studies by Gelman and Gallistel (1978). In contrast, some research has found that children do not necessarily exhibit the stable-order principle consistently beginning at two years of age, but develop this gradually and separate from the other principles at first. Children as young as two are able to acknowledge the most basic of order-related qualities regarding sets of numbers, which is to say they are able to tell which set is bigger than another (Mix, Huttenlocher, & Levine, 2002). In fact, two-year-old children use the stable-order principle more often than any of the other counting principles, followed by one-to-one, and least of all cardinality (Klein & Starkey, 1988). Fischer and Beckey (1990) have stated that children at five years of age begin to have a solid grasp of more complex ordinal relations, and they can demonstrate this ability while looking at more than two sets of objects at a time.

The next principle that Gelman and Gallistel (1978) described is the cardinality principle, with which preschool children begin to demonstrate the ability to answer how many items are in a set. Having a sense of cardinality refers to the ability to recognize that the last object counted indicates how many objects are in a set (Cross, Woods, & Schweingruber, 2009). According to Fuson (1992), children may begin to demonstrate the emergence of cardinality in their counting, but they do not necessarily understand the meaning of the last count word as answering a question of quantity. In fact, children between the ages of three and four may make several errors in their counting (e.g., using incorrect count words, repeating count words already used in the sequence) and still adhere to a learned rule of using the last count word to describe a set. For example, a child may use the word seventeen three times in counting a set which contains many more items than seventeen; however, if the child ends the counting at seventeen, this is the answer s/he will give as the number of items in a given set (Fuson, 1992).

The shift to counting with cardinality in mind and providing the correct number word as both the last number counted and the number of objects seems to occur when a child has passed the four year age mark (Fuson, 1992). Together, the one-to-one correspondence, stable-order, and cardinality principles make up what Gelman and Gallistel (1978) described as the “how to count” (p. 83) principles. In addition to the how-to-count principles, Gelman and Gallistel also described the abstraction principle and the order-irrelevance principle, which relate closely together and comprise the “what-to-count” principles (p. 136). The abstraction principle is the notion that many different types of things may be counted, while the order-irrelevance principle states that objects in a set will still yield the same total regardless of the order in which they are counted (Baroody, 1992). A summary of the counting principles can be seen in Table 1.

The literature on children’s abilities in the aforementioned number processes shows that children are able to use this information in certain combinations by certain ages, and that children’s development of number sense exists on a continuum. As delineated by the framework presented in Baroody, Eiland, and Thompson (2009), children go through three phases of acquiring number knowledge, including counting skills as phase one, strategies for transformation and utilization of numbers as phase two, and retrieval of what they have learned in order to apply their knowledge to new situations as phase three. In the counting strategies phase, children between two and three years of age have begun to demonstrate their abilities to use the one-to-one correspondence and cardinality principles in small set sizes no larger than three.

Table 1
Gelman and Gallistel's Counting Principles

Principle	Description	Age of Correct Use
One-to-one	Assignment of one unique label to one item; children with an understanding of the one-to-one principle are able to count items individually and know when an item has already been counted	2 – 3 years old
Stable order	Items should be counted in the same order and children should be able to repeat this sequence; children who understand this principle do not always count on from one but know that wherever they start, they continue in the same order every time (e.g., if the count starts at 4, the child counts on to 5, 6, and so on)	2 – 3 years old
Cardinality	Recognition that the last item counted divulges the total number of objects in a set; young children (3-4 years old) may begin using the cardinality principle without understanding its revelation of the quantity within a set of objects (e.g., children may make several mistakes in their counting and still declare that the last count word assigned to the last object counted, regardless of accuracy, identifies the number of items in a set	4 years old
Abstraction	Recognition that many different things may be counted	4+
Order-irrelevance	Understanding that the same total number of objects exists within a set regardless of the order in which the objects are counted	4+

Additionally at this age, children use the names of the numbers in the number word list, though these words are used to count and describe objects in a rote memorization fashion rather than in a knowingly meaningful way. Between the ages of two and three, children are able to use the cardinality principle to count to six reliably (Cross, Woods, & Schweingruber, 2009). As children begin to progress from three to four years of age, they are able to use the cardinality principle to begin working on the teen and 20 numbers, but reliably count to 10 (Cross, Woods, & Schweingruber, 2009).

Additionally, children are able to recognize and identify number symbols up to 10 by age four (Mix, Huttenlocher, and Levine, 2002). As children progress to age five, they are able to integrate the principles and use them together to begin counting higher. By first grade, children should be able to count to 100 using both single numbers and groups of ten (Cross, Woods, & Schweingruber, 2009).

As children's understanding of increasingly complex numerical relationships progresses, they begin to show evidence of comprehending the ways in which problems can be solved by manipulating these relationships. Thus, skills in solving simple calculations can be seen in children younger than earlier research had previously demonstrated.

Calculation. Children begin to utilize the number concepts they have learned through their development in the counting principles to solve problems with small numbers. For example, by the age of three, children are developing the ability to solve problems that involve numbers less than five when manipulatives are present (Cross, Woods, & Schweingruber, 2009). As preschoolers progress to the age of five, they become better able to solve these problems, but still rely on the concrete manipulatives being present in order to aid them in their calculation (Carpenter & Moser, 1982). Thus, it is posited by Mix, Levine, and Huttenlocher (2002) that these concrete manipulatives serve to aid children in understanding what they are being asked to do by representing the numerosities and their relationships within the orally presented problems. An example of this is presented in a study done by Hughes (1981), in which problems were presented to 60 children between the ages of three and five in a number of conditions (i.e., using small numbers of objects up to three, larger numbers of objects up to eight, with manipulatives present, and strictly verbal presentation with no manipulatives present). Results indicated that problems which contained smaller numbers and had concrete objects available for the children's use were solved with greater ease than those which had larger numbers or were presented only verbally.

Another example can be seen in a study by Levine, Jordan, and Huttenlocher (1992) in which children between the ages of four and six were given problems where they either had access to manipulatives in one condition or were simply presented with a story problem orally. The four-year-old children demonstrated markedly better performance for the problems that included concrete objects than those that did not. This difference was much smaller for the six-year-old children, which makes sense given their progressing development in completing more abstract problems that are presented orally (Bisanz, Sherman, Rasmussen, & Ho, 2005). Thus, it is not until children are ready for first grade that they can reliably calculate problems which do not include any visible concrete objects (Cross, Woods, & Schweingruber, 2009).

Retrieval. The ability to correctly calculate problems relates back to the counting principles, in that it demonstrates that the child has grasped the concept of cardinality and the relationships that objects can have when added to or subtracted from one another. In addition, this propensity is important in order to be able to move into the third phase of the number sense framework, namely that of retrieving knowledge of numerical relationships in order to apply them to new situations (Baroody, Eiland, & Thompson, 2009). As stated by Bisanz, Sherman, Rasmussen, and Ho (2005, p. 152), "retrieval refers to the rapid process of solving an arithmetic problem by accessing an answer directly from memory." Children build their capacity to retrieve knowledge about numerical relationships based on previous experiences they have had with solving problems using concrete objects and/or visual stimuli. This in turn helps them to more rapidly pull up this information when they encounter similar problems in progressively more abstract situations (i.e., problems where concrete objects are shown but then hidden and children must remember the relationship between what they can and cannot see (Baroody, Eiland, & Thompson, 2009). This retrieval process becomes easier with practice, particularly with problems which involve small numbers and simple relationships (e.g., one and two is three; Siegler & Shrager, 1984). Thus, children begin learning through experience with problems which allow them to use concrete objects that aid their use of addition and subtraction operations, progress to more abstract problems, and begin building fluency.

As the previous discussion showed, the development of number sense and the skills which children acquire through experience comprises their early numeracy abilities. The foundation for basic math skills is built early on, and it is here that the focus of research and efforts to improve children's understanding of elementary mathematical concepts can aid these children in building on these skills later in their scholarly career. The following discussion will explain the importance of targeting mathematics achievement early, how students in this country compare with other countries, and the current status of mathematics achievement in schools within the United States (U.S.).

Mathematics Achievement in the United States

Early foundations. As the previous discussion concerning the learning paths of children in mathematics has demonstrated, the foundation for basic math skills is built early on, and children develop number sense in an interdependent progression in which the concepts of one stage must be understood before comprehension of the concepts in the next stage can be understood. Thus, placing a focus on research and efforts to improve children's understanding of elementary mathematical concepts can add to the literature and provide insight on how to build children's skills with number as they progress in school. As stated by the National Academies (2005, p. 114), "the critical lack of technically trained people in the United States can be traced directly to poor K-12 mathematics and science instruction. Few factors are more important than this if the United States is to compete successfully in the 21st century."

The issue of mathematics achievement has become a distinct area of concern that has attracted national attention. Such was the need for addressing the lack of attention to early mathematics education that in 2000, the National Council of Teachers of Mathematics (NCTM) added curriculum focal points for pre-kindergarten to its *Principles and Standards for School Mathematics*, which help guide what content is appropriate and should be taught in order to foster learning of mathematics concepts in preschool. The focal points serve as guidelines for the inclusion of key mathematical content that is essential to incorporate into the curriculum at each grade level for which they are written. In addition, this foundational knowledge is meant to be learned and built upon as children progress through their schooling experience. In regard to pre-kindergarten focal points, NCTM included many of the aforementioned skills and principles for young preschool children, including instruction on the number-word list, the counting principles, and core components of relations among numbers (NCTM, 2000). Additionally, in 2005 the National Association for the Education of Young Children (NAEYC), a well known organization involved in early education, and the

NCTM came together to issue a position statement regarding the status of early mathematics education in the country. In this joint statement, the two organizations asserted that “high-quality, challenging, and accessible mathematics education for three- to six-year-old children is a vital foundation for future mathematics learning” (NAEYC, 2002, p. 1).

Number sense and later math achievement. Studies have examined the role that number sense plays in children’s mathematical achievement. Jordan, Glutting, and Ramineni (2010) looked at the achievement of a group of first and third grade students (n = 279, n =175, respectively) to see how number sense would relate to their achievement. In order to measure this, the investigators used the Number Sense Brief (NSB), a screening tool developed by the authors of the study. The NSB is a 33 item untimed measure which determines children’s number sense through items that assess knowledge of counting principles, addition and subtraction knowledge, and number combinations presented with manipulatives (Jordan, Glutting, & Ramineni, 2008). Additionally, children’s achievement was measured by using the Math Composite Score (i.e., made up of Math Calculation and Math Applications tests) of the Woodcock Johnson III Tests of Achievement (WJ III ACH; Woodcock, McGrew, & Mather, 2001). The researchers found that even when other variables such as cognitive abilities (e.g., language, memory) were controlled, number sense still prevailed over these cognitive factors as a better predictor of later mathematical achievement outcomes, providing further evidence of the importance of number sense as a construct that powerfully predicts later achievement.

Additionally, Mazzocco and Thompson (2005) investigated the possibility of being able to predict poor mathematics achievement in children. The researchers studied a sample of 209 children in kindergarten who were at risk for academic underachievement and followed them through the third grade. The investigators looked at a number of skills, including mathematics skills, and used appropriate subtests from such measures as the Tests of Early Math Ability, Second Edition (TEMA-2; Ginsburg & Baroody, 1990), four subtests of the KeyMath-Revised (KM-R; Numeration, Addition, Geometry, Measurement; Connolly, 1988), and Calculations from the Woodcock Johnson—Revised (WJ-R; Woodcock & Johnson, 1989). The researchers' goal was to find the measure that would best predict students who would encounter poor mathematics achievement. They found that four items from the TEMA-2, which are indicators of number sense (i.e., Reading Numerals, Number Constancy, Magnitude Judgments of One-Digit Numbers, and Mental Addition of One-Digit Numbers) served as the best predictors for later difficulties in third grade mathematics achievement. This study provides additional evidence that difficulties early on in being able to mentally manipulate numbers and understand counting principles can affect later mathematics achievement (Geary, Hoard, & Hamson, 1999).

Latino mathematics achievement. The data on the role that number sense plays in later achievement provides evidence that an early foundation is critical for building proficiency in mathematics in the upper grades and beyond. However, a notable majority of U.S. students continue to struggle to meet expectations related to mathematics proficiency. Furthermore, concerns surrounding the achievement of students in the U.S. are especially strong for minority students, and in particular Latino students.

As a substantial part of the U.S. population, Latinos now make up the minority group with the fastest growing rate in the country (U.S. Census Bureau, 2000). From 2000 to 2009, the population of native-born and immigrant Latinos increased by 35% and 28%, respectively. Estimates regarding the continued growth of Latino children in the U.S. is said to reach 25 percent by the year 2020. Additionally, the number of Latino children under age 5 living in the U.S. who speak Spanish will reach nearly 5 million by 2025 (Sun-Aplerin & Wang, 2009). These staggering demographic facts alone mean that attention to this population is highly merited (Garcia & Gonzales, 2006). Thus, it is concerning that Latino students in this country are struggling academically.

When looking at the data regarding the performance of Latinos in the U.S. as compared to their Caucasian counterparts, a clear achievement gap is evident. Data from the National Assessment of Educational Progress (NAEP) on mathematics proficiency shows that 43% of Hispanic/Latino students were below the Basic level—a drastically higher rate than that of Caucasian children, of which only 17% met the criteria for being below proficiency (National Center for Education Statistics, 2009). Even more concerning is the fact that little has changed regarding this gap since 1990 (Brown-Jeffy, 2009). Reardon and Galindo (2009) note that Latino students trail their Caucasian and African-American peers in school readiness when entering elementary school, and Latino students attend college at lower rates than their Caucasian peers. Additionally, Bali and Alvarez (2004) were able to show that the gap between Latino children and Caucasian children becomes noticeable after the children have completed the first grade, and this gap continues to grow as the children progress through school. Further, Latino students drop out of school at the highest rate across all ethnic backgrounds (National Center for Education Statistics, 2009).

Given the fact that Latino children in the U.S. struggle to achieve basic levels of proficiency in mathematics and have an even more difficult time reaching national standards for proficiency, it is of interest to investigate the skills of Latino children in mathematics, particularly in early numeracy skills. Furthermore, many of these children are Dual Language Learners (DLL), with estimates as high as 40% living in the United states as of 2006 (National Council of La Raza, 2009).

To date, there has been very little research examining the early numeracy skills of DLL Latino children. One recent study by Xue, Atkins-Burnett, and Moiduddin (2012) looked at the status of early numeracy skills, in addition to other academic school readiness skills for 675 four-year-old Latino preschool children from the Los Angeles Universal Preschool (LAUP) as part of the Universal Preschool Child Outcomes Study (UPCOS). The investigators in this study utilized the Applied Problems test, a measure of mathematical problem solving, from the Woodcock Johnson III Tests of Academic Achievement (Woodcock, McGrew, & Mather, 2001) to assess the child participants' math skills. Results revealed that the four-year-old LAUP child participants scored below the national average as compared to same-aged peers. These findings suggest that an understanding of the impact that bilingualism may have on DLL Latino children's skills in mathematics is an area that has garnered attention, but for which research is scarce.

In light of the current research on math achievement in monolingual children, it is imperative to begin understanding mathematical competencies in the Latino population. In order to better understand how the previously discussed mathematical principles apply to a bilingual population, the remainder of the chapter will focus on the theoretical framework for bilingualism, the impact of a dual language model on achievement for this population, and the exploration of parental demographic characteristics that may influence DLL preschool children's early numeracy skills.

Theoretical Framework for Bilingualism

Though relatively little work has been done in the area of bilingual abilities, the seminal work by Cummins (1977) describes a theory of cognition that compares the cognitive abilities of bilingual persons in terms of what he called thresholds. Cummins's "threshold theory" (p. 8) discusses the different levels of proficiency with the two languages to which the bilingual individuals are exposed. In order for a person's bilingualism to be considered additive, the person must have high proficiency in both of their languages. Within this threshold, the cognitive effects for a person with high proficiency in each of his/her languages are considered to be positive and contribute to better performance on measures of cognitive ability (Cummins, 1977). The next level down is described by Cummins as dominant bilingualism. This means that the person can speak proficiently in one of the languages, but does not speak the second language as well. Cummins affirms that people within this threshold do not incur effects, either positive or negative, on their cognitive abilities.

Finally, the lowest level of proficiency is called semilingualism, or low levels of proficiency in both of the languages spoken by the bilingual person. This low proficiency can manifest in both linguistically dominant (i.e., better in one language over another) and balanced (i.e., speaking both languages with relatively equal proficiency) bilinguals. Within this threshold, Cummins' theory states that persons who attain this level of bilingual abilities actually experience negative effects on their cognitive development. In other words, the mismatch between a semilingual individuals' lack of proficiency in each language and the demands of cognitive functions may result in poorly developed skills (e.g., problem solving, flexibility in reasoning, working memory; Cummins, 1984).

Studies examining bilingualism and its effects on cognition have seldom included data regarding the level of bilingualism that participants possess, making research findings more challenging to interpret in terms of the cognitive implications. One study by Ricciardelli (1992) examined the cognitive abilities of bilingual participants as compared to monolingual participants, with hypotheses regarding outcomes rooted in Cummins' threshold theory. The study included 57 five- to six-year-old Australian participants who spoke both English and Italian, and 55 monolingual children who spoke only English. The study assessed the participants in English and translated Italian using subtests from the Wechsler Preschool and Primary Scales of Intelligence (WPPSI; Wechsler, 1967). In order to determine language proficiency, the z-scores obtained from these subtests were converted to T-scores, and the median of 51.28 was used as a marker for high proficiency (if above the median) and low proficiency (if below the median), respectively. Results were consistent with threshold theory and indicated that children who were proficient in both languages had superior cognitive scores to those who were proficient in either language alone.

In addition, Adesope and colleagues (2010) conducted a meta-analysis of previous research pertaining to the effects of bilingualism on cognitive abilities. The researchers examined 63 studies which looked at the effects of bilingualism on various cognitive factors, and they used several criteria for inclusion. These criteria included studies which utilized a sample of bilingual participants who had balanced proficiency in both languages, a bilingual experimental group and control monolingual group, data that allowed effect sizes to be calculated, and clearly described outcome data delineating how cognitive benefits of bilingualism (e.g., attentional control, working memory, problem-solving abilities, abstract reasoning, and flexibility in thinking) were demonstrated over monolingual participants.

Results indicated that overall, bilingualism was shown to have a moderate weighted mean effect size (g = 0.41). The authors also included effect size data for a number of the cognitive factor categories separate from the overarching effect size, given the fact that the inclusion of varying cognitive factors was heterogeneous in nature. The factor reported to have the greatest effect size was attentional control (g = 0.96), followed by abstract reasoning (g = 0.52) and working memory (g = 0.48). When collapsed, the aforementioned constructs had a combined effect size in the moderate range (g=0.52). Given the fact that some of these factors are involved in a foundation for number sense (i.e., problem-solving ability and working memory; Baroody, Eiland & Thompson, 2009), these data provide some support for investigating further the effects of bilingualism on DLL students' mathematic abilities.

Dual language and mathematics. The relationship between language and mathematics is highly complex. Solano-Flores (2010) discusses the many ways in which language can be defined in order to analyze its impact on mathematics learning and comprehension. Language as a system accounts for the large amount of variation across Dual Language Learners (DLL) in their respective proficiencies related to reading, writing, listening, and speaking in each of the two languages to which DLL persons are exposed. Language as a process, on the other hand, looks at the way that DLLs learn what terms and symbols mean and how DLLs go about building this understanding not only across their two languages, but across various mathematical contexts. An example provided by Solano-Flores (2011) is that of having to know multiple ways in which to represent a number. Terms used to refer to a fraction, decimal, and order in which a number appears in a set in English may differ from Spanish, depending on the context of the problem (e.g., the use of the word *third* can be used to describe both the order of a number in a set and a fraction of a whole in English but not in Spanish; Solano-Flores, 2011, p. 287).

Given the fact that different languages encode mathematical concepts in ways that differ from each other, DLL students not only have to distinguish between the two languages when approaching math problems, but they also must consider the context in which the problem is presented in order to filter the rules that apply to either language. Solano-Flores and Li (2009) explain that assessments which do not take these factors into account when assessing DLL students are automatically putting these students at a marked disadvantage in comparison to their monolingual peers, particularly because many DLL students pull from previous experience in order to supplement their understanding of novel mathematical concepts. Additionally, the complexity of text involved in mathematical problems can have a significant impact on DLL students' comprehension of what a particular problem requires (i.e., structure of the language; Solano-Flores, 2010). Since the ability to problem solve has been shown to be influenced by one's skills in the language in which the problem is being presented (Barwell, 2009), text complexity in regards to the wording of mathematical problems can present an additional issue for DLL students.

Furthermore, research regarding the impact of language on mathematic achievement has produced results which indicate that Spanish/English bilingualism may have a negative impact on mathematical achievement. De Avila and Duncan (1979) examined the effects of English language proficiency and other factors (i.e., cognitive style/intellectual development, conceptual tempo, school adjustment, dependence, and impulsivity) on 903 ethnically diverse students in kindergarten through sixth grade from several states across the nation, including Latino bilingual students of Mexican, Puerto Rican, and Cuban descent. Results from step-wise multiple regression analyses revealed that there were weak overall correlations of the six factors to mathematics achievement, as well as an inverse correlation between English language proficiency and mathematics achievement (i.e., as oral language proficiency in English went up, mathematics achievement went down). Morales, Shute, and Pellegrino (1985) on the other hand, posit that DLL students' mathematical performance depends on whether it is being presented in their dominant language since, "performance transcends the language differences [in this case];" p. 30). Thus, DLL students who are more dominant in English should be able to achieve without issue on mathematical problems presented in English.

In addition, Rosenthal, Baker, and Ginsburg (1983) examined the impact of language on achievement in both reading and math utilizing a nationally representative sample of 12,322 first through sixth grade students (i.e., whose households either spoke primarily Spanish or primarily English) from the household survey component of the Sustained Effects Study of 1976. Results indicated that math achievement for Spanish-language students had a smaller mean difference than reading achievement, when compared to their English-language counterparts. Finally, Myers and Milne (1988) examined whether home language would have an effect on Spanish bilingual high school students' mathematics achievement in comparison to English monolingual speakers, when other variables (i.e., socioeconomic status, ethnic background, mathematics curriculum) were controlled. Mathematics achievement was measured through the use of two mathematics tests from the High School and Beyond Study (HSB) of 1980. Results indicated that bilingual students with a home language of Spanish had an unmediated negative effect on mathematics achievement.

Abedi and Herman (2010) posit that one possible reason for the negative impact of dual language on mathematics achievement is the fact that DLL students have fewer opportunities to learn (OTL). However, there is research that suggests that certain skills may transfer across languages. Specifically, a previous study conducted by Durgunoglu, Nagy, and Hancin-Bhatt (1993) found that phonological awareness in Spanish for 31 first grade students who were Spanish speakers transferred to English (i.e., correlations were noted between the children's recognition of English vocabulary words and phonological awareness in Spanish). Similarly, Dickinson and colleagues (2004) found that phonological awareness in English was very strongly related to phonological awareness in Spanish for 123 bilingual 4-year-old Head Start students from low income families on vocabulary tasks in each language, suggesting transfer of skills across languages.

However, no current literature exists regarding the cross-language transfer of mathematics skills, particularly of early numeracy skills in preschool-aged children. Thus, it is an important area to explore in order to ascertain whether numeracy skills can be transferred from one language to another. Additionally, given these results regarding the impact of dual language on mathematics achievement and the fact that data on this topic are both scarce and dated, an investigation of the impact of bilingualism on mathematics achievement is warranted, particularly with young children.

Although language has been shown to play a role in the mathematic achievement of DLL students, other factors, such as those related to DLL students' home environment and parent demographics may also contribute to these students' facility with numbers. Thus, DLL student achievement may be impacted by risk factors that can affect other populations in a similar fashion (i.e., low socioeconomic status and parent level of education). However, factors which may be unique to the experience of many DLL students (i.e., parents' years of residence in the U.S., parent proficiency in English, and parent proficiency in Spanish) may present as additional risks with the potential to have an impact on DLL achievement in math. The following discussion highlights the available literature regarding the aforementioned risk factors and their relationship to DLL math achievement.

Parent Demographic Characteristics and DLL Student Achievement

Socioeconomic status. The impact of socioeconomic status (SES) on student achievement has been well documented in the general population, and researchers have demonstrated that a lower SES can negatively affect student achievement (Zill, et al., 1995; Bradley & Corwyn, 2002). Similarly, research has shown that children who come from homes where they are impacted by a poor socioeconomic status often have fewer resources available to them and do not experience a rich learning environment from which to gain knowledge. Crosnoe and colleagues (2010) provided some support for this notion through their study of 1,364 children whom they followed from preschool to the age of 6 in the first grade. Those children who had access to more resources and stimulation, especially in the home and preschool environments, had better achievement in both math and reading than did their counterparts from lower SES backgrounds.

In addition, if there are fewer materials in the home (e.g., books to read), DLL children from lower SES backgrounds do not receive the same type of enriching interaction with their parents and helpful academic related materials as do children from higher SES backgrounds (Hammer, Miccio, & Wagstaff, 2003). Additionally, Farver, Xu, Eppe, and Lonigan (2006) posited that lower SES backgrounds were restrictive in the lives of children who grow up in these environments in terms of development.

Parent education. Similarly to socioeconomic status, the level of parents' education is a factor which can affect the achievement of students within the general population. There are several studies in the literature which have found a connection between children's academic outcomes and the level of education that a parent possesses. Seefeldt, Denton, Galper and Younoszai (1999) found that when looking at parents of children in Head Start for variables that contribute to achievement, parent education was linked to self-efficacy, which had a significant relationship to children's academic abilities (i.e., as measured by PPVT and TVIP scores). Similarly, Dollaghan and colleagues (1999) found that the higher a mother's education level was, the greater effect was seen in the language development of their children.

Another example can be found in Magnuson, Lahaie, and Waldfogel (2006). These researchers used the Kindergarten Cohort of the Early Childhood Longitudinal Survey to investigate the effect of the previous year of preschool on children in their first semester of kindergarten (*n* = 12,626). In addition, the investigators also looked at the effects of parent level of education on the achievement of children in the fall semester of kindergarten. Seventeen percent of the sample was made up of parents who immigrated from another country (*n* = 1,926). The researchers found that English proficiency went up for children of immigrants who attended preschool programs (e.g., Head Start), especially for those children whose mothers had an education level below high school. Additionally, these children also had improved scores in mathematic achievement. In contrast, there is limited literature pertaining to the connection between parent education and DLL children's achievement. One study by Lee (2010) found that a DLL child's mother's level of education has a positive effect on reading outcomes of these children (Lee, 2010). Given that there are still many aspects of parent education and its effect on DLL Latino children's achievement which need to be explored, further research into this topic is merited.

Parent years of residence in the U.S. In contrast to parent education and socioeconomic status, factors which may have a unique impact on DLL Latino student achievement should also be explored. One such factor is the number of years that parents of DLL Latino students have resided in the U.S. Given that the length of time which parents of DLL Latino children have lived in a country other than their place of origin can have many implications for their views on culture and the importance of academic involvement (Hammer & Miccio, 2004), it is imperative that an understanding of the impact which length of residency in this country may have upon achievement is attained for DLL Latino children. Goldenberg, Gallimore, Reese, and Garnier (2001) used a mixed methods design to look at the beliefs of parents, length of residence in the U.S. and the effects on long term achievement of their children from kindergarten through middle school. Participants included 121 kindergarten children and their families, and the children were assessed throughout their academic career until they reached middle school to see if the parents' expectations had an effect on their academic performance. Researchers found that years of residence in the U.S. were related to parents' higher expectations for their children's success. In other words, the longer that the parents had been living in the U.S., the more evident it became that their beliefs about outcomes related to their children's school success were important factors in their lives and the lives of their children.

In addition, Weisskirch and Alva (2002) posit that besides having to adapt to a new and foreign language, people of other countries who emigrate to the U.S. are often expected to adopt a new way of life. This includes different cultural values and norms, together with a novel environment in which they must learn to navigate. Often children of these immigrants adapt more quickly than their parents, thus becoming the link between the parents and the new language. As such, a better understanding how the number of years that parents of DLL Latino children have resided in the U.S. relates to their children's mathematics achievement is merited.

Parent proficiency in English. Another factor that may uniquely impact DLL Latino students' mathematics achievement is that of their parents' English proficiency and ability to communicate with their children in English at home. Veltman (1981) found that children who had at least one parent that spoke English in the home was more likely to primarily speak English. More specifically, Hammer and Rodriguez (2010) noted that roughly two-thirds of DLL Latino children whose mothers spoke another language in addition to English were monolingual English speakers themselves, compared with less than one-fifth of DLL children whose mothers primarily spoke a language other than English. These findings regarding the impact of mothers' language use in the home on their children's use of English are important, since there is evidence to show that when parents play an active role in their child's learning through involvement in the home (i.e., in literacy), academic achievement increases. In other words, those parents that are able to communicate with their children in English may be able to be more involved in their children's academic tasks, which in turn may impact their achievement (Payne, Whitehurst, & Angell, 1994).

In addition, Good, Masewicz, and Vogel (2010) conducted a qualitative study which looked at various barriers to academic achievement for DLL Latino children, which included parents' proficiency in English. One notable theme which emerged from focus group data indicated that parents who did not speak English with sufficient fluency felt that they could not communicate effectively with their children as well as their children's teachers. Thus, parents expressed language as a barrier to providing more quality involvement in their children's achievement. In contrast, Keith and Lichtman (1994) investigated the impact of parent English proficiency, among other variables, on Mexican-American eighth grade students' academic achievement through the National Education Longitudinal Study of 1988. Results from path analyses indicated that parent English proficiency did not have a statistically significant impact on academic achievement ($\beta = 0.058$), contrary to what the authors hypothesized.

The literature is relatively scarce regarding parent English proficiency and its possible relationship with DLL Latino student achievement. Given that in order to participate with their children in the activities related to their learning in the language in which they are being taught, English proficiency of parents may be related to DLL Latino children's achievement in various academic areas. Thus, it is a subject that merits further research for this particular population. Additionally, the fact that DLL Latino children who come from poor socioeconomic backgrounds may be at a disadvantage regarding their achievement merits the investigation of parental demographic characteristics which may contribute to these children's abilities in early numeracy skills.

Parent Proficiency in Spanish

In addition to English proficiency, mothers' Spanish proficiency should also be examined as a variable that may be related to DLL Latino children's early numeracy skills, particularly given these children's dual language status. However, there is no current literature regarding Spanish proficiency and mathematics achievement for this population. Thus, it is an area that merits investigation.

Conclusion

The literature has shown that many factors contribute to children's mathematics achievement, including a strong foundation of number sense. Several researchers (Gelman & Gallistel, 1978; Baroody, 1985; Klein & Starkey, 1988) have described important facets of number sense, including counting principles, abilities with calculation, and the retrieval of these learned rules when solving problems (Baroody, Eiland, and Thompson, 2009). Additionally, attention to mathematics and specifically early numeracy is particularly important, given its relationship to later achievement and the current status of student mathematics proficiency in the U.S. (National Center for Education Statistics, 2009).

Although there has been a fair contribution to the literature on math achievement in the general population, literature on early numeracy skills in preschool-age children is relatively sparse. Thus, there is still a need for research regarding the early numeracy skills of young children, particularly Dual Language Learner Latino children, for which there is virtually no current literature. As such, understanding DLL Latino children's abilities in math and the contributing factors which relate to this achievement is an area which merits investigation, but for which the literature is limited. Thus, the current study sought to ascertain the status of early numeracy skills of DLL Latino children, explore whether relationships exist among DLL Latino children's performance on mathematical tasks in English and Spanish, and determine whether parent demographic variables predict mathematic achievement in this population of children. Findings may contribute to the literature by providing information which would be useful for practitioners and educators in order to promote awareness of DLL Latino children's existing early numeracy skills, as well as to make improvements to mathematics curriculum for DLL Latino children early on in their school experience.

Chapter Three: Method

Purpose of the Study

A scarce amount of research has been conducted with bilingual Dual Language Learner (DLL) Latino children in general, and thus it follows that almost nothing can be found in terms of the early numeracy skills of this population. As noted previously, the underachievement by Latinos in this country in the area of mathematics is a matter of national concern. With the advances of technology ever increasing, achievement of the foundational mathematics skills for DLL Latino children becomes even more crucial. In addition, the parent demographic variables which may contribute and/or relate to bilingual DLL Latino children's achievement in early numeracy is an area of great interest which may shed some light on aspects of these students' skills. Thus, the purpose of this study was to determine the status of the early numeracy skills of DLL Latino children attending Head Start programs within the state of Florida, examine relationships among these students' skills in English and Spanish, determine whether cross-language differences exist among these children's skills, and ascertain whether parent demographic variables are related to these children's achievement of early numeracy skills.

This study was conducted in order to contribute to the literature on the early numeracy skills of DLL Latino children, as there is a scarcity of research regarding the relationships among their mathematics achievement and their mothers' demographic variables (i.e., education, residence in the U.S., proficiency in English, and proficiency in Spanish). In the following sections, this chapter will describe the data source for the current study, the participants of this study, the ethical considerations which were taken to conduct this study within a careful and methodologically appropriate framework, the variables of interest (i.e., independent and dependent variables within the design of the study), the measures used within the study, the procedures which were used to conduct the study, and the way in which data analysis was conducted.

Research Questions

The current study attempted to answer the following research questions which pertain to the variables of interest that were utilized in the study:

1. What is the status of early numeracy in Dual Language Learner Latino children attending Head Start Programs?
2. What is the relationship between early numeracy skills in English and Spanish for Dual Language Learner Latino children attending Head Start Programs?
3. Are there cross-language differences in early numeracy for Dual Language Learner Latino children attending Head Start Programs?
4. What parental demographic variables (i.e., mothers' level of education, mothers' years of residence in the U.S., mothers' proficiency in English, mothers' proficiency in Spanish) are related to early numeracy skills of Dual Language Learner Latino children attending Head Start programs?

Data Source

The current study utilized data from a larger project called the Florida English Language Learners Attending Head Start (FELLA-HS). The FELLA-HS project was a study that examined the school readiness abilities of approximately 350 DLL Latino Head Start children. The children who participated in the study were divided into two cohorts, and their abilities were assessed at three different time points. The first cohort was assessed during the end of their three-year-old Head Start year, the beginning of their four-year-old Head Start year, and again at the end of their four-year-old Head Start year. The second cohort of children was assessed at the end of their four-year-old Head Start year, the beginning of their kindergarten year, and again at the end of their kindergarten year.

In terms of recruitment for participation, children were recruited through 29 different Head Start sites in five counties around Florida (i.e., for the purposes of anonymity, these counties will hereafter be referred to as County A, B, C, D, and E). These counties were chosen because they serve a relatively high concentration of Latino children and agreed to participate in the original study. In addition, children were eligible to participate if they had at least one parent living in the home who spoke Spanish. The vast majority of the children from the sample (i.e., 94%) were born in the U.S. Families of these children also participated in the original study and represented 15 Latin American countries, including Puerto Rico, Mexico, Cuba, Honduras, Guatemala, Peru, Columbia, El Salvador, Argentina, Dominican Republic, Panama, Venezuela, Nicaragua, Ecuador, and Bolivia.

The children were evaluated in both English and Spanish on all school readiness domains. Parent interviews were also conducted with the families of these children via telephone in either English or Spanish. The families had their choice of responding to the questions of the interview in the language which was most comfortable for them, though a majority of the parents interviewed by phone answered in Spanish (i.e., 85% vs. 15% in English). Additionally, classroom teacher questionnaires were filled out by the participating children's Head Start teachers, and classroom observations were also conducted as part of the original study.

Present Study

Participants. The current study focused on a subsample of the original FELLA-HS study. This subsample consisted of 132 DLL Latino children who were attending Head Start at the end of their pre-kindergarten four-year-old year and who were assessed at this time point in the original study (i.e., 80 female and 52 male participants, making it an approximately 60/40 ratio). The majority of the child participants in the current study had the U.S. listed as their country of origin (i.e., 92%). In addition, 3% of the current study's child participants were originally from Cuba; 2% were from Mexico; 2% were from Puerto Rico; and less than 1% were from Guatemala. These children were also fairly evenly distributed among the counties in which they were assessed (i.e., (25% in County A; 23.48% in County B; 12.12% in County C; 18.94% in County D; and 20.45% in County E).

Additionally, this subsample of the original study included the selected child participants' mothers in order to examine demographic variables and their relation to the DLL Latino children's math achievement. Mothers reported various countries of origin, with the vast majority originating from Mexico (56%); other reported countries of origin for mothers in the current study included the United States (2%), Cuba (16%), Puerto Rico (5%), Guatemala (8%), and Honduras (4%). In addition, each of the following countries was represented by less than 2% of mothers in the present study's final sample: Columbia, El Salvador, Venezuela, Nicaragua, Ecuador, Bolivia, and Jamaica. Mean income for the sample participants was between $10,000 and $19,999. Additional demographic data for both child participants and their mothers is further detailed in Chapter Four.

Ethical Considerations

In order to conduct this study within the boundaries of ethical practice, University of South Florida Institutional Review Board (IRB) approval was sought and obtained before any data was analyzed for the current study. It should be noted that IRB approval was sought and obtained for the original FELLA-HS study (i.e., from which data for the current study was utilized) before any contact with participants or data was made. Thus, the following ethical considerations were already made for the data used in the current study and are discussed in the context of the original study.

Due to the fact that this sample of children attending Head Start was too young to give their assent, consent forms were administered to and signed by parents to give permission for their children to participate in the original study. These consent forms were available in both English and Spanish. The staff at the individual Head Start sites was available to the parents in order to explain the study to each potential participant prior to obtaining their signature, after which the parents had one week to return the signed consent form in order for their child to participate in the study. This week-long time period was provided both to give parents the opportunity to carefully review what the study entailed and to give them time to return the consent form for their child to participate. The children were free to stop and/or refuse the assessments at any time during testing, at which point the assessors ended the assessment for that child and recorded the refusal or discontinuation. All data were kept confidential in order to protect participants' privacy by assigning identification numbers to all of the documents associated with each participant. Thus, there was no need to use names or other identifying information when coding and reviewing the data. All the data collected (i.e., assessments, informed consent forms, and parent interviews) were filed and locked at all times within a file cabinet in a research lab at the University of South Florida, to which only the principal investigator and her research team had access.

Variables

Parent demographic characteristics. The independent variables that were examined for the current study were parent demographics. More specifically, the current study utilized demographic data from the parent interview administered to the mothers of participating children in order to ascertain which of these variables may have some association with DLL Latino Head Start children's early numeracy skills. These variables included questions which ascertained how many years the mothers of these children have lived in the United States (i.e., "How many years has the mother been residing in the U.S.?"), the mothers' level of education (i.e., "What is the highest level of schooling the mother has completed?"), the level of proficiency in English that the mother possesses (i.e., "How well does the mother understand English?"; "How well does the mother speak English?"; "How well does the mother read English?"; "How well does the mother write English?"), and the mothers' Spanish proficiency (i.e., "How well does the mother understand Spanish?"; "How well does the mother speak Spanish?"; "How well does the mother read Spanish?"; "How well does the mother write Spanish?").

The questions regarding level of education, proficiency in English, and proficiency in Spanish had response options presented in a multiple choice format, while the years of residence question was presented in an open-ended response format (i.e., see

Appendix). Additionally, it should be noted that the four questions regarding mothers' proficiency in English were combined into a composite variable and expressed as a percentage (i.e., each question pertaining to English proficiency had four response options valued 0 to 3; these were added together and divided by 12, then multiplied by 100 to obtain an English proficiency percentage). The same process was utilized for the questions pertaining to mothers' proficiency in Spanish in order to obtain a composite variable expressed as a percentage.

It should be noted that a previous study (Lopez, submitted) utilized the Peabody Picture Vocabulary Test (PPVT) to validate the use of the self-report scale for English proficiency that was included in the study. Results indicated that the relationship between the mothers' self-reported English proficiency and their scores on the PPVT were strongly related ($r = .76$, $p < .001$). Thus, evidence exists that mothers' self-reported English proficiency is related to an established English vocabulary measure, and the previous study provides support for using the self-report items on the parent questionnaire as a combined composite variable to represent mothers' language proficiency.

Early numeracy skills. The dependent variable that was examined in the current study was the early numeracy skills of bilingual DLL Latino children attending Head Start programs in the aforementioned counties in Florida. Several measures were utilized in order to obtain data regarding the school readiness skills of these children in the original study. The measures which provide data that answered the research questions for the present study are described in the following section.

Measures

The original study utilized a number of assessments in order to collect data on the school readiness skills of the total sample, and all data were collected in both English and Spanish. All assessments were chosen because they were considered appropriate for the age range of the participants and were available in both English and Spanish. Also, the fact that these measures had been used in other studies with samples of similar compositions (i.e., with children attending Head Start) was taken into account as a deciding factor for their utilization. From these assessments, the data from two tests of the Woodcock Johnson III Tests of Achievement (i.e., Applied Problems and Quantitative Concepts; Woodcock, McGrew, & Mather, 2001) and the Batería III Woodcock- Muñoz Pruebas de Aprovechamiento (i.e., Problemas Aplicados and Conceptos Cuantitativos; Muñoz-Sandoval, McGrew, & Mather, 2004) were selected from the battery administered to the sample in the original study in order to measure the early numeracy skills of the current study's sample. Although each of these tests have respectable reliability and validity data, a separate Cronbach's alpha for each test based on the study sample was computed with the data from the current study.

Woodcock Johnson III Tests of Achievement (WJ III ACH; Woodcock, McGrew, & Mather, 2001). The WJ III ACH is a comprehensive, standardized instrument that measures academic performance and provides tests which produce scores in the areas of literacy, oral and written language, and mathematics (Woodcock, McGrew, & Mather, 2001). The sample upon which this instrument was normed (n = 8,818) was randomly selected using a stratified sampling method from the population in over 100 locations across the U.S. This method allowed test authors to control for such variables as sex, race, U.S. region, community size, and socioeconomic variables (e.g., level of education, occupation type; Woodcock, McGrew, & Mather, 2001). As such, the normative sample for this instrument is considered to be a representative sample of participants that ranges from two years of age to over 90 years of age.

Applied Problems test. This test of the WJ III ACH consists of 63 items which measure the ability to apply knowledge of mathematical procedures to a verbally and visually presented math problem. Additionally, one must be able to filter extraneous information and perform the necessary calculations to solve the problem. This test incorporates age appropriate early numeracy skills, including several counting principles (e.g., one-to-one correspondence, cardinality, abstraction) as well as quantity discrimination and simple calculations using visually presented stimuli. In the standardization sample, Applied Problems has a split-half internal reliability for four-year-old subjects of .94.

Quantitative Concepts test. This test contains 57 items (34 items in the first part *Concepts;* 23 items in the second part, *Number Series*). The *Concepts* section of this test measures the ability to identify numerical symbols and shapes, while the *Number Series* section measures the ability to identify the missing digit in a series of numbers presented in a particular pattern. Quantitative Concepts also includes age appropriate early numeracy skills, including counting principles (e.g., cardinality, stable-order) and retrieval (i.e., utilizing knowledge of number relationships to complete number series). In the standardization sample, Quantitative Concepts has a split-half internal reliability for four-year-old subjects of .89.

The Batería III Woodcock- Muñoz Pruebas de Aprovechamiento (Batería III; Muñoz-Sandoval, McGrew, & Mather, 2004). The Batería III is the Spanish equivalent of the WJ III ACH and measures the same abilities as its counterpart in English using items and instructions which have been written in Spanish. This battery was developed such that it would be useable and appropriate for use with all individuals who speak the Spanish language. The calibration sample (*n* = 1,413) was drawn from both regions across the U.S. and several countries (i.e., Argentina, Colombia, Costa Rica, Mexico, Panama, Puerto Rico, and Spain). Selected subjects were required to speak Spanish as their primary language and were also required to demonstrate Spanish dominance on an oral language test. The calibration data for the Batería III has also been equated with WJ III ACH norms. In other words, the difficulty of each test's required tasks in Spanish on the Batería III was compared to the difficulty of the same test's tasks in English on the WJ III ACH, and a Rasch-model was utilized to complete this process. Once these difficulty levels were established and calibrated for the items in Spanish, the coordinates of the Batería III and the WJ III ACH difficulties were plotted, and a linear regression model was utilized to eliminate extreme outliers. Tests used from the Batería III were also chosen because of their appropriateness with the composition of the original study's sample (i.e., 3, 4, and 5 year old children; Woodcock, Muñoz-Sandoval, McGrew, & Mather, 2004).

Problemas Aplicados test. This test, which mirrors its English counterpart in the WJ III ACH, contains 63 items and measures an individual's ability to solve mathematical problems through determining the proper calculation procedure after being presented with a math problem both orally and visually. Additionally, extraneous information must be filtered and simple calculations must be utilized to solve the problem. The same early numeracy skills incorporated into the Applied Problems test are utilized in the Problemas Aplicados test (e.g., counting principles, simple calculation). In the standardization sample, Problemas Aplicados has a split-half internal reliability of .90.

Conceptos Cuantitativos test. This test, much like its equivalent in the WJ III ACH, measures an individual's ability to recognize mathematical symbols, what the individual knows regarding concepts related to mathematics, and vocabulary associated with mathematical principles. This test contains 57 items, split in an identical fashion to the WJ III ACH (i.e., 34 items in *Concepts* and 23 items in *Number Series*). As with the Quantitative Concepts test in English, the same early numeracy skills are incorporated for the Conceptos Cuantiatitivos test (e.g., counting principles, retrieval). In the standardization sample, Conceptos Cuantitativos has a split-half internal reliability for four-year-old subjects of .85.

Math Reasoning and Compuesto de Razonamiento en Matematicas clusters. When both tests (i.e. Applied Problems and Quantitative Concepts) are administered to the same child, the Compuscore software program provides the option of creating a Math Reasoning cluster score for the child based on the combined performance on the two math tests. These cluster scores were therefore calculated in each language for the finalized data set in addition to the individual test scores. This process included entering each Applied Problems raw score and Quantitative Concepts raw score into the Woodcock-Johnson III Normative Update Compuscore Profiles computer software program. This program in turn converted the raw scores into one Math Reasoning cluster score. The process was identical for the Problemas Aplicados and Conceptos Cuantitativos tests in Spanish to obtain the Compuesto de Razonamiento en Matematicas score for each child participant. These cluster scores also provide global measures of mathematical reasoning that includes knowledge of mathematical vocabulary, calculation procedures, and problem solving strategies. As such, these cluster scores were utilized to represent the child participants' global early numeracy skills in analyses conducted to answer research questions three and four. The cluster reliability in the standardization sample for Math Reasoning is .94 and the reliability for Razonamiento en Matematicas is .96.

Additionally, the Math Reasoning cluster demonstrates concurrent validity with composites on other achievement test batteries that measure similar constructs related to mathematics. The WJ III ACH Math Reasoning cluster correlates moderately with the Kaufman Test of Educational Achievement (KTEA; Kaufman & Kaufman, 1985) Mathematics Composite (r = .41) and with the Wechsler Individual Achievement Test (WIAT; Wechsler, 1992) Mathematics Composite (r = .56). It should be noted that a school-aged sample was utilized for these correlations (i.e., a sample of 52 children in first through eighth grades). No validity studies reported in the WJ III ACH Technical Manual (McGrew & Woodcock, 2001) utilized preschool-aged subjects for the achievement tests and clusters. In addition, the validity data for the WJ III ACH is applicable to the Batería III, given that the underlying psychometric properties are the same for both batteries (i.e., according to the Batería III Woodcock- Muñoz Technical Supplement; Schrank, et al., 2005).

Parent interview. A parent interview was developed for the original study to obtain data regarding the demographics of the parents whose children participated in the study. The interview was conducted over the telephone by research assistants who worked under the principle investigator in the original study. Interview items were developed by the original study's research team in an effort to obtain data regarding the parent's background information and home practices with their children. This was done in order to compare demographic variables within the study. The interview consisted of 107 items and took approximately 30 minutes to administer. The interview ascertained such information as the number of years the parents had been living in the U.S., their home country, the language most often used in the home, other languages spoken in the home, academic practices which the parents engaged in at home with their children, and parent level of education. The interview was conducted in the parent's preferred language, and was available in both English and Spanish (i.e., see Appendix).

Procedures

The children who participated in the original study were assessed during the first part of their day (i.e. typically between the hours of 8am and 12pm) at the Head Start sites which they attended. These sessions were conducted on an individual basis, where one assessor met with one child at a time, and the assessments were done in any available space within the Head Start site that was conducive to working independently with the child. The battery of assessments measured the children's abilities in oral language, early literacy, early numeracy, and cognitive domains. Each child was assessed on two consecutive days in one language, and one week later, they were assessed across two consecutive days in the other language. This was done to avoid fatiguing the children, so that a total of four days was used for obtaining all assessments for each of the children. Additionally, the language of assessment was counterbalanced so that half of the sample was assessed in English first and the other half was assessed in Spanish first. Once the assessments were completed in the first language, children were assessed in the remaining language approximately one week later. The assessment procedure for each language took approximately 90 minutes to complete. Children were compensated for their time by receiving stickers during the assessment and a small toy at the end of each assessment. For the purposes of the current study, children's assessments that were conducted using the aforementioned procedures during the end of their pre-kindergarten four-year-old Head Start year were utilized.

In addition, parent interviews were conducted via telephone with the parents of the participating children. Research assistants called parents and obtained demographic data in the parents' preferred language by asking questions on the interview. Families were compensated for their time by receiving a bilingual children's book, which was mailed to their home address as a gift for participation in the original study. Child and parent level data were scanned and stored on a secure computer in the principle investigator's lab, using Remark Office OMR 7 software.

Qualifications

Applicants for the original study's assessor positions were required to fill out a survey answering questions regarding experience with children, assessment, and research. Surveys were reviewed by research assistants (i.e., advanced undergraduate students and graduate students working for the primary investigator of the original study), and interviews were scheduled in person or via phone with applicants, based on the quality of answers on the survey. Once hired, all assessors participated in an intensive two hour training, which was provided by the primary investigator of the original study at each Head Start site, prior to administering the assessments. Additionally, the assessors were required to submit their first completed set of assessments for review before they were permitted to continue in the original study. If approved by the primary investigator, the assessors resumed collecting data and conducting assessments with the children at Head Start sites. In addition, these assessors were required to speak only the language to which they were assigned when in the presence of the child during administration. Thus, there were two teams of assessors who collected data for the original study (i.e., one team to conduct assessments exclusively in English, and a second team to conduct assessments exclusively in Spanish). Assessors in each language were employed in order to minimize the likelihood that children would switch between languages during the administration of the assessments in one language or the other.

In addition, bilingual research assistants were recruited to administer the parent interviews via telephone. These research assistants were trained on the administration of the interview prior to being able to contact the families. Research assistants were trained by an advanced graduate student who worked on the original study, and training lasted approximately one hour. Each question of the parent interview was reviewed with the research assistants in order to ensure that they understood the information being asked and the expected responses for each question.

Research assistants also received training on how to properly enter raw assessment data into the Woodcock Johnson III Normative Update Compuscore Profiles Program. This software program provided the conversion of raw scores (i.e., number of items correct on each test) to standard scores (i.e., scores with a mean of 100 and a standard deviation of 15) and W scores (i.e., scores unique to the Woodcock Johnson battery of assessments, obtainable only through the Compuscore program). Training was conducted by an advanced graduate student who was also part of the original study, and it involved modeling correct entry of scores into the program, as well as having research assistants enter the scores for practice under supervision. Additionally, the scores that research assistants entered underwent a 10% quality check conducted by another advanced graduate student to ensure the accuracy of the data entry process.

Data Analysis

Prior to data analysis for the present study, the database was quality checked using the following procedures. All child participant ID numbers were compared against all parent ID numbers to ensure that each ID number had corresponding child and parent data. Once the sample with matching ID numbers was obtained, 100% of the sample (N = 182) was checked on each column to ensure that the correct type of data was entered (i.e., numbers or letters) in the corresponding row. In addition, ID numbers with any missing data were eliminated from the study (i.e., children who were missing math test data in English or Spanish, or who were missing parent interview demographic variables included in this study). This process resulted in a reduced final sample size (N = 132). Once the finalized data set was established, the Microsoft Excel worksheet containing the data set was imported into SAS, a statistical analysis software program, in order to conduct the data analyses.

Preliminary analyses included screening the data for univariate outliers, and scatter plots were also examined for nonlinearity. Descriptive statistics were then calculated in order to obtain means and standard deviations for all the continuous variables of interest, and frequency statistics were calculated for the categorical variables. Normality of the distribution was also addressed by examining the skewness and kurtosis of the data. Additionally, raw scores from each of the tests in both languages were entered into the Woodcock Johnson III Compuscore and Profiles Program, which then produced the Math Reasoning cluster standard scores in English and the Compuesto de Razonamiento en Matematicas standard scores in Spanish.

To address research question one, means, standard deviations, confidence intervals, and minimum and maximum values were obtained for the standard scores of the Applied Problems test, the Quantitative Concepts test, and the Math Reasoning cluster scores in English. Additionally, these statistics were calculated for the standard scores of the Problemas Aplicados test, the Conceptos Cuantitativos test, and the Compuesto de Razonamiento en Matematicas cluster scores in Spanish.

To address research question two, correlations between the child participants' performance in English and Spanish were examined, using standard scores for each of the measures (i.e., on the Applied Problems test and the Problemas Aplicados test, as well as between the Quantitative Concepts test and Conceptos Cuantitativos test). Additionally, a correlation examined the relationship between the Math Reasoning cluster standard score in English with the Compuesto de Razonamiento en Matematicas cluster standard score in Spanish.

In order to address research question three, the child participants' math cluster scores in both languages were utilized to conduct a dependent means t-test in order to ascertain whether any cross-language differences existed among the children's scores in

English and Spanish. The cluster scores were chosen for this analysis after examination of the correlation matrix from research question two revealed high correlations with the individual tests of which the clusters are comprised, indicating that they serve as a representative measure of the child participants' global mathematical skills.

Finally, to address research question four, correlations between the parent demographic variables of interest (i.e., mothers' level of education, mothers' years of residence in the U.S., mothers' proficiency in English, and mothers' proficiency in Spanish) and the dependent variables (i.e., Math Reasoning cluster scores in English and Compuesto de Razonamiento en Matematicas scores in Spanish) were examined to identify relationships among the variables. Then, mothers' demographic variables were included in two multiple regressions to examine whether these variables served as predictors of the children's early numeracy skills in English and Spanish. It should be noted that the four questions from the parent interview pertaining to mothers' perceived utility of the English language were summed obtain a composite score for mothers' English proficiency. The same procedure was conducted to obtain a composite of mothers' Spanish proficiency (i.e., see procedure outlined in the Variables section of this chapter).

Chapter Four: Results

The following sections contain descriptions of the results from the statistical analyses that were conducted in order to both prepare the dataset for analysis and to answer the four research questions which pertained to the current study. The first section describes the procedures utilized to create a full data set matched for both child and parent participants, as well as delineates the quality checking process (i.e., how missing data were handled, management of outliers, exclusion criteria for the final data set). The second section pertains to the preliminary analyses conducted to describe the data, as well as the way in which the final data set was compared to excluded data on relevant variables (i.e., with an independent means t-test). The final section describes the results from analyses conducted to address the four research questions.

Data Entry and Screening

The primary investigator for the current study began quality checking procedures by matching child participant data identification numbers (N = 245) with corresponding parent participant identification numbers (N = 304), in order to have a full set of data with all variables of interest. Child participants were excluded from the data set if they did not match up with a corresponding parent data ID number, and vice versa. This process was conducted in Microsoft Excel, and it resulted in a full data set of matched ID numbers with both parent and child data (N = 182). Once matched ID numbers for the sample were obtained, the primary investigator examined 100% of the data to ensure that each ID number had complete data on the variables of interest for the current study (i.e., math test scores in English and Spanish, mothers' years of residence in the U.S., mothers' level of education, the four interview questions that pertained to mothers' proficiency in English, and the four questions that pertained to mothers' proficiency in Spanish). An ID number and its corresponding data were deleted if any of the aforementioned variables of interest were missing in that row. This rigorous quality check of the data led to a further reduction in final sample size (N = 132). Thus, a total of 50 ID numbers were eliminated from the final data set due to missing data on the variables of interest.

In addition, an independent reviewer conducted a separate quality check of 25% of the final data set, checking all data for every fourth ID number (i.e., a total of 33 ID numbers were checked). No errors were found during this independent check of the data. Once the final data set was obtained, the Math Reasoning cluster standard scores in English and the Compuesto de Razonamiento en Matematicas scores in Spanish were calculated for the final data set, as described in Chapter Three (i.e., using the Woodcock Johnson III Normative Update Compuscore Profiles software program). A subsequent quality check on the transfer of the cluster scores in both English and Spanish from Compuscore to the Microsoft Excel worksheet containing the complete data set resulted in no errors (i.e., every fourth ID number's cluster score was checked for a total of 33 checks in English and 33 in Spanish, totaling 66 checked cluster scores, or 25% of all cluster scores).

Preliminary Analyses

Means and standard deviations were calculated for child participants' math scores in English and Spanish (i.e., raw scores, standard scores, and W scores). These data are summarized in Table 2. In addition, frequency statistics were calculated for the categorical variables of the study sample (i.e., gender and county in which children attended Head Start). Additional means and standard deviations for the continuous variables (i.e. mothers' level of education, mothers' years of residence in the U.S., mothers' proficiency in English, mothers' proficiency in Spanish, and income) were also obtained. Statistical tests were also conducted in order to compare the complete data set that was used for the research study with the 50 eliminated ID numbers on several variables (i.e., Chi-square for child gender and county; independent means t-test for mothers' level of education, mothers' years of residence in the U.S., mothers' proficiency in English and Spanish, and income). The categorical data are summarized in Table 3 and the continuous data are summarized in Table 4.

As can be seen in Tables 3 and 4, the comparison analyses yielded mixed results. The chi-square distribution utilized for the categorical variables revealed that there was no significant difference between the set with complete data (Male = 39.39%; Female = 60.61%) and the set comprised of the 50 deleted ID numbers (Male = 48%; Female = 52%) on gender ($X^2 = 1.10$, $p = .291$). However, the difference between the two data sets on county ($X^2 = 9.72$, $p = .045$) was statistically significant, suggesting that the sample with complete data (i.e., County A: 25%; County B: 23.48%; County C: 12.12%; County D: 18.94%; County E: 20.45%) and the sample with missing data (i.e., County A: 28%; County B: 16%; County C: 8%; County D: 8%; County E: 40%) were not equal in regards to distribution across counties. Regarding the continuous variables, there was no statistically significant difference for income between the sample with complete data ($M = 2.03$, $SD = 1.00$) and the sample with missing data ($M = 2.18$, $SD = 1.06$), *t*(179) = 0.84, $p = .40$. Additionally, mothers' years of residence in the U.S. did not yield a statistically significant difference between the complete data sample ($M = 11.59$, $SD = 6.66$) and the missing data sample ($M = 9.86$, $SD = 6.13$), $t(174) = -1.52$, $p = .13$. There was also no statistically significant difference noted for mothers' level of education between the complete data sample ($M = 3.71$, $SD = 2.48$) and the missing data sample ($M = 4.30$, $SD = 2.48$), $t(180) = 1.43$, $p = .15$. In contrast, statistically significant differences were observed for mothers' proficiency in English (i.e., complete data sample, $M = 39.77$, $SD = 31.19$; missing data sample, $M = 50.85$, $SD = 28.37$; $t(179) = 2.17$, $p = .03$) and mothers' proficiency in Spanish (i.e., complete data sample, $M = 86.11$, $SD = 19.85$; missing data sample, $M = 72.52$, $SD = 19.65$; $t(177) = -4.04$, $p < .0001$). This suggests that mothers included in the complete data sample had lower English proficiency and higher Spanish proficiency than mothers in the sample with missing data. Thus, the complete data sample is not perfectly representative of the population in terms of language proficiency among DLL Latino Head Start children's mothers.

Additionally, correlations were analyzed in order to determine whether the individual math test scores or the math cluster scores in each language would be utilized to answer research questions three and four (i.e., dependent means t-test and multiple regressions, respectively). Given the large correlations among the math cluster scores in both languages and the individual tests of which they are comprised in each language (i.e., correlations between individual test scores and cluster scores in English and Spanish ranged from .76 to .92, $p < .0001$), the analyses for research questions three and four were conducted using the math cluster scores in both English and Spanish to represent the child participants' overall early numeracy skills.

In addition, the normality of the finalized analytic sample was analyzed by examining the skew and kurtosis values of the distribution (i.e., a normal distribution typically has skew and kurtosis values between -1.0 and +1.0; Johnson & Kuby, 2007). Scores on the English Applied Problems, Spanish Conceptos Cuantitativos, and Spanish Compuesto de Razonamiento en Matematicas cluster had approximate normal distributions. In contrast, scores for the remaining measures were somewhat non-normal (i.e., Spanish Problemas Aplicados: skew = -.41, kurtosis = 1.38; English Quantitative Concepts: skew = -2.01, kurtosis = 6.45; English Math Reasoning cluster: skew = -1.14, kurtosis = 3.79). Although the scores for the aforementioned measures did not meet traditional criteria for skew and kurtosis of a normal distribution, Kline (2010) suggests that skew which does not exceed a value of 3 and kurtosis which does not exceed a value of 10 would be considered within acceptable limits. Given that the three scores in question (i.e., Spanish Problemas Aplicados, English Quantitative Concepts, and the English Math Reasoning cluster) did not exceed Kline's parameters for normality, no variables were transformed for analyses as part of the current study.

Outliers

Univariate outliers were defined as participants whose scores on any of the variables of interest (i.e., child math scores in English and Spanish, mothers' years of residence in the U.S., mothers' level of education, mothers' proficiency in English, mothers' proficiency in Spanish) were more than three standard deviations from the sample mean (Johnson & Kuby, 2007). Using these criteria, no outliers were detected within the analytic sample. Additionally, scatter plots containing the aforementioned variables of interest were examined, and no evidence was found of nonlinearity.

Reliability

In order to obtain a measure of reliability for each of the measures utilized to quantify the children's math scores in the analytic sample of the current study, Cronbach's alpha was calculated for each of the test standard scores in both English and Spanish. These findings are summarized in Table 5. All measures in both languages demonstrated adequate reliability. The highest internal consistency reliability was found when Cronbach's alpha was calculated for the standard score of the Spanish test Conceptos Cuantitativos (.95). No Cronbach's alpha score was found to be below .93 for any of the other measures. For example, both individual math tests in English had a Cronbach's alpha of .94, while the English Math Reasoning cluster score had a Cronbach's alpha of .93. In addition, alpha for the Spanish test scores and cluster score ranged between .93 and .95.

Cronbach's alpha was also calculated for the four questions which comprised mothers' composite English proficiency scores and composite Spanish proficiency scores. These findings are summarized in Table 6. Adequate reliability was found for all questions comprising the English proficiency composite (i.e., alpha ranged from .93 to .96), and for all questions comprising the Spanish proficiency composite (i.e., alpha ranged from .69 to .84).

Research Question One: What is the status of early numeracy in Dual Language Learner Latino children attending Head Start Programs?

The means, standard deviations, confidence intervals, minimum, and maximum values for the children's math standard scores on the individual tests, as well as the math cluster scores in both English and Spanish are presented in Table 7. Standard scores were chosen for analysis due to their ability to be interpreted easily. As can be seen in Table 7, the mean for Applied Problems in English (M = 91.60, SD = 13.89) is similar to the mean for Problemas Aplicados in Spanish (M = 92.42, SD = 12.45). In addition, the children in the analytic sample obtained nearly identical standard scores on the Quantitative Concepts in English (M = 85.86, SD = 23.22) and the Conceptos Cuantitativos in Spanish (M = 85.69, SD = 13.52). The mean for the Math Reasoning cluster in English (M = 84.73, SD = 19.64) was slightly higher than the mean for the Compuesto de Razonamiento en Matematicas score in Spanish (M = 83. 85, SD = 17.18).

Research Question Two: What is the relationship between early numeracy skills in English and Spanish for Dual Language Learner Latino children attending Head Start Programs?

A correlation matrix was created in order to determine the relationship among the test scores in English and Spanish for the child participants in the analytic sample. In addition, scatter plots for these correlations were visually inspected, and no evidence of nonlinearity or bivariate outliers was detected. Table 8 displays these results. Overall, the standard scores on the individual tests (i.e., Applied Problems, Quantitative Concepts) in English had small correlations with the individual tests in Spanish (i.e., Problemas Aplicados, Conceptos Cuantitativos; correlations between the tests in English and the tests in Spanish ranged from .40 to .44, $p < .0001$). In addition, a moderate correlation was noted between the English Math Reasoning cluster score and the Spanish Compuesto de Razonamiento en Matematicas score ($r = .53$, $p < .0001$).

Research Question Three: Are there cross-language differences between the early numeracy skills in English and Spanish for Dual language Learner Latino children attending Head Start Programs?

In order to answer research question three, a dependent-means t-test was conducted, using the math cluster standard scores in English and Spanish (i.e., a single variable was created to represent the difference between the Math Reasoning cluster score in English and the Compuesto de Razonamiento en Matematicas score in Spanish in the SAS software program). Results of the dependent means t-test indicate that there was no statistically significant difference between the children's performance on the cluster standard scores in English and Spanish ($M_{Diff} = -.88$, $SD_{Diff} = 17.95$, $t(131) = -0.56$, $p = 0.57$).

Research Question Four: What parental demographic variables (i.e., level of education, years of residence in the U.S., proficiency in English, proficiency in Spanish) are related to the early numeracy skills of Dual Language Learner Latino children attending Head Start Programs?

A correlation matrix was first conducted in order to determine if any of the mothers' demographic variables were related to one another as well as to the dependent variables being included in the current study. The correlations can be seen in Table 9. Results indicate that small correlations were found between mothers' level of education and the child participants' Math Reasoning cluster score in English ($r = .24$, $p < .01$), as well as the Compuesto de Razonamiento en Matematicas cluster score in Spanish ($r = .31$, $p < .001$). Additionally, small to moderate correlations were found between mothers' years of residence in the U.S. and mothers' proficiency in English ($r = .38$, $p < .001$), and between mothers' proficiency in English and the child participants' Math Reasoning cluster scores in English ($r = .20$, $p < .05$). A moderate correlation was found between mothers' level of education and mothers' proficiency in English ($r = .56$, $p < .001$). No other statistically significant relationships were found among mothers' demographic variables or between these demographic variables and the dependent variables of children's math cluster scores in English and Spanish.

Two multiple regression analyses were conducted in order to answer research question four. The dependent variable for the first regression model was the Math Reasoning cluster score in English, while the independent variables included mothers' level of education, mothers' years of residence in the U.S., and mothers' proficiency in English (i.e., proficiency in English and Spanish were composites of four questions from the parent interview in each language expressed as a percentage). The second regression model utilized the Compuesto de Razonamiento en Matematicas score as the dependent variable, and the same demographic variables as the first regression model for the independent variables (i.e., with the exception of mothers' proficiency in Spanish). Table 10 displays the results for the English measures and proficiency scores, and Table 11 displays the results for the Spanish measures and proficiency scores.

Results of the first regression model indicate that when combined, mothers' demographic variables do statistically significantly predict children's math performance in English, $F(3,128) = 3.01$, $p = .033$. However, the demographic variables in the model accounted for only 6% of the variance in math scores for child participants. In addition, it should be noted that the individual demographic variables did not uniquely contribute to the prediction of the child participants' math performance in English. Similarly, mothers' combined demographic variables were found to statistically significantly predict the children's math performance in Spanish, but accounted for only 11% of the variance in math scores for child participants, $F(3,128) = 5.14$, $p = .002$. Though neither mothers' years of residence in the U.S. or mothers' proficiency in Spanish were uniquely predictive of the children's math performance in Spanish, a statistically significant result was found for mothers' level of education ($b = 2.2$, $t(1) = 3.74$, $p = .0003$). In addition, the squared semi-partial correlation reveals that the amount of variance accounted for by mothers' level of education was approximately 10% (i.e., .098). Interpretation of these results is described in greater detail and within the context of previous relevant literature in Chapter Five.

Table 2

Means and Standard Deviations for all Math Scores of Complete Data and Missing Data Samples

Variable	*N*	*M*	*SD*
English Applied Problems			
Raw Score[a]	161	9.34	5.06
Standard Score[b]	160	91.28	14.50
W Score[c]	160	394.32	54.23
English Quantitative Concepts			
Raw Score A[d]	163	5.09	2.53
Raw Score B[d]	160	2.17	2.70
Standard Score[b]	162	86.01	21.70
W Score[c]	162	414.54	16.64
Spanish Problemas Aplicados			
Raw Score[a]	174	10.01	4.18
Standard Score[b]	173	90.59	13.85
W Score[c]	173	392.82	26.77
Spanish Conceptos Cuantitativos			
Raw Score A[d]	177	5.93	2.49
Raw Score B[d]	175	1.78	1.93
Standard Score[b]	174	84.20	15.38
W Score[c]	176	427.28	26.84

Note. [a] Range for Applied Problems Raw Scores = 0-63 (i.e., identical for Spanish); [b] Standard scores have a *M* of 100 and an *SD* of 15; [c] W score scale is centered on a value of 500; [d] Range for Quantitative Concepts Raw Score A = 0-34, Raw Score B = 0-23 (i.e., identical for Spanish)

Table 3

Demographic Characteristics and Comparison Data for Categorical Variables

	Analytic Sample		Missing Data Sample			
Variable	*N*	%	*N*	%	X^2	*p*
Child Gender	132	100	50	100.00	1.10	.291
Male	52	39.39	24	48.00		
Female	80	60.61	26	52.00		
County					9.72	.045
A	33	25.00	14	28.00		
B	31	23.48	8	16.00		
C	16	12.12	4	8.00		
D	25	18.94	4	8.00		
E	27	20.45	20	40.00		

Table 4

Demographic Characteristics and Comparison Data for Continuous Variables

	Analytic Sample			Missing Data Sample				
Variable	*N*	*M*	*SD*	*N*	*M*	*SD*	*t*	*p*
Mothers' Level of Education[a]	132	3.71	2.48	50	4.30	2.48	1.43	.15
Mothers' Years of Residence in the U.S.	132	11.59	6.66	44	9.86	6.13	-1.52	.13
Mothers' Proficiency in English[b]	132	39.77	31.19	49	50.85	28.37	2.17	.03
Mothers' Proficiency in Spanish[b]	132	86.11	19.85	47	72.52	19.65	-4.04	<.0001
Income[c]	132	2.03	1.00	50	2.18	1.06	.84	.40

Note. [a] Self-reported mothers' level of education options were as follows: 0=None; 1=Some elementary school; 2=Completed elementary school; 3=Some secondary school; 4=Completed secondary school; 5=GED certificate; 6=Vocational/Trade school; 7=Some community college; 8=Completed two years of community college; 9=Some college/university (not vocational/trade); 10= Completed 4-year college/university; 11=Some graduate level education after college; 12=Completed graduate level education after college.

[b] This number was the composite (i.e., expressed as a percentage) of four items on the parent interview for each language (i.e., wording was identical for both languages): "How well does the mother understand English/Spanish?"; "How well does the mother speak English/Spanish?"; "How well does the mother read English/Spanish?"; "How well does the mother write English/Spanish?"); self-reported answers ranged as follows: 0=Does not understand/speak/read/write; 1=Not very well; 2=Well; 3=Very well; composite responses could range from 0 to 12.

[c] Self-reported income ranged as follows: 1=Less than $10,000; 2=$10,000 – $19,999; 3=$20,000 – $29,999; 4=$30,000 – $39,999; 5=$40,000 – $49,999; 6=$50,000 – $59,999; 7=$60,000 – $69,000.

Table 5

Cronbach's Alpha for Math Standard Scores in English and Spanish (N =132)

Measure	Cronbach's alpha
English Applied Problems Standard Score	.94
nglish Quantitative Concepts Standard Score	.94
English Math Reasoning Cluster Standard Score	.93
Spanish Problemas Aplicados Standard Score	.93
Spanish Conceptos Cuantitativos Standard Score	.95
Spanish Compuesto de Razonamiento en Matematicas Standard Score	.93

Table 6

Cronbach's Alpha for Questions Comprising Mothers' English and Spanish Proficiency Composites (N =132)

Question	Cronbach's alpha
How well does the mother understand English?	.93
How well does the mother speak English?	.93
How well does the mother read English?	.96
How well does the mother write English?	.93
How well does the mother understand Spanish?	.84
How well does the mother speak Spanish?	.75
How well does the mother read Spanish?	.69
How well does the mother write Spanish?	.72

Table 7

Descriptive Statistics for Math Standard Scores in English and Spanish (N = 132)

Measure	*M*	C.I. (95%)	*SD*	Skewness	Kurtosis	Minimum	Maximum
English Applied Problems	91.60	89.2 – 93.99	13.89	-.38	.06	55	119
English Quantitative Concepts	85.86	81.87 – 89.86	23.22	-2.01	6.45	63	136
English Math Reasoning Cluster	84.73	81.35 – 88.11	19.64	-1.14	3.79	56	122
Spanish Problemas Aplicados	92.42	90.27 – 94.56	12.45	-.41	1.38	57	122
Spanish Conceptos Cuantitativos	85.69	83.36 – 88.02	13.52	.30	.03	56	126
Spanish Compuesto de Razonamiento en Matematicas	83.85	80.89 – 86.81	17.18	-.64	.66	37	119

Table 8

Correlation Matrix for Math Standard Scores in English and Spanish (N =132)

	1	2	3	4	5	6
1. English Applied Problems	1.00					
2. English Quantitative Concepts	.56*	1.00				
3. English Math Reasoning Cluster	.88*	.76*	1.00			
4. Spanish Problemas Aplicados	.44*	.40*	.48*	1.00		
5. Spanish Conceptos Cuantitativos	.42*	.44*	.51*	.60*	1.00	
6. Spanish Compuesto de Razonamiento en Matematicas	.44*	.45*	.53*	.92*	.79*	1.00

Note. **p* < .0001

Table 9

Correlation Matrix for Mothers' Demographic Variables and Child Math Cluster Scores (N =132)

	1	2	3	4	5	6
1. Mothers' Level of Education	1.00					
2. Mothers' Years of Residence in U.S.	.055	1.00				
3. Mothers' Proficiency in English[a]	.56***	.38***	1.00			
4. Mothers' Proficiency in Spanish[b]	.14	-.02	.02	1.00		
5. English Math Reasoning Cluster Score	.24**	.048	.20*	.048	1.00	
6. Spanish Compuesto de Razonamiento en Matematicas	.31***	-.09	.09	.04	.53***	1.00

Note. $*p < .05$ $**p < .01$ $***p < .001$

[a] See description listed in Table 4

[b] See description listed in Table 4

Table 10

Model 1—Predictors for English Math Performance (N =132)

Variable	Parameter Estimate	Standard Error	*t*	*p*	Partial R^2
Intercept	76.683	4.119	18.62	<.0001	
Mothers' Years of Residence in the U.S.	.005	.278	.02	.984	.000
Mothers' Education[a]	1.511	.836	1.81	.073	.024
Mothers' Proficiency in English[b]	.060	.072	.83	.408	.005

Note. R-Square = .066; Adjusted R-Square = .044, $F(3,128) = 3.01$, $p = .033$

[a] See description listed in Table 4

[b] See description listed in Table 4

Table 11

Model 2— Predictors for Spanish Math Performance (N =132)

Variable	Parameter Estimate	Standard Error	*t*	*p*	Partial R^2
Intercept	79.173	6.999	11.31	<.0001	
Mothers' Years of Residence in the U.S.	-.279	.216	-1.29	.199	.012
Mothers' Level of Education[a]*	2.187	.584	3.74	.0003	.098
Mothers' Proficiency in Spanish[b]	-.002	.073	-.03	.923	.000

Note. R-Square = .108; Adjusted R-Square = .087, $F(3,128) = 5.14$, $p = .002$

* $b = 2.2$, $t(1) = 3.74$, $p = .0003$

[a] See description listed in Table 4

[b] See description listed in Table 4

Chapter Five: Discussion

The purpose of the current study was to explore the status of early numeracy skills among bilingual Dual Language Learner Latino children attending Head Start programs in Florida. In addition, the current study sought to discover what relationships existed between the child participants' performances in English and Spanish, as well as how selected demographic variables of DLL Latino Head Start children's mothers related to their performance on early numeracy measures. This chapter summarizes the current study's findings regarding these questions, in addition to providing implications for practice in the field of school psychology and directions for future research.

Status of Early Numeracy in Dual Language Learner Latino Head Start Children

This study examined the status of Dual Language Learner (DLL) Latino Head Start children's performance on measures of early numeracy skills in English and in Spanish. Results of the analyses to ascertain how DLL Latino children are performing on early numeracy tasks at the end of their four-year-old Head Start year revealed that these children are performing within the average to low average range, according to age-based norms. However, a critical point should be noted about the child participants' performance in the current study, regarding the comparison of this sample with the national normative samples of the instruments in both English and Spanish. Namely, the normative samples of both the Woodcock Johnson III Tests of Achievement (WJ III ACH; Woodcock, McGrew, & Mather, 2001) and the Batería III Woodcock- Muñoz

Pruebas de Aprovechamiento (Batería III; Muñoz-Sandoval, McGrew, & Mather, 2004) are based on monolingual subjects. In contrast, the sample for the current study was comprised of bilingual DLL Latino children attending Head Start programs. In addition, these DLL Latino children come from families with lower income and socioeconomic statuses (i.e., students were attending Head Start programs, which primarily serve low-income families; National Head Start Association, 2009). Thus, DLL Latino children may have limited access to resources which can provide an academically enriching environment in the home (Hammer, Miccio, & Wagstaff, 2003). Given these conditions, the child participants' performance on the early numeracy tasks presented in the current study are performing relatively well, and scores should be interpreted within this context. It should be noted that in order for children's functioning to be considered within the average range on the math tests of the WJ III ACH, a four-year-old child would need to demonstrate understanding of basic number concepts (i.e., counting principles, naming and recognizing numerical symbols and shapes, quantity discrimination). Thus, the child participants included in the study are demonstrating that they have acquired several of the skills delineated by researchers as essential for number sense (Baroody, Eiland, & Thompson, 2009).

The DLL Latino children attending Head Start in the current study performed within the average range on the Applied Problems test in English and the Problemas Aplicados test in Spanish. The Applied Problems and Problemas Aplicados tests measure the ability to apply knowledge of numerical relationships in order to solve problems presented in a story format. The DLL Latino Head Start children's scores indicate that they were able to successfully utilize the concrete visual representations of the items in this test to help them solve the problems, which suggests that they understand several prerequisite counting principles represented on the math tests of the WJ III ACH (e.g., one-to-one, cardinality, abstraction, order-irrelevance; Gellman & Gallistel, 1978). Additionally, the application of these counting principles to correctly answer problems that require calculation suggests that the child participants' calculation skills are age appropriate and are following the progression outlined by researchers regarding the increasing complexity of understanding relationships among numbers and their utility (Carpenter & Moser, 1982; Cross, Woods, & Schweingruber, 2009).

These findings are supported by Hughes (1981), who found that when simple story problems (i.e., similar to the ones presented on the WJ III ACH Applied Problems test) containing smaller numbers (i.e., up to three) and visual representations to aid the children in comprehending the task were presented to a sample of 60 children between three and five years of age, the children included in the study were able to successfully solve these problems. Even though more recent research with a similar population to that of the current study found that DLL Latino preschool-aged children are performing below the national average on the Applied Problems test in English (i.e., 675 four-year-old child participants were included in the study; Xue, Atkins-Burnett, & Moiduddin, 2012), the current study's findings suggest that DLL Latino children attending Head Start programs are demonstrating skills on the Applied Problems test that are commensurate with national age-based monolingual norms in English and Spanish. It is possible that factors such as larger sample size and different geographical location (i.e., the aforementioned study was conducted in Los Angeles, California) may contribute to the explanation for the discrepancy between the current study's findings and those obtained by Xue, Atkins-

Burnett, and Moiduddin (2012).

In addition, the DLL Latino child participants' scores on the Quantitative Concepts test in English and the Conceptos Cuantitativos test in Spanish suggest that their performance fell within the low average range relative to same-aged monolingual peers in the national normative sample. The Quantitative Concepts/Conceptos Cuantitativos tests measure one's ability to identify mathematical and numerical symbols, as well as utilize pattern reasoning to identify a missing numeral in a series. These findings suggest that DLL Latino Head Start children are demonstrating some difficulty with providing correct responses to items related to the names of numbers or symbols. As outlined by Mix, Huttenlocher, and Levine (2002), children begin to identify and recognize number symbols up to number 10 by age four; however, this may be heavily influenced by the amount of exposure to numerical symbols and practice in the environment that is received. Another possible explanation for DLL Latino child participants' low average scores on the Quantitative Concepts and Conceptos Cuantitativos tests may be related to retrieval of learned knowledge. Bisanz, Sherman, Rasmussen, and Ho (2005) indicate that retrieval is a vital component of being able to identify symbols and solve problems, and it is a later step in the progression of number sense (i.e., requiring prerequisite skills of counting and calculation to be obtained prior to its successful utilization). However, without individual item analysis, no definite conclusions can be drawn regarding the child participants' retrieval capacities.

Lastly, the DLL Latino Head Start children's Math Reasoning cluster scores in English and Compuesto de Razonamiento en Matematicas scores in Spanish also fell within the low average range compared to same-aged monolingual peers in the national normative sample. These cluster scores combine the Applied Problems with Quantitative Concepts in English and the Problemas Aplicados with the Conceptos Cuantitativos in Spanish to represent the overall mathematical reasoning abilities of the DLL Latino child participants in each language (i.e., the cluster scores were chosen to be representative of the child participants' math performance, given strong correlations between individual test scores and cluster scores in each language ranging from .76 to .92, $p < .0001$). Given the child participants' average to low average performance on early numeracy tasks when compared to monolingual peers in each language, the data suggest that DLL Latino children attending Head Start programs are performing close to expected levels in the area of mathematics. This finding is an important addition to the scarce literature which exists regarding DLL Latino children's actual early numeracy skills.

Relationships and Differences in DLL Latino Head Start Children's Math Performance

The next set of analyses pertained to the examination of possible connections between the child participants' math scores in English and Spanish. Correlations conducted in order to answer the question of whether relationships exist between the child participants' early numeracy skills in English and Spanish revealed that overall, the standard scores for each math test in each language were related to some degree. Specifically, the individual test standard scores in English had small correlations with the same tests in Spanish (i.e., correlations ranged from .40 to .44, $p < .0001$). In addition, The English Math Reasoning cluster score had a moderate correlation with the Compuesto de Razonamiento en Matematicas score in Spanish ($r = .53$, $p < .0001$). It should be noted that although small to moderate correlations were found between the child participants' early numeracy performance in English and Spanish within the current study, these correlations across the two languages are relatively high when compared to negative correlations that have been observed between measures of vocabulary in English and Spanish for four-year-old DLL Latino children in previous research (Tabors, Páez, & López, 2003).

The fact that the measures in English were correlated with the measures in Spanish provides evidence of concurrent validity, indicating that they are both measuring the same early numeracy skills in each language. Similarly, Rosenthal, Baker, and Ginsburg (1983) noted in their study of over 12,000 students between first and sixth grades that the mean difference between performance on math tasks in English and Spanish was not significant. In other words, the authors of this study found that the math achievement of Spanish-language background participants as measured by scores on the Comprehensive Test of Basic Skills (CTBS) did not significantly differ from the scores of their English-only counterparts within the study (i.e., according to study authors, it seemed that the included language-minority students within the study were able to comprehend the math tasks on the CTBS even with poor English fluency).

Additionally, the fact that DLL Latino Head Start children's early numeracy skills in English were moderately correlated to their skills in Spanish may provide some support for the notion of mathematics skills transcending the constraints of language structure, as posited by Klein and Starkey (1988). The fact that the child participants' performance in English and Spanish was related seems to substantiate the theorized universality of the concepts underlying the math items, regardless of language of presentation (Klein & Starkey, 1988). In addition, comprehension of numeracy is related to cognitive skills which are not language dependent. Thus, these findings are suggestive of the cross-language transfer of numeracy skills between English and Spanish. Previous research has shown that cross-language transfer has been demonstrated for aspects of language, such as literacy and phonological awareness skills (Durgunoglu, 2002; Dickinson, McCabe, Clark-Chiarelli, & Wolf, 2004).

Currently, no studies have been found regarding the cross-language transfer of early numeracy skills in Dual Language Learners, making this study an important addition to the literature (i.e., adding support for the notion that early numeracy skills may be able to transcend the structural boundaries of language). It should be noted that the correlation observed between the cluster scores in English and Spanish may have been moderate and not large because of the DLL Latino Head Start child participants' ages (i.e., given that these child participants are quite young, it is possible that they have not yet experienced full transfer of skills from one language to another). These findings also highlight the importance of assessing DLL Latino children in both of the languages to which they are exposed in order to obtain a more holistic picture of their actual abilities (McCardle, McCarthy & Leos, 2005).

In addition to exploring the relationships between the child participants' math performance, the current study also examined possible differences between DLL Latino Head Start children's early numeracy skills in English and Spanish. Results of a dependent means t-test revealed that no statistically significant difference existed between the child participants' performance on the early numeracy measures in English and Spanish. Based on these findings, the bilingualism of the DLL Latino Head Start children included in this study did not seem to negatively affect their performance on early numeracy tasks.

The current study's findings are consistent with the theoretical framework chosen for bilingualism (Cummins, 1977; 1984). Namely, child participants in the current study's sample performed relatively well (i.e., within the average to low average range on standardized tests of math achievement) in English and Spanish. Thus, the findings suggest that the child participants' bilingualism may have positively contributed to their performance on the early numeracy tasks, since Cummins notes that bilingual individuals who are strong in both languages demonstrate better performance on cognitive tasks and bilingual individuals who are dominant in one language do not incur negative effects on their cognitive abilities. However, the findings seem to contrast the previous, albeit limited literature that suggests bilingualism may have a negative impact on math performance in DLL students (De Avila & Duncan, 1979; Myers & Milne, 1988). It should be noted that these studies utilized older participants (i.e., De Avila and Duncan's sample consisted of 903 students in kindergarten through sixth grade; Myers and Milne's study utilized data on 28,000 high school students). In addition, the design of De Avila and Duncan's study (1979) was correlational, meaning that conclusions regarding the impact of bilingualism on mathematics could not be drawn. To date, no research has been found which has examined the differences that may exist between DLL Latino preschool-aged children's performance in English and Spanish on math related tasks. Thus, this finding is a very important addition to the scarce literature that exists on the topic of early numeracy of preschool-aged children.

Predictors of DLL Latino Head Start Children's Math Performance

Significant correlations suggested that the predictor variables chosen for the current study (i.e., mothers' level of education, mothers' years of residence in the U.S., mothers' proficiency in English, mothers' proficiency in Spanish) are related to the dependent variable of DLL Latino Head Start children's performance on early numeracy measures in some ways. Subsequently, two multiple regressions were conducted. Results of the first multiple regression model revealed that when combined, mothers' demographic variables did serve as statistically significant predictors of the child participants' early numeracy performance in English. However, only a very small proportion of the variance was explained by this regression model and the combination of mothers' demographic variables, suggesting that there may be other contributing factors which were not measured by this model. In addition, no individual variable included in the regression model uniquely contributed to the prediction of DLL Latino Head Start children's performance in English.

Additionally, the second multiple regression model revealed that mothers' demographic variables served as statistically significant predictors of the child participants' performance on early numeracy tasks in Spanish when combined. Similarly to the results for English performance, only a small amount of the variance was explained by this model as well, suggesting that other factors may be contributing to the prediction of these children's performance in Spanish. Also notable is that although mothers' years of residence in the U.S. and proficiency in Spanish did not uniquely contribute to the prediction of child participants' performance on the Compuesto de Razonamiento en Matematicas score, a statistically significant result was found for mothers' level of education. In other words, mothers' level of education uniquely contributed to the prediction of child participants' cluster scores in Spanish, and a positive relationship was revealed (i.e., as mothers' level of education increased, so did the children's early numeracy scores in Spanish).

Although there is currently no direct comparison in the previous literature, the current study's findings do seem to corroborate aspects of studies which were conducted using similar demographic variables. For instance, the finding that mothers' level of education did serve as a unique predictor of children's early numeracy scores in Spanish seems to contribute support for the notion of maternal education as an important factor in the development of young children (Dollaghan, et al., 1999; Lee, 2010). Additionally, previous research related to parental years of residence in the U.S. has examined relationships with different aspects of children's development, such as expectations for academic success (Goldenberg, Gallimore, Reese, & Garnier, 2001) and adoption of new values and norms in a place different from their country of origin (Weisskirch & Alva, 2002). Thus, this study represents a unique contribution to the literature regarding the relationship between mothers' demographic variables and DLL Latino Head Start children's early numeracy performance. Specifically, mothers' demographic variables were not a strong predictor of the DLL Latino Head Start children's early numeracy outcomes. This suggests that there are other factors contributing to DLL Latino Head Start children's learning of numerical concepts and math performance. These findings are promising, since they provide support for the notion that family demographic variables are only one small factor in DLL Latino Head Start children's potential to demonstrate school readiness in the area of mathematics when they begin school.

Practical Implications for School Psychologists

The current study provides several implications for practitioners in the field of school psychology. One implication based on the current study's findings is for school psychologists to promote awareness of Dual Language Learner Latino preschool-aged children's skills in early numeracy. Given the fact that DLL Latino children who attend Head Start programs are exposed to two languages and often come from families of low socioeconomic status (SES), there is often an assumption that these children will not perform as well as their higher SES, monolingual peers. The current study provides evidence that DLL Latino children attending Head Start programs in fact are performing close to expected levels for their age range, despite being compared to national norms comprised of monolingual peers in English and Spanish. Thus, school psychologists should utilize this study's findings to inform relevant personnel (e.g., teachers, school administrators) of DLL Latino children's early numeracy skills in order to avoid biased assumptions of these children's skills.

Additionally, school psychologists can utilize this study's findings to review curricula being used in Head Start classrooms to ensure that a strong core curriculum is being implemented for DLL Latino children attending these programs. Specifically, school psychologists could review curricula for inclusion of lessons and activities designed to teach and reinforce critical early numeracy skills (e.g., the counting principles, simple calculation skills, identification and recognition of numerical symbols) in order to facilitate DLL Latino children's academic growth in mathematics. This can help to promote the enhancement of their existing early numeracy skills and continue to support their academic achievement.

In addition, this study found that mothers' individual demographic variables did not uniquely contribute to the prediction of DLL Latino Head Start children's early numeracy skills in English, and that only mothers' level of education uniquely contributed to the child participants' early numeracy skills in Spanish. The current study's findings are consistent with previous literature that suggests continuing to utilize home language (Bialystok, 1999; Cummins, 1977) and fostering a culturally sensitive learning environment, which promotes rather than deters use of the home language (Brisk, 2005) may be beneficial to DLL Latino children. As such, school psychologists could communicate to parents of these DLL Latino children that continuing to teach their children mathematics skills in their home language is not detrimental to their performance in English, since the primary investigator of the current study hypothesizes that these skills seemed to transfer between the two languages As such, school psychologists could collaborate with teachers in order to review and send home materials which target specific and age appropriate early numeracy skills (i.e., counting, simple calculation, identification and recognition of numerical symbols and concepts) that would allow families to reinforce early numeracy skills at home in both languages (i.e., by providing materials with both English and Spanish directions and visual representations). In this way, school psychologists might help to highlight the importance of the reinforcement of early numeracy skills through both carefully selected classroom curricula and continuous practice in the home environment.

Contributions to the Literature

The current study's findings are an important addition to the scarce literature related to Dual Language Learners and early numeracy in several ways. First, the study provided data regarding the current status of early numeracy skills in English and Spanish for preschool-aged DLL Latino children and the relationship between their performance in each language, which was previously an area with very limited research. In addition, findings from this study provide a point of origin from which to design, implement, and test core curricula that will foster these children's existing early numeracy skills and assist DLL Latino Head Start children to continue to demonstrate performance that is consistent with expected levels as they continue their academic career. Specifically, understanding that DLL Latino Head Start children are performing close to expected levels for their age range with regard to age appropriate math skills such as counting, simple numerical relationships among objects, and identification/ recognition of mathematic symbols can direct relevant school personnel (e.g., teachers, school psychologists, administrators) to ensure that the means by which these children are taught mathematics both reinforce and enhance these skills. In other words, knowing which early numeracy skills DLL Latino children already understand when entering school can serve as a guide for where to place focus regarding instruction and progression of mathematics knowledge.

Secondly, the current study provided findings that explored the relationship between parent demographic characteristics and DLL Latino Head Start children's performance on math related tasks, and is the first of its kind to examine these variables related specifically to preschool-aged DLL Latino children. Understanding how mothers' demographic variables were related to DLL Latino children's early numeracy skills imparts knowledge that can be used to extend research in this area, as well as promote awareness of these children's performance comparative to monolingual peers.

Specifically, the current study revealed that mothers' demographic variables did not strongly predict DLL Latino Head Start children's math performance. This information is important to share with educational professionals in order to facilitate accurate decisions regarding curricula and assessment of DLL Latino Head Start children's math skills.

Delimitations and Limitations

The sample utilized for the current study included Dual Language Learner Latino children attending Head Start programs at the end of their four-year-old year, from five counties around the state of Florida. In addition, the child participants' mothers were included in the current study, by way of selected demographic variables. As such, the study's findings can be generalized to be representative of bilingual DLL Latino preschool-aged children currently attending Head Start programs in Florida, who are from low socioeconomic backgrounds. However, the findings also suggest that results may not be applicable to higher income families, monolingual preschool-aged children, or children of preschool-age who do not attend any academic programs prior to entering kindergarten, thereby also making the limited generalizability of the sample a limitation. In addition, the findings may also fail to generalize to DLL Latino children of this age in other states, or DLL children and their families who speak a second language other than Spanish. It should also be noted that females were overrepresented in the analytic sample of child participants utilized for this study (i.e., at a 60/40 ratio with male child participants).

Another limitation is that this was a non-experimental study, and as such, no conclusions can be drawn regarding the observed relationships among the variables which were examined. Additionally, the exploration of parent characteristics was limited to certain demographic variables of mothers. This study did not take into account the possible impact of fathers' demographic variables or any other caretakers that may have an influence on DLL Latino children's early numeracy skills. Similarly, no other facets of parents' contributions were examined in the current study (e.g., parent involvement, home practices related to early numeracy). Thus, there is a limited amount of data regarding how parents' characteristics may be related to academic achievement of preschool-aged children, specifically in the area of mathematics.

Yet another limitation pertains to the assessment tools used to examine DLL Latino Head Start children's early numeracy skills. Specifically, the normative sample from the Woodcock Johnson III Tests of Academic Achievement (Woodcock, McGrew, & Mather, 2001) and the Batería III Woodcock- Muñoz Pruebas de Aprovechamiento (Muñoz-Sandoval, McGrew, & Mather, 2004) included monolingual subjects in each language (i.e., English and Spanish, respectively) to comprise the national normative samples of each assessment battery. Thus, the child participants included in the current study were not assessed with instruments using a truly comparative population. However, it should be noted that this method (i.e., assessing bilingual DLL Latino children in English and Spanish compared to monolingual peers) is currently the best available, since bilingual norms are difficult to create and do not yet exist for valid, reliable instruments in order to assess DLL subjects.

Finally, the fact that mothers' proficiency in English and proficiency in Spanish within the final sample for the current study were significantly different from one another is a limitation. Specifically, it is possible that the low reported English proficiency and higher reported Spanish proficiency may have affected the way that mothers' language proficiency in English and Spanish was related to the child participants' early numeracy performance, as well as the amount of variance that proficiency in English and Spanish accounted for in the regression analyses.

Future Directions

There are many areas in which research related to the topics explored within the current study can be conducted. Several factors which were not addressed by the current study and which may provide further information regarding the way that preschool-aged children's early numeracy skills are related to or impacted by their dual language status merit exploration. First, more research with this population (i.e., Dual Language Learner Latino preschool-aged children) is needed, since this continues to be an area of scarce literature. More studies examining DLL Latino children's academic skills and the factors that contribute to these schools are warranted. Additionally, a longitudinal design would allow for examination of growth and/or regression in early numeracy skills, in comparison to the children's growing and/or deteriorating proficiency in English and Spanish. In other words, examining children's performance on early numeracy tasks over time and comparing that performance to their level of English and Spanish proficiency would allow for exploration of the relationship between math skills and the impact of language abilities on those skills. Of particular interest would be to conduct these comparisons utilizing instruments with sensitivity to incremental growth, such as curriculum-based measurement (Shapiro, 2004).

An additional area that would benefit from further research would be to examine the impact of home practices that may foster the enhancement of early numeracy skills in DLL Latino preschool-aged children. Specifically, exploring activities that families engage in within the home environment which may promote number sense (e.g., counting, number games, teaching quantities with manipulatives) may assist researchers in discovering whether the presence of these practices is related to and/or impacts DLL Latino preschool children's performance on early numeracy tasks.

Summary

The current study sought to answer questions related to early numeracy in Dual Language Learner Latino children, the relationships between these children's performance in English and Spanish, and the possible relationships between parent demographic variables and these children's math achievement. Findings indicated that DLL Latino children attending Head Start at the end of their four-year-old year are performing within average to low average range in comparison to monolingual peers in English and Spanish. In addition, small to moderate correlations were found for their performance on early numeracy tasks in English and Spanish. Demographic variables, including mothers' years of residence in the U.S., mothers' language proficiency in English and Spanish, and mothers' level of education were found to serve as statistically significant predictors of performance for these children in both languages when combined; however, individually, only level of education uniquely contributed to the prediction of DLL Latino children's performance on early numeracy tasks presented in Spanish.

These findings represent a significant addition to the scarce literature that exists related to early numeracy in Dual Language Learner Latino children, particularly those of preschool-age. More research is needed to discover the degree to which the current study's findings are representative of the skills of these DLL Latino children and what other factors may be implicated in their academic achievement as it relates to early numeracy. Additionally, an examination of other parent demographic variables that may contribute to DLL Latino children's mathematics achievement can help to increase knowledge regarding these children's abilities. This in turn can inform efforts to assist DLL Latino children to continue building upon their existing skills in early numeracy as they continue their academic careers.

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Appendices

Appendix A: USF IRB Approval

USF
UNIVERSITY OF SOUTH FLORIDA

DIVISION OF RESEARCH INTEGRITY AND COMPLIANCE
Institutional Review Boards, FWA No. 00001669
12901 Bruce B. Downs Blvd., MDC035 • Tampa, FL 33612-4799
(813) 974-5638 • FAX (813) 974-5618

February 8, 2012

Chavely Iglesias
Psychological and Social Foundations

RE: **Expedited Approval** for Initial Review
IRB#: Pro00007014
Title: Investigating the Status of Early Numeracy Skills in Bilingual Dual Language Learner Latino Children Attending Head Start and the Association with Parent Demographic Characteristics

Dear Chavely Iglesias:

On 2/8/2012 the Institutional Review Board (IRB) reviewed and **APPROVED** the above referenced protocol**.** Please note that your approval for this study will expire on 2/8/2013.

Approved Items:
Protocol Document(s):

Iglesias_COMPLETE_01.15.doc	1/23/2012 3:09 PM	0.01

Study involves children data and falls under 45 CFR 46.404:
Research not involving more than minimal risk

Consent/Assent Documents:

Name	Modified	Version

Waiver of Informed Consent Process

It was the determination of the IRB that your study qualified for expedited review which includes activities that (1) present no more than minimal risk to human subjects, and (2) involve only procedures listed in one or more of the categories outlined below. The IRB may review research through the expedited review procedure authorized by 45CFR46.110 and 21 CFR 56.110. The research proposed in this study is categorized under the following expedited review category:

(7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Your study qualifies for a waiver of the requirements for informed consent as outlined in the federal regulations at 45CFR46.116 (d) which states that an IRB may approve a consent procedure which does not include, or which alters, some or all of the elements of informed consent, or waive the requirements to obtain informed consent provided the IRB finds and documents that (1) the research involves no more than minimal risk to the subjects; (2) the waiver or alteration will not adversely affect the rights and welfare of the subjects; (3) the research could not practicably be carried out without the waiver or alteration; and (4) whenever appropriate, the subjects will be provided with additional pertinent information after participation.

As the principal investigator of this study, it is your responsibility to conduct this study in accordance with IRB policies and procedures and as approved by the IRB. Any changes to the approved research must be submitted to the IRB for review and approval by an amendment.

We appreciate your dedication to the ethical conduct of human subject research at the University of South Florida and your continued commitment to human research protections. If you have any questions regarding this matter, please call 813-974-5638.

Sincerely,

John A. Schinka, Ph.D.

John Schinka, PhD, Chairperson
USF Institutional Review Board

Cc: Various Menzel, CCRP
USF IRB Professional Staff

Appendix B: FELLA-HS Parent Interview

FELLA-HS YEAR 1 PARENT INTERVIEW RESPONSE SHEET

DURING THE INTERVIEW INSERT THE NAME OF THE CHILD for (child) below.

Last Name: ______________________________

First Name: ______________________________

Date: ____________________________________

Child ID:
⓪⓪⓪⓪ ①①①① ②②②② ③③③③ ④④④④ ⑤⑤⑤⑤ ⑥⑥⑥⑥ ⑦⑦⑦⑦ ⑧⑧⑧⑧ ⑨⑨⑨⑨

1) What is your relationship to (child)?

O Mother
O Father
O Step-mother
O Step-father
O Grandmother
O Grandfather
O Aunt
O Uncle
O Other – please specify:________________

I would like to ask you a few general questions about (child) that will help us understand more about the kinds of students participating in this project.

2) What is (child's) birth date? (confirm with cover page)

Month	Day	Year
⓪⓪ ①① ②② ③③ ④④ ⑤⑤ ⑥⑥ ⑦⑦ ⑧⑧ ⑨⑨	⓪⓪ ①① ②② ③③ ④④ ⑤⑤ ⑥⑥ ⑦⑦ ⑧⑧ ⑨⑨	⓪⓪ ①① ②② ③③ ④④ ⑤⑤ ⑥⑥ ⑦⑦ ⑧⑧ ⑨⑨

3) How would you classify (child's) ethnicity? *List options if needed.*

O White (not of Hispanic Origin)
O Black (not of Hispanic Origin)
O Hispanic
O American Indian or Alaska Native
O Asian or Pacific Islander
O Other
O Unknown

4) What country was (child) born in? ***List options if needed.***

O United States or U.S. Territory (NOT Puerto Rico)
O Puerto Rico
O Colombia
O Cuba
O Dominican Republic
O Ecuador
O El Salvador
O Guatemala
O Nicaragua
O Honduras
O Mexico
O Peru
O Spain
O Other country: _____________

Ask only if the child was born outside the United States or in Puerto Rico.

5) How old was (child) when s/he first came to the United States?

O Less than 1 year old
O 1 year old
O 2 years old
O 3 years old
O 4 years old

6) Who is the adult FEMALE HEAD of your household? *List options if needed.*

O the child's mother
O the child's stepmother
O other (e.g. girlfriend, grandmother) print title here: ________________________
O there currently is no female head of this household

7) Does this person live in your household at this moment?

O Yes
O No

8) Who is the adult MALE HEAD of your household? *List options if needed.*

O the child's father
O the child's stepfather
O other (e.g. boyfriend, grandfather) print title here: ________________________
O there currently is no male head of this household

9) Does this person live in your household at this moment?
O Yes
O No

In the rest of this survey the terms MOTHER and FATHER should be replaced with the title of the person reported to be the FEMALE and MALE HEADS OF HOUSEHOLD in questions #12 and #13 above.

If the person being interviewed is *one of the HEADS of household ask the questions for that individual using YOU and YOUR instead of the title.*

If there is currently no FEMALE or MALE head in this child's household skip the questions asked about that individual.

The next few questions I will be asking are about the home/household that (child) lives in.

If the person you are speaking to is the mother or father or someone who lives in The home with the child ask about "your home instead of the child's home.

10) How many people - including all children and adults - live in your home?
① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ O Other _______

11) How many children - under 18 - live in your home?
① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ O Other _______

The next few questions I am going to ask are about activities AT HOME. *List options if needed.*

12) How many books for adults are there in your home?
O None
O 1- 10
O 11-20
O 21-30
O 31-40
O 41- 50
O More than 50

13) How many books for children are there in your home?

O None
O 1- 10
O 11-20
O 21-30
O 31-40
O 41- 50
O More than 50

14) What language are the books in?
O Only Spanish
O Mostly Spanish
O English and Spanish equally
O Mostly English
O Only English

15) How often does an adult/older sibling read or look at books with (child) *IN SPANISH (related to school work)*?
O Daily
O 1-2 times a week
O 2-3 times a month
O Once a month
O Almost never

16) How often does an adult/older sibling read or look at books with (child) *IN SPANISH (not related to school work)*?
O Daily
O 1-2 times a week
O 2-3 times a month
O Once a month
O Almost never

17) How often does an adult/older sibling read or look at books with (child) *IN ENGLISH (related to school work)*?
O Daily
O 1-2 times a week
O 2-3 times a month
O Once a month
O Almost never

18) How often does an adult/older sibling read or look at books with (child) *IN ENGLISH (not related to school work)*?
O Daily
O 1-2 times a week
O 2-3 times a month
O Once a month
O Almost never

19) How often does someone take (child) to the library?

O Daily
O 1-2 times a week
O 2-3 times a month
O Once a month
O Almost never

20) How often does the child look at books at home on their own?

O Daily
O 1-2 times a week
O 2-3 times a month
O Once a month
O Almost never

21) Is there a computer at home that (child) can use?

O Yes
O No

22) *If the answer to question 21 is yes ask,* **How many hours does (child) spend on the computer daily?**

O child does not use the computer
O less than one hour
O 1 to 2 hours
O 2 to 3 hours
O 3 to 4 hours
O more than 4 hours

23) *If child uses the computer***, What does (child) use the computer for?**

O Entertainment purposes only
O Mostly for entertainment purposes
O Entertainment and education purposes equally
O Mostly for education purposes
O Educational purposes only

24) How often does the child or a sibling serve as a translator at home?

O Daily
O Once a week
O Sometimes
O Never
O N/A – family speaks English

25) Do you or anyone else read any of the following with the child? *Mark all that apply.*

O FUNNIES

- O CATALOGUES (like toy catalogues or other)
- O CHILDREN'S MAGAZINES
- O NEWPAPERS
- O BIBLE OR OTHER RELIGIOUS MATERIAL
- O CEREAL PACKAGES
- O OTHER_______________________________

26) Which of the following have you taught your child?

	Spanish	English
Letters	O	O
Numbers	O	O
Colors	O	O
Shapes	O	O
Reading	O	O
How books work	O	O
How to behave	O	O
How to complete tasks	O	O
Other _____________	O	O

Ask only if there is a FEMALE head of household currently in the home..

27) What language does the *MOTHER* use when she speaks to (child)?

O Only Spanish
O Mostly Spanish
O Mostly English
O Only English
O English and Spanish equally
O Does not apply

Ask only if there is a MALE head of household currently in the home.

28) What language does the *FATHER* use when he speaks to (child)?

O Only Spanish
O Mostly Spanish
O Mostly English
O Only English
O English and Spanish equally
O Does not apply

29) What language do other adults (aside from the mother and father) use when they speak to (child)?

O Only Spanish
O Mostly Spanish
O Mostly English
O Only English
O English and Spanish equally
O Does not apply

30) What language do children in this household use when they speak to (child)?

O Only Spanish
O Mostly Spanish
O Mostly English
O Only English
O English and Spanish equally
O Does not apply

Ask only if there is a FEMALE head of household currently in the home.

31) What language does (child) use when s/he speaks to his/her *MOTHER* at home?

O Only Spanish
O Mostly Spanish
O Mostly English
O Only English
O English and Spanish equally
O Does not apply

Ask only if there is a MALE head of household currently in the home..

32) What language does (child) use when s/he speaks to his/her *FATHER* at home?

O Only Spanish
O Mostly Spanish
O Mostly English
O Only English
O English and Spanish equally
O Does not apply

33) What language does (child) use when s/he speaks to other adults (not the mother or father) in the household?

O Only Spanish
O Mostly Spanish
O Mostly English
O Only English
O English and Spanish equally
O Does not apply

34) What language does (child) use when s/he speaks to other children at home?

O Only Spanish
O Mostly Spanish
O Mostly English
O Only English
O English and Spanish equally
O Does not apply

35) What language does (child) use when s/he speaks to his/her friends outside of the home?

O Only Spanish
O Mostly Spanish
O Mostly English
O Only English
O English and Spanish equally
O Does not apply

36) What is your favorite family time activity?

____

37) How often does your family take part in this activity?

O Daily
O 1-2 times a week
O 2-3 times a month
O Once a month
O Almost never

38) Do you eat any meals together as a family?

O yes
O no

39) If the answer is yes, **Which meal?**

O breakfast
O lunch
O dinner

40) How often?

O daily
O 2-3 times a week
O once a week
O 2-3 times a month
O monthly

The next few questions I am going to ask are about (child's) SCHOOLING last year

41) At what age did the child begin attending day care/ Head Start?

O Less than one-year-old
O 1 year-old
O 2-years-old
O 3-years-old
O 4 years-old

42) Fill in the corresponding bubbles for each year of day care/ Head Start the child attended.

	0-1 year-old	1-2 year-old	2-3 year-old	3-4 year-old	4-5 year-old	5-6 year-old
Attended	O	O	O	O	O	O
9-month	O	O	O	O	O	O
12- month	O	O	O	O	O	O
Part-time	O	O	O	O	O	O
Full-time	O	O	O	O	O	O
English	O	O	O	O	O	O
Spanish	O	O	O	O	O	O
U.S.	O	O	O	O	O	O
Other	O	O	O	O	O	O

43) If child attended school outside of the US, where was (child) in school?

O Puerto Rico
O Colombia
O Cuba
O Dominican Republic
O Ecuador
O El Salvador
O Guatemala
O Nicaragua
O Honduras
O Mexico
O Peru
O Spain
O Other country: _____________

What activities are you involved in at the child's school?

44) Doing work at home to help the teachers (e.g. making snacks, helping with a special activity, or other classroom-related work)	○ ALMOST EVERY DAY ○ 1-2 DAYS A WEEK ○ 2-3 TIMES A MONTH ○ ONCE A MONTH ○ ALMOST NEVER
45) Visiting and helping in the classroom, doing a cultural or other special activity in the classroom	○ ALMOST EVERY DAY ○ 1-2 DAYS A WEEK ○ 2-3 TIMES A MONTH ○ ONCE A MONTH ○ ALMOST NEVER
46) Attending parent meetings, teacher conferences, or special celebrations	○ ALMOST EVERY DAY ○ 1-2 DAYS A WEEK ○ 2-3 TIMES A MONTH ○ ONCE A MONTH ○ ALMOST NEVER
47) Taking a leadership role (e.g. Parent council, class parent)	○ ALMOST EVERY DAY ○ 1-2 DAYS A WEEK ○ 2-3 TIMES A MONTH ○ ONCE A MONTH ○ ALMOST NEVER

48) Has there been any change in the language your child prefers to speak at home since (child) started Head Start?

- ○ Yes
- ○ No

49) If yes, **What has this change been?** (Mark all that apply)

- ○ More English
- ○ Less English
- ○ More Spanish
- ○ Less Spanish

50) Do you participate in community organizations and/ or events with (child)?

- ○ yes
- ○ no

51) If yes, **Which ones?** (Mark all that apply)

- ○ boys and girls club/ ymca
- ○ church groups/ event
- ○ library events
- ○ festivals

○ fairs
○ Gymboree/ My gym/ etc.
○ Other: ________________

52) Which extracurricular activities does (child) participate in?

○ sports (baseball, basketball, football, soccer, etc.)
○ dance (ballet, jazz, tap, cheerleading, etc.)
○ Martial Arts (karate, tae kwon do, etc.)
○ other (__________________________)
○ N/A

53) What school/program is your child attending next year?

○ Don't know
○ public (Name: ______________________)
○ private (Name: ______________________)
○ parochial (Name: ______________________)

Program Type:
○ regular (English mainstream)
○ bilingual
○ two-way
○ other_____________

In this part of the survey the term MOTHER should be replaced with the title of the person reported to be the FEMALE HEAD OF HOUSEHOLD in questions #10 above.

If the person being interviewed is *the FEMALE HEAD OF HOUSEHOLD ask the questions using YOU and YOUR instead of a title.*

If there is currently no FEMALE HEAD OF HOUSEHOLD in this child's home, Skip these questions and go to question #43.

The next set of questions I will be asking you are about the "MOTHER" (ADULT FEMALE HEAD OF HOUSEHOLD from question #10).

54) In what country or U.S. territory (for example, Puerto Rico) was the *MOTHER* born?

O United States or U.S. Territory (NOT Puerto Rico)
O Puerto Rico
O Colombia
O Cuba
O Dominican Republic
O Ecuador
O El Salvador
O Guatemala

O Nicaragua
O Honduras
O Mexico
O Peru
O Spain
O Other country: ____________

55) Did the MOTHER live in the countryside (rural) or in a city (urban)?
O rural
O urban

Ask only if the mother was born outside the United States or in Puerto Rico.

56) How old was she when she first came to the United States?	**57) How many years has she been in the U.S.?**
⓪⓪ ①① ②② ③③ ④④ ⑤⑤ ⑥⑥ ⑦⑦ ⑧⑧ ⑨⑨	⓪⓪ ①① ②② ③③ ④④ ⑤⑤ ⑥⑥ ⑦⑦ ⑧⑧ ⑨⑨

58) How often does the *MOTHER* read a book, magazine, or newspaper?
O Not at all
O Once or twice a month
O Almost every day
O Less than once a month
O Once or twice a week
O More than once a day

Ask only if the mother reads ……
59) In what language does the *MOTHER* typically read?

O Only Spanish
O Mostly Spanish

O English and Spanish equally
O Mostly English
O Only English
O Does not apply

60) If the MOTHER does not read in English, who reads or translates documents written in English for her?

O Spouse
O Other adult
O Child -Girl - child is _____ years-old
O Child -Boy - child is _____ years-old
O Nobody

61) What is the highest level of schooling the *MOTHER* has completed?

O None
O Some elementary school (*primaria*) (Grades 1-6)
O Completed elementary school (*primaria*) (to Grade 6)
O Some secondary school (*secundaria and/or preparatoria*) (Grades 7-12)
O Completed secondary school (*secundaria and/or preparatoria*) (to Grade 12)
O GED Certificate
O Vocational/trade school *(formación técnica/vocacional, no universitaria)*
O Some community college
O Completed 2 years of community college
O Some college or university, not vocational school or trade school (*universidad*)
O Completed 4-year college or university (*universidad*) or *licenciatura*
O Some graduate level education after college (*maestría o doctorado*)
O Completed graduate level education after college (*maestría o doctora*

62) Overall, how many total years of formal education has the *MOTHER* completed?

⓪	⓪
①	①
②	②
③	③
④	④
⑤	⑤
⑥	⑥
⑦	⑦
⑧	⑧
⑨	⑨

63) How well does the *MOTHER* <u>understand</u> Spanish?

- ○ Does not understand
- ○ Not very well
- ○ Well
- ○ Very well

64) How well does the *MOTHER* <u>speak</u> Spanish?

- ○ Does not speak
- ○ Not very well
- ○ Well
- ○ Very well

65) How well does the *MOTHER* <u>read</u> Spanish?

- ○ Does not read it
- ○ Not very well
- ○ Well
- ○ Very well

66) How well does the *MOTHER* <u>write</u> Spanish?

- ○ Does not write it
- ○ Not very well
- ○ Well
- ○ Very well

67) How well does the *MOTHER* <u>understand</u> English?

- ○ Does not understand
- ○ Not very well
- ○ Well
- ○ Very well

68) How well does the *MOTHER* <u>speak</u> English?

- ○ Does not speak
- ○ Not very well
- ○ Well
- ○ Very well

69) How well does the *MOTHER* <u>read</u> English?

- ○ Does not read it
- ○ Not very well
- ○ Well
- ○ Very well

70) How well does the *MOTHER* <u>write</u> English?

- ○ Does not write it
- ○ Not very well

O Well
O Very well

71) If the mother speaks English, ask: **Where did you learn English and how?**
O Home country in school
O Home country at home
O Home country through other means (Explain: __________________)
O US in school
O US at home
O US through other means (Explain: ___________________________)

72) If the mother does not speak English, ask: **Do you plan on learning English?**
O Yes
O No

73) Does the *MOTHER* speak any other language or dialect?
O Yes
O No
If yes, what _____________________

74) If the mother speaks another language or dialect ask, **Does the *MOTHER* speak this language or dialect with (child)?**
O Yes
O No

75) Is the Mother currently in school?

O Yes
O No

76) Does the *MOTHER* have a job or jobs?

O YES, she works full time
O YES, she works part time
O No she does not currently have a job(s)

77) If she works ask, **What is her occupation?**
____

78) Did the MOTHER work in her home country?
O yes
O No

79) If she worked in her home country ask, **What was her occupation?**
____

In this part of the survey the term FATHER should be replaced with the title of the person reported to be the MALE HEAD OF HOUSEHOLD in questions #12 above.

If the person being interviewed is *the MALE HEAD OF HOUSEHOLD ask the questions using YOU and YOUR instead of a title.*

If there is currently no MALE HEAD OF HOUSEHOLD in this child's home, the interview is completed and you may move to concluding remarks.

The next set of questions I will be asking you are about the "FATHER" (ADULT MALE HEAD OF HOUSEHOLD from question #12).

80) In what country or U.S. territory was the *FATHER* born?

O United States or U.S. Territory (NOT Puerto Rico)
O Puerto Rico
O Colombia
O Cuba
O Dominican Republic
O Ecuador
O El Salvador
O Guatemala
O Nicaragua
O Honduras
O Mexico
O Peru
O Spain
O Other country: ___________

81) Did the FATHER live in the countryside (rural) or in a city (urban)?

O rural
O urban

Ask only if the father was born outside the United States or in Puerto Rico.

82) How old was he when he first came to the United States?	**83) How many years has he been in the U.S.?**
⓪⓪ ①① ②② ③③ ④④ ⑤⑤ ⑥⑥ ⑦⑦ ⑧⑧ ⑨⑨	⓪⓪ ①① ②② ③③ ④④ ⑤⑤ ⑥⑥ ⑦⑦ ⑧⑧ ⑨⑨

84) How often does the *FATHER* read a book, magazine, or newspaper?

O Not at all
O Once or twice a month
O Almost every day
O Less than once a month
O Once or twice a week
O More than once a day

Ask only if the father reads ……

85) In what language does the *FATHER* typically read?

O Only Spanish
O Mostly Spanish
O Mostly English
O Only English
O English and Spanish equally
O Does not apply

86) If the FATHER does not read in English, who reads or translates documents written in English for him?

O Spouse
O Other adult
O Child -Girl - child is _____ years-old
O Child-Boy - child is _____ years-old
O Nobody

87) What is the highest level of schooling the *FATHER* has completed?

O None
O Some elementary school (*primaria*) (Grades 1-6)
O Completed elementary school (*primaria*) (to Grade 6)
O Some secondary school (*secundaria and/or preparatoria*) (Grades 7-12)
O Completed secondary school (*secundaria and/or preparatoria*) (to Grade 12)
O GED Certificate
O Vocational/trade school *(formación técnica/vocacional, no universitaria)*
O Some community college
O Completed 2 years of community college
O Some college or university, not vocational school or trade school (*universidad*)
O Completed 4-year college or university (*universidad*) or *licenciatura*
O Some graduate level education after college (*maestría o doctorado*)
O Completed graduate level education after college (*maestría o doctorado*)

88) Overall, how many total years of formal education has the *FATHER* completed?

⓪	⓪
①	①
②	②
③	③
④	④
⑤	⑤
⑥	⑥
⑦	⑦
⑧	⑧
⑨	⑨

89) How well does the FATHER understand Spanish?

O Does not understand
O Not very well
O Well
O Very well

90) How well does the FATHER speak in Spanish?

O Does not speak it
O Not very well
O Well
O Very well

91) How well does the FATHER read Spanish?

O Does not read it
O Not very well
O Well
O Very well

92) How well does the FATHER <u>write</u> Spanish?

- ○ Does not write it
- ○ Not very well
- ○ Well
- ○ Very well

93) How well does the FATHER <u>understand</u> English?

- ○ Does not understand
- ○ Not very well
- ○Well
- ○ Very well

94) How well does the FATHER <u>speak</u> in English?

- ○ Does not speak it
- ○ Not very well
- ○ Well
- ○ Very well

95) How well does the FATHER <u>read</u> English?

- ○ Does not read it
- ○ Not very well
- ○ Well
- ○ Very well

96) How well does the FATHER <u>write</u> English?

- ○ Does not write it
- ○ Not very well
- ○ Well
- ○ Very well

97) If the father speaks English, ask: **Where did he learn English and how?**

- ○ Home country in school
- ○ Home country at home
- ○ Home country through other means (Explain: ___________________)
- ○ US in school
- ○ US at home
- ○ US through other means (Explain: ___________________________)

98) If the father does not speak English, ask: **Do you plan on learning English?**

- ○ Yes
- ○ No

99) Does the FATHER speak any other language or dialect?

- ○ Yes
- ○ No

If yes, what ______________________

100) If the father speaks another language or dialect ask, **Does he speak this language or dialect with your child?**

O Yes
O No

101) Is the FATHER currently in school?

O Yes
O No

102) Does the *FATHER* have a job or jobs?

O YES, he works full time
O YES, he works part time
O No he does not currently have a job(s)

103) If he works, what is his occupation?

____

104) Did the FATHER work in his home country?

O yes
O No

105) If the father worked in his home country, **What was his occupation?**

____

106) What language or languages would you like (child) to speak when s/he grows up?

O Spanish
O English
O Spanish and English
O Other ______________________________

107) What is the current annual income for your family? *List options if needed*

O less than 10,000
O 10,000 - 19,999
O 20,000 - 29,999
O 30,000 - 39,999
O 40,000 - 49,999
O 50,000 - 59,999
O 60,000 - 69,999
O 70,000 - 79,999
O 80,000 or more

Please provide the names, addresses, and phone numbers of two people who will know how to contact you in the future as we will need to be in touch with you next year.

1. ____
(name)

____
(address)

____
(phone number)

____
(relationship)

2. ____
(name)

____
(address)

____
(phone number)

____
(relationship)