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The Relationship Between Bilingualism and Executive Functioning in Spanish- and English-Speaking Head Start Preschoolers

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THE RELATIONSHIP BETWEEN BILINGUALISM AND EXECUTIVE FUNCTIONING IN SPANISH- AND ENGLISH-SPEAKING HEAD START PRESCHOOLERS

By

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Executive functions (EF) are an important aspect of school readiness that have been shown to predict higher achievement in language, math, and science starting in the early years (Blair & Razza, 2007; Bull, Espy, & Wiebe, 2008; Nayfeld, Fuccillo, & Greenfield, 2013; Ponitz, McClelland, Matthews, & Morrison, 2009). Children who are bilingual have been shown to have enhanced EF skills when compared to their monolingual peers (Bialystok & Viswanathan, 2009; Carlson & Meltzoff, 2008; Poulin-Dubois, Blaye, Coutya, & Bialystok, 2011; Riggs, Shin, Unber, Spruijt-Metz, Pentz, 2013). While this association has been found among children of different ages, languages, and socioeconomic statuses, to date, no study has addressed this relationship in low-income bilingual Latino preschoolers, one of the fastest growing populations of children in the United States (Barrueco, Lopez, Ong, & Lozano, 2012).

The current study examined the link between the degree of bilingualism and EF in a sample of 303 Spanish- and English-speaking Head Start preschoolers. Data on children's language ability and EF were collected. Results revealed that bilingual children performed better than monolingual children on EF, and that the degree of bilingualism predicted EF in the entire sample. Findings from this study offer new insights into both the language and cognitive development of young Latinos growing up in the United

States. These findings can help inform teachers and policy-makers about the importance of fostering dual-language learning and executive functioning in preschool, especially in at-risk bilingual populations.

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CHAPTER ONE

INTRODUCTION

Children from low-income backgrounds are consistently at risk for lower academic achievement at school entry, when compared to their higher-income peers, disparities that continue into primary school and increase over time (Ryan, Fauth, & Brooks-Gunn, 2006). Unfortunately, ten million children under the age of six fall into this low-income bracket, making up 48 percent of all children under six years of age in the United States (NCCP, 2013). A large percentage of these children from low-income backgrounds also come from homes where more than one language is spoken. In early childhood programs such as Head Start, dual language learners (DLLs) make up almost 30% of the entire population served by the program (ACF, 2008). As a group, dual language learners often struggle to attain English proficiency and are at-risk for lower academic achievement, when compared to their native English-speaking peers (Rumberger & Tran, 2007). The vast majority of young children who are DLLs come from Spanish-speaking homes (Barrueco, Lopez, Ong, & Lozano, 2012). Latinos, when compared to other racial and ethnic groups, have the highest high school dropout rate (Zambrana & Zoppi, 2002), highlighting the importance of focusing on the processes that affect the early learning experiences of Latino children. While it was initially thought that childhood bilingualism could be confusing and deleterious for children, research has now begun to highlight potential cognitive advantages early bilingualism can have (for a review, see Bialystok, Craik, & Luk, 2012). Thus, a careful examination of these processes in Latino preschool children from low-income backgrounds is needed to help support their development and prepare them the best possible to be ready to learn at school entry.

The preschool years (ages 3-5) have been recognized as a critical time in development because of the rapid cognitive changes that occur during this time that can set the foundation for later learning. While academic skills at this age are an important part of school readiness, domain-general cognitive and social skills, such as executive functions (EF) and approaches to learning, are also significant predictors of school readiness and academic achievement across multiple domains (Blair & Razza, 2007; Bull, Espy, & Wiebe, 2008; McWayne, Fantuzzo, & McDermott, 2004; Schaefer & McDermott, 1999). These mental processes, such as working memory and attentional control, support goal-oriented approaches to learning and develop quickly during the preschool years (Welsh, Nix, Blair, Bierman, & Nelson, 2010). Domain-general skills such as these are not tied to only one specific content area (e.g. language or mathematics), but are rather relevant across multiple learning contexts, affecting how a child approaches and experiences any learning situation (George & Greenfield, 2005). For example, learning to recognize the letter of the alphabet is directly relevant for language development, as is learning to recognize numbers for mathematics development. Contrastingly, learning to manipulate information and be flexible in one's problem solving approach applies to learning in all domains. Thus, it is important to understand the role of these domain-general skills in supporting school readiness, especially among children that are at-risk for poor academic achievement due to low-socioeconomic status and/or language learning status.

Increased awareness of the importance of domain-general skills such as EF in predicting school readiness has led researchers to attempt to understand the cognitive processes that occur as these skills emerge in the early years (e.g. Blair & Razza, 2007; Bull et al., 2008; Lan, Legare, Ponitz, Li, Morrison, 2011; Vitiello, Greenfield, Munis, & George, 2011). An important aspect of this research focuses specifically on how bilingual children develop EF. Multiple studies have shown that those who are bilingual perform better on tasks that require the EF skills of cognitive flexibility, inhibition, and an active working memory when compared to their monolingual peers (Bialystok & Viswanathan, 2009; Carlson & Meltzoff, 2008; Poulin-Dubois, Blaye, Coutya, & Bialystok, 2011; Riggs, Shin, Unber, Spruijt-Metz, Pentz, 2013).

Understanding the relationship between bilingualism and EF is of particular importance in the United States, considering the rising number of children from low-income backgrounds who are dual-language learners. Often, these children are seen as deficient because of limited English proficiency and lower academic achievement (Rumberger & Tran, 2007). If, however, these individuals benefit from enhanced cognitive functioning because they are simultaneously learning two languages, they may possess an inherent strength that could potentially help them achieve academic success. While the association between bilingualism and executive functioning has been found among children of different ages, languages, and socioeconomic statuses, to date, no study has addressed this relationship in one of the most important minority groups in our country: Spanish- and English-speaking Latino preschoolers from low-income backgrounds. This group is of particular interest because low-income Latino DLL children consistently score below the national average in math and reading achievement when they enter kindergarten, highlighting the need to support this population's early learning (Espinosa, 2013).

It is already a well-established fact that EF impacts school readiness outcomes across domains, including those of low-income Latino children (e.g. Blair & Razza, 2007; Nayfeld, Vitiello, & Greenfield, 2013). Thus, if in fact this group of Latino bilingual preschoolers from low-income backgrounds has higher EF compared to other monolingual preschoolers of similar SES status, the present study has the potential to identify an important strength for these children and a possible protective factor for their learning. In turn, early educators can use these strengths to bridge the connection between EF and academic achievement to help potentially ameliorate the early achievement gap.

The purpose of the current study was to determine the relationship between bilingualism and executive functioning skills in a sample of Spanish- and English-speaking preschool children enrolled in Head Start. First, the theoretical background on cognitive development and EF in early childhood is discussed, followed by a review of the literature on EF and bilingualism in childhood. The current study will then be described and results will be presented. Lastly, a discussion on the implications and future directions of the current research will ensue.

Background on Executive Functioning in Early Childhood

Research on executive functioning in early childhood stems from a body of cognitive and neuropsychological literature that explores how information is processed in the brain. While historically it was believed that there was a single general factor of intelligence that explained individual variation in mental performance (Spearman, 1927), in recent decades, neuropsychological and cognitive theorists have pointed to ways in which certain cognitive processes that are not necessarily tied to one single factor of intelligence may help or hinder learning. For example, the idea of *fluid cognition* suggests that specific skills, such as inhibition and attention shifting, help to organize and learn new information, in contrast to *crystallized intelligence*, which refers to previously acquired knowledge stored in long-term memory (Baddeley, 1996; Blair, 2002; Blair, 2006; Kane & Engle, 2002). These fluid skills are not tied to a single content domain, but instead are activated more generally across multiple learning situations, especially in environments when irrelevant, competing, or prepotent information interferes with the processing of information relevant for the task at hand (Blair, 2002).

Fluid cognition is said to be more susceptible to environmental influences than *crystallized cognition* (Blair, 2002) and is said to undergo the most rapid changes during early childhood (McArdle, Ferrer-Caja, Hamagami, Woodcock, 2002). These theories are supported by evidence in the neurodevelopmental literature that shows a high correlation between areas of activation in the brain, most notably the prefrontal cortex, and executive control processes, emotional reactivity, and the stress response system, indicating neurological correlates that correspond to these mental processes (Blair, 2006). Early childhood marks a time of great sensitivity in the developing brain, which can and will be affected by a variety of factors that range anywhere from environmental toxins and malnutrition, to early caregiving relationships and cultural norms (Phillips & Shonkoff, 2000). Given the various environmental influences in the development of fluid cognition, it is important to consider dual language learning as a potential environmental factor that may affect the development of these skills.

These fluid cognition skills that are activated when we learn new information have been labeled executive functions. The core executive functions are cognitive flexibility (or shifting), inhibition, and working memory (Miyake, Friedman, Emerson, Witzki, Howerter, & Wager, 2000). Cognitive flexibility refers to the ability to shift from one mindset to another, often requiring an individual to attend to multiple incompatible rules at once (Davidson, Amso, Anderson, & Diamond, 2006). Inhibition refers to one's self-regulation and ability to give a sub-dominant response, when appropriate, over a dominant response (Blair, 2002). Working memory refers to the ability to maintain and manipulate multiple pieces of information at the same time (Hughes & Graham, 2002). These functions come into play in situations when one must make sense of the surrounding environment and organize this new information effectively in one's cognitive system. Children make dramatic gains in EF skills, particularly in the preschool period, due to the rapid cognitive, social, and emotional changes that occur during this time (Carlson, 2005).

Many experts have adopted an integrative framework of EF, especially when examining its development in early childhood. This theory suggests that the various aspects of EF mentioned above are too difficult to tease apart in early childhood, because they are all part of the same underlying process (Carlson, 2005; Garon, Bryson, & Smith, 2008; Miyake et al., 2000). These skills are just forming and developing in early childhood and may not yet be uniquely defined. Thus, in early childhood, EF is best treated as a unitary construct, both theoretically and statistically (Fuhs & Day, 2011; Garon et al., 2008).

Executive functions in early childhood have received increasing attention over the past decades because of multiple studies that show a relationship between EF and academic outcomes. They are important predictors of school readiness, as they have been shown to predict higher achievement in language, math, and science, starting in the early years (Blair & Razza, 2007; Bull et al., 2008; Nayfeld et al., 2013; Ponitz, McClelland, Matthews, & Morrison, 2009), and continue to be important predictors of academic achievement throughout the school years (Gathercole, Pickering, Knight, & Stegmann, 2004). For example, a study conducted with Head Start children showed that inhibition and cognitive flexibility predicted math and phonemic awareness in kindergarten, indicating that a longitudinal relationship between EF and academic outcomes exists *and* that this relationship holds true for economically disadvantaged children (Blair & Razza, 2007). Research on EF has also found that these skills can benefit from interventions that give children practice in developing skills such as working memory, self-control, and problem-solving (Diamond & Lee, 2011). Therefore, fostering the development of EF in at-risk children may be particularly important, considering that these skills have the potential to act as protective factors for school success.

Executive Functioning and Bilingualism

Executive functioning involves actively manipulating information in the brain in problem solving situations where there is conflicting information and the need for cognitive flexibility. In thinking about young children who are simultaneously learning more than one language, these EF skills will naturally come into play. For example, consider a child that comes from a primarily Spanish-speaking household and learns English in school. Imagine that the child is interacting with a Spanish-speaking peer in a school setting when a monolingual English-speaker enters the play situation. In maintaining the three-person play situation, the bilingual child must draw upon her working memory to maintain conversations in both languages using the appropriate language for each child, flexibility switch between the two languages, and inhibit one language while using the other. Therefore, it is not surprising that various studies have shown an advantage for bilingual children on EF tasks that involve cognitive inhibition, flexibility, and working memory when compared to their monolingual peers (Bialystok, 2001; Carlson & Meltzoff, 2008; Riggs et al, 2013). This relationship has been found in children as young as two (Poulin-Dubois et al. 2011) and extends into adulthood (Bialystok, Craik, Klein, & Viswanathan, 2004).It has been suggested that the earlier and more consistent the experience is with both languages, the greater the impact bilingualism will have on one's cognitive functions (Luk, De Sa, & Bialystok, 2011).

This relationship has been particularly strong for tasks that involve cognitive control (Bialystok, 1999; Bialystok & Majumder, 1998; Bialystok & Viswanathan, 2009; Carlson & Meltzoff, 2008; Poulin-Dubois et al. 2011). Control tasks are described as those in which one must selectively attend to relevant aspects of a situation during problem solving, be flexible in one's problem solving approach and inhibit distraction of irrelevant factors (Bialystok & Majumder, 1998). Many studies on this topic have been conducted to include EF tasks that involve either attentional control (conflict tasks) or impulse control (delay tasks). Carlson & Meltzoff (2008), for example, found that the bilingual effect in their sample was specific to attentional control tasks, which require a high level of attention and memory, rather than impulse control tasks, which require merely the inhibition of a behavior. These findings suggest that the bilingual effect is particularly influential on the attentional aspects of inhibition, rather than its behavioral components. Taken together, evidence points to a pattern of distinct cognitive activity occurring in the bilingual brain that makes it easier to focus attention and manipulate information, especially when the demands are high.

While initially research on this topic suggested that cognitive control/inhibition was the main reason bilinguals performed better, recently it has been found that cognitive flexibility, or task switching, is equally important in explaining the enhanced EF skills among bilinguals (Bialystok & Visawanthan, 2009). This relationship makes sense because of the constant practice these bilingual individuals have in switching languages, depending on the situation. Studies have also looked specifically at the role of working memory in this relationship. Riggs and colleagues, for example, found that bilingualism significantly predicted a self-report measure of working memory in Latino youth in 5th and 6th grade (Riggs et al., 2013). Working memory is also often activated in individuals who learn two languages, especially in environments in which both languages are spoken. Therefore, it appears that the three core components of executive functioning, cognitive inhibition, flexibility, and working memory, are an important part of the bilingual experience.

Many investigators have attempted to explain why this relationship exists. In a comprehensive review on the connection between bilingualism and executive control, Bialystok (2001) describes how bilingual individuals constantly need to hold in mind the relevant language and inhibit the non-relevant language, depending on the environment, a process that activates frontal lobe processing. Bilingual children are repeatedly in situations in which they need to pay attention to abstract dimensions of language that monolinguals do not have to do (Bialystok, 1999), and thus have more practice in processes that engage EF, such as cognitive control, than their monolingual peers do (Soveri, Rodriguez-Fornells, & Laine, 2011). The bilingual child must first inhibit, and then shift his or her cognitive mindset to another language in order to produce a fluid switch between two languages (Riggs et al. 2013). Simultaneously, he or she must hold in mind which languages are appropriate activating the working memory system. Thus, the bilingual experience utilizes multiple aspects of EF simultaneously.

Measurement of Bilingualism

Bilingual development is a complex process. The way in which a child becomes bilingual can vary substantially, which, in turn, has implications for how influential one's bilingualism is on the development of EF. Factors such as home literacy environment and the percentage of time the first and second languages are spoken at home and in surrounding environments will determine the extent to which a child becomes bilingual (Barrueco et al., 2012). It is common that bilinguals are often dominant and more capable in one language over the other (Dixon, Wu, & Daraghmeh, 2012), but it is also the case that some bilinguals achieve high proficiency in both languages (Gatehercole & Thomas, 2009), suggesting a gradient of bilingual language ability. Because of this variability, it is important to examine children's competency in each language, in addition to their language competency as a whole. Such an approach to bilingualism is particularly important when using bilingualism as a variable in predicting other constructs. In the context of EF, depending on the degree to which each language is used in the child's daily life, he or she will have unique experiences with language switching and inhibiting, resulting in different levels of bilingualism, and thus varying associations with EF.

Many of the studies examining the relationship between EF and bilingualism have treated bilingualism as a "yes" or "no" dichotomous variable (e.g. Bialystok, 1999; Poulin-Dubois et al. 2011; Riggs et al. 2013). In these studies, consequently, there is a straightforward answer: the bilingual group has higher EF compared to the monolingual group. However, this approach fails to take into account the varying and complex nature of bilingualism. Other studies have attempted to create degrees of bilingualism by forming more than two discrete groups. For example, Bialystok & Majumder (1998) compared three groups among a sample of third graders: English-speaking monolinguals, French-English *balanced* bilinguals, and Bengali-English *partial* bilinguals. The bilingual groups were formed based on observations of how often and in what contexts the languages were used. In the balanced group, observers found that the French-English bilinguals attended purposeful bilingual school programs and spoke mostly French and some English at home, indicating equal proficiency in both languages. In the partial group, conversely, the children attended schools that instructed only in English and lived in homes where both Bengali and English were spoken, indicating stronger proficiency in English over Bengali. In this study, children were assigned to groups based on observations of language use in the home and school environment and not on their performance or ability levels in each language. Despite this relatively gross level of assignment, nonetheless, results showed that those in the balanced bilingual group performed better than the other two groups on the EF tasks, suggesting an advantage in EF for children who are "more" bilingual.

Carlson & Meltzoff (2008) also attempted to create multiple discrete groups of degrees of bilingualism, by comparing kindergartners who were native Spanish-English bilinguals, to monolingual English-speaking kindergartners and to English speakers that were enrolled in a second language immersion kindergarten program. Despite comparisons among groups of inherently different individuals, mainly based on socioeconomic status (the native bilinguals were of significantly lower socioeconomic status than both the monolinguals and the group of children enrolled in the immersion program), findings showed that the native bilinguals performed better on conflict tasks of EF than the other two groups, also supporting the idea that those who are “more” bilingual show greater advantages in EF. Evidence suggests, therefore, that it is important to determine the extent to which a child is bilingual when examining how bilingual experience can enhance EF skills.

The current literature has yet to effectively determine the extent to which children differ in their range of bilingualism and how this may impact the relationship between bilingualism and executive function skills. To date, there is no universal classification to account for the differences in language proficiency that bilinguals often experience (Altarriba & Heredia, 2008). At the same time, it is agreed upon that no one component of language can determine proficiency in a certain language, considering the complexity of the language system (Treffers-Daller, 2011). These factors make it difficult to operationalize language proficiency in bilinguals. Many studies that use direct language assessments to determine bilingualism, most often vocabulary (e.g. Read & Chepelle, 2001). Vocabulary is one of the most direct language measures that is commonly used to assess a child’s knowledge in a particular language, as it is closely linked to academic achievement in general (Dickinson, Cote, & Smith, 1993). While this is clearly not the only factor that affects bilingualism, assessing children on vocabulary in each language is a common way to obtain an estimate of bilingual ability.

Limitations of Previous Research

Due to the lack of agreement on how to measure bilingualism, the current research is limited in how to treat this construct as a variable. A few different techniques have been used in an attempt to capture the degree of bilingualism of participants, instead of treating it as a dichotomous variable. One study, conducted by Dixon and colleagues (2012) used scores on vocabulary measures to yield four language profiles, that included high in both English and the ethnic language (Chinese, Malay, or Tamil), low in both English and the ethnic language, high in ethnic language and low in English, and high in English and low in the ethnic language. These four groupings were created by determining if the child was above or below average (within that sample) in each language on the PPVT. This grouping technique, however, is problematic. One concern is that “average” is typically viewed as a range of scores and children who fall in the “average” range on both measures would be mixed into each of these four groups, based on whether they were above or below the mean on each measure. Children who have very similar scores, one just above the average and one just below the average, are placed in different groups, but might be better placed in the same language group.

Other techniques involve the use of difference scores. For example, some studies have created difference scores based on performance in each language, concluding that those with a difference score closest to zero are the most balanced, while those with a bigger difference score indicate dominance of one language over the other (e.g. Gollan, Weissberger, Runnqvist, Montoya, & Cera, 2012). Often, these difference scores create groupings of individuals based on proficiency. However, this technique can be particularly problematic, especially if the measures are not equated with one another or if they are not standardized for use with the particular population; two potential confounds for this score. In addition, children with either low proficiency in both languages or high proficiency in both languages have the same difference score and are included in the same group, despite the fact that one group has very high proficiency in both languages (and the expectation of higher EF) and the other group has low proficiency in both languages (and the expectation of lower EF). Other studies have created an index of bilingualism by creating a ratio of performance in one language to that in the other (e,g, Gollan, Salmon, Monotya, & Galasko, 2011). This approach, similar to computing difference scores, however, provides no distinction for children who are high in both or low in both languages, as they would both obtain the same ratio score. Despite the ability to create discrete levels of bilingualism that are more than just a “yes” or “no” distinction, using the techniques mentioned above clearly have their limitations. Therefore, it could benefit research to look at bilingualism on a continuum when determining its relationship to, in this case, EF.

Limitations of previous studies also involve the groups of comparison. It is hard to equate bilingual and monolingual children on variables such as SES or home language exposure due to the various factors that impact dual language learning (Carlson & Meltzoff, 2008). Many of the studies conducted on the topic of bilingualism and EF have focused on children of middle- or high-income status (Bialystok, 1999; Bialystok & Majumder, 1998; Bialystok & Viswanathan, 2009; Poulin-Dubois et al. 2011). Few have assessed children of low-income status, and when they do, it may involve a comparison to a group of monolingual peers of higher income status (e.g. Carlson & Meltztoff, 2008). Also, a child's level of bilingualism is often related to other factors that influence social-cognitive development that tend to correlate with each other, such as parent education level, literacy in the home, proficiency in each language, and SES (Bialystok, 2001). Therefore, Carlson & Meltzoff (2008) describe that the ideal experiment is with bilingual and monolingual speakers that have equal proficiency in their common language and equivalent SES status.

To date, no study has looked at the relationship between bilingualism and executive functioning in a sample of bilingual Head Start Latino preschoolers, in comparison to a sample of monolingual peers that are matched on socioeconomic status. In addition, previous studies have treated bilingualism mostly as a categorical or a grouping variable, and not as a continuous variable, which would allow for an examination of the effects of different levels of bilingualism.

The Current Study

The current study will seek to extend research on the connection between bilingualism and executive functioning in a group of Spanish- and English-speaking Head Start preschoolers. Data on children's language ability in English and Spanish will be collected in addition to an assessment of their EF to determine if Spanish-English bilingual ability predicts EF in this sample. The Specific Aims for the current study attempt to replicate (Aim 1) and extend (Aim 2) previous research, as follows:

1. Do bilingual children have higher executive functions than monolingual children when treating bilingualism as a categorical variable?

2. Does Spanish-English bilingual ability predict executive functions when treating bilingualism along a continuum?

The sample will include monolingual English-speaking and monolingual Spanish-speaking children, as well as bilingual children with varying levels of proficiency in both languages. In regard to the first question, it is hypothesized that bilingual children will outperform monolingual children on a battery of EF tasks. To address the second question, I hypothesize that a continuous measure of bilingualism will predict EF in this sample, such that children who have a high score on English language and a high score on Spanish language, indicating a high competency in both languages, will display higher EF. This is based on previous research that suggests that those who have more practice and are more balanced in their language abilities have higher EF skills (Bialystok & Majumder, 1998; Carlson & Meltzoff, 2008; Luk et al., 2001).

CHAPTER TWO

METHOD

Participants

Participants included 303 children attending the Miami-Dade County Head Start program. Centers and classrooms were selected with the goal of obtaining a sample that was evenly split between monolingual and bilingual children. A total of 21 Head Start classrooms across 7 centers were included in the study. All children in the sample were of low socioeconomic status, considering their enrollment in Head Start. Of the 303 participants, about half were female (54.5%). The majority of the sample was Latino (83.5%), and the remaining participants were African American (16.5%). Children were between the ages of three and five years (M=52.29 months; S.D = 7.07). Children who were determined to be bilingual in languages other than English and Spanish (such as Creole), as indicated by teacher report were excluded from the sample (N=27). The focus of this study is on Spanish-English bilinguals, and because of lack of reliable and valid assessments in other minority languages (Snow & Van Hemel, 2008), this study was limited to studying children who are bilingual in Spanish and English, only.

Measures

Language. The Picture Vocabulary subtest of the *Woodcock Muñoz Language Survey – Revised NU* (Woodcock, Muñoz-Sandoval, Ruef, & Alvarado, 2005) was administered as a measure of expressive vocabulary. All children in the sample were administered the assessment in English and Spanish to determine proficiency in each language. In this task, children are presented with various pictures and asked to name them. This is a valid and reliable measure that is normed in both Spanish and English for children as young as two years of age (α=.82; Alvarado, Ruef, & Schrank, 2005).

Executive Functioning. The *Executive Functioning Touch Battery* (Willoughby, Blair, & Kuhn, 2012) is a computerized version of a number of widely-used EF tasks that have previously been developed and have been used with low-income children (Willoughby & Blair, 2011). The battery has both an English and Spanish version and is intended for use with children as young as three (ρ=.72; Willoughby, Blair, & Pek, 2013). The tasks that make up the battery tap into the three core components of EF (cognitive inhibition, working memory, and cognitive flexibility). Each task takes about 4-7 minutes to complete. A brief description of each task in the battery is included.

Spatial Conflict Arrows (SCA)- This is a task of inhibitory control. Children are presented with two "buttons" on the bottom of the screen and various trials of individual arrows that appear on the top of the screen. The arrows vary in their orientation (facing left or right) and position (on the left or right side of the screen). Children are instructed to touch the button that the arrow points to. Inhibition is most strongly activated on incongruent trials (e.g. when the arrow is on the left side, but pointing to the right).

Go No-Go (GNG)- This is a task intended to assess inhibitory motor control. Children are presented, on screen, with a large green button. Children are instructed to touch the button every time that they see an animal, *except* when that animal is a pig. The child is then presented with various items in which one of seven animals appears on the screen. The child must touch the button (for all animals, except the pig) or inhibit touching the button (when it is a pig).

Silly Sounds Stroop (SSS) – This task is intended to assess inhibitory control of a prepotent response. In this task when children hear a dog sound ("woof") they are asked to touch the picture of the cat, and when they hear the cat sound ("meow") they have to touch the picture of the dog. Both the dog and cat pictures are present on the screen for each item. Children must inhibit their dominant response of picking the animal that is congruent with the sound.

Working Memory Span Houses (WM) –In this task, children are presented with a drawing of an animal above which is a colored dot located within the outline of a house. The examiner asks the child to name the animal and then to name the color. Then the child is presented with a new screen which only shows the outline of the house. The examiner then asks the child which animal was in the house. The task requires children to name and hold in mind two pieces of information, while simultaneously activating the animal name and overcoming interference from naming the color.

Pick the Picture (PTP) – This is another working memory task. Children are presented with a set of two or more pictures on the screen. For each set, they are shown consecutive screens with the same pictures, and for each screen are instructed to pick a picture so that all of the pictures "get a turn". This task requires working memory because children have to remember which pictures in each item set they have already touched.

Something's the Same (STS) – This task assesses attention shifting. Children are first presented with two items that are similar in terms of shape, size or color. The examiner indicates to the child which dimension is similar between the items. The child is then presented with a screen that has the same two items again, and then a picture of a third item. The new third item is similar to one of the first two items along a second dimension, which is different from the similarity of the first two items. This task requires children to think flexibly about the pictures based on three different dimensions.

Bubbles (SRT) – This task is a measure of children's speed of processing. Children are asked to touch pictures of blue bubbles, as they appear on the screen, as fast as they can.

Procedure

Data were collected in the fall and winter of the 2013-14 school year. Consent was acquired from center directors, teachers, and parents for child's participation in the project. First, the Picture Vocabulary subtest of the WMLS-R was administered to all children in Spanish and English. Children who scored at or above the normed age equivalent of 2 years on each assessment (a raw score of 5 or above for Spanish and a raw score of 6 or above for English), were considered bilingual. Children that passed the assessment in one language only were considered either English-monolingual or Spanish-monolingual. Children that were unable to obtain passing criteria in both languages were excluded from the sample (N=22). In addition, child demographic information was obtained from the Miami Dade County Head Start program, which included information about ethnicity and home language.

Following administration of the language measure, children were subsequently assessed on their EF skills using the Executive Functioning Touch Battery. All children were administered the assessment in their dominant language, as determined by the WMLS-R. If children scored equally well on the Spanish and English versions, the battery was administered in the child's home language, as indicated by the program. Children were first presented with a set of training items for each task in the battery (except for the Bubbles task). If children failed to pass the training set twice in a row, they were not administered that task.

Data Analytic Plan

Structural equation modeling (SEM) was chosen as the analytic technique, as it allows for the creation of latent variables using multiple indicators of that construct and is able to estimate parameters with missing data. Subsequently, latent variables can be used as predictor or outcome variables in structural regression models. Within SEM, parameters are estimated based on all existing data using full information maximum likelihood (FIML; Kline, 2011; McCartney, Burchinal, & Bub, 2006).

Model fit was assessed using a series of fit indices. The Bentler comparative fit index (CFI) was examined based on the criteria that values at or around 0.95 are considered acceptable fit (Bentler, 1990; Browne & Cudeck, 1992). The root mean square error of approximation (RMSEA) was also considered, under the criteria that values below .06 are considered adequate model fit (Browne & Cudeck, 1992). In addition, the standardized root mean square residual (SRMR) was examined with the criteria that a value below .08 is acceptable for model fit (Hu and Bentler, 1999). The chi-square test of model fit was interpreted with caution in the current analyses, due to the fact that this fit index is overly sensitive to sample size and often becomes significant when sample sizes are large, even if the model fits the data (Kline, 2011). In SEM, a lack of significance ($p>.05$) typically indicates acceptable model fit (Kline, 2011).

Measurement model. The six subtests of EF assessed in this study were used to test the fit of a single latent variable of EF. While EF has been defined by three core components (i.e. inhibition, working memory, and flexibility), it has been suggested these aspects of EF may be undifferentiated in early childhood, and may be better defined as a unidimensional construct in the early years (Carlson, 2005). Many studies, therefore, treat EF as an aggregate (e.g. Wiebe, Espy, & Charak, 2008). This approach is supported by evidence that a one-factor model of EF fits the data better than a two-factor model, using scaling data from the Executive Functioning Touch Battery (Willoughby, Blair, Wirth, & Greenberg, 2012). Also, effects between EF and bilingualism have been found for all three sub-components of EF that are assessed in the current measure, suggesting that EF as a unitary construct is playing a role in this relationship. Thus, guided by previous research and theory, the six distinct subtests assessed with the EF Touch Battery (three measuring inhibition, two measuring working memory, and one measuring flexibility) were combined into a single latent variable for use in further analyses.

To assess the first goal of the study, a measurement model of EF was established using confirmatory factor analyses (CFA). The model of EF was first fit for the entire sample to establish a latent variable of EF. Two separate models were then run with the entire sample included in the model to establish measurement invariance across groups: first, by language of test administration (English or Spanish), and then, by language group (monolingual or bilingual). This was done to ensure that the measurement model fit all of the data equally well using two different grouping variables, allowing for the comparison between the two different language versions of the test battery and subsequently, differences on EF between the monolingual and bilingual samples. In the group comparison model between monolingual and bilingual children, age, gender, and processing speed were included as covariates, and constrained equal across groups. As processing speed is consistently correlated with psychometric intelligence (Fry & Hale, 2000; Neisser et al. 1996), scores on children's processing speed, as obtained from the *Bubbles* task were added to the model as a control for non-verbal cognitive ability. Ethnicity was not included as a covariate in the model due to the lack of variability in the sample on ethnicity (84% Latino; 16% AA) and high collinearity between ethnicity and the language groups (all but three of the AA participants were in the monolingual English group). In addition, the two ethnic groups showed no difference on mean difference estimates of EF (Latino and African American, β_{AA}=-0.232, p=0.112), indicating that ethnicity did not explain differences in EF between groups.

Index of bilingualism. An index of bilingualism was calculated for each participant by calculating the product of raw scores on the Woodcock-Muñoz Picture Vocabulary test in both English and Spanish. The product term reflects a continuous approach to measuring bilingualism. Those children with absolutely no ability in one language received an index of 0, indicating no bilingual ability. As children increase in their ability in both languages, the product term grows accordingly, reflecting a gradient of bilingual ability. Those children with moderate levels of bilingualism tend to receive an index that is higher than those children with strong competency in one language and little or no competency in the other. Unlike ratio scores or difference scores, where children with low ability in both language and high ability in both languages receive the same score, this index of bilingualism differentiates between children who are high in both languages and those that are low in both languages.

Structural regression model. To determine if a child's bilingual ability predicted EF, the latent variable was used as a dependent variable, predicted by the indices of bilingualism that were calculated for the entire sample. Age, gender, and processing speed were included as covariates in the structural regression model.

CHAPTER THREE

RESULTS

Descriptive Analyses

Descriptive statistics for all variables are reported in Tables 1 and 2. The indicators of inhibition, cognitive flexibility, and working memory are represented by proportion scores indicating the number of items answered correctly. All variables were assessed for skewness and kurtosis and found to be sufficiently normal in distribution.

Measurement Model

Using confirmatory factor analysis, an initial measurement model was estimated using the six subtests of EF to create a single latent variable (see Figure 1). The loading of the first indicator (Arrows) was set to 1. All indicators significantly loaded onto the latent variable of EF, with loadings ranging from .467 to .731 (standardized). The model fit the data extremely well according to the following indices: χ^2 (9) = 8.286, p=.5056, the RMSEA value, 0.000, the CFI value, 1.000, and SRMR value, 0.025.

Once it was established that the initial measurement model fit the data, subsequent analyses were done to establish measurement invariance between the two languages of test administration (Spanish or English). To test metric and scalar invariance between the Spanish and English versions of the EF battery, a single measurement model was estimated with language of the test as the grouping variable. Intercepts and loadings were constrained equal across groups, implying metric and scalar invariance between the Spanish and English versions of the test. The model fit the data well [χ^2 (28) = 29.509, p=..3871, the RMSEA value, 0.019, the CFI value, 0.993, and SRMR value, 0.064], so it was retained, and interpreted[1]. Having established measurement invariance, the model was used to interpret differences in the latent variable of EF based on the language of assessment. The group administered the EF assessment in English was set to zero, thus, estimating the mean difference of the Spanish administration group. There was no significant difference in EF performance between the Spanish and the English versions as indicated by the mean difference estimate of the latent for the Spanish version (β_{Span}=-.008, p=.955). Therefore, differences in performance in EF cannot be attributed to language of test administration.

Subsequently, invariance of the factor structure was tested by language group (monolingual or bilingual). A measurement model was run in which groups were specified (monolingual=0, bilingual=1), and loadings and intercepts were constrained across groups to demonstrate measurement invariance across language groups. This model fit the data extremely well: χ^2 (28) = 23.252, p=0.7203, the RMSEA value, 0.000, the CFI value, 1.000, and SRMR value, 0.057, indicating measurement invariance between monolinguals and bilinguals[2]. This model was retained for further analyses.

Covariates were then added to the model to interpret the mean differences between the monolingual and bilingual language groups, controlling for gender, age, and

[1]This model was compared to a model in which loadings and intercepts were freed across groups, implying non-invariance. The model fit the data well [χ^2 (18) = 11.769, p=0.859, the RMSEA value, 0.000, the CFI value, 1.000, and SRMR value, 0.032], but a chi-square difference test indicated that there was no significant difference between the models [χ^2 (10) = 17.74, crit @ p=.05 = 18.31], allowing one to conclude measurement invariance and retention of the model in which loadings and intercepts were equal across language of test administration.

[2]This model was compared to a model in which loadings and intercepts were freed across groups, implying non-invariance. The model fit the data well [χ^2 (18) = 17.355, p=..499, the RMSEA value, 0.000, the CFI value, 1.000, and SRMR value, 0.039], but a chi-square difference test indicated that there was no significant difference between the models [χ^2 (10) = 5.897, crit @ p=.05 = 18.31], allowing one to conclude measurement invariance and retention of the model in which loadings and intercepts were equal across monolingual and bilingual groups.

processing speed. Age and processing speed were grand mean centered, and gender was entered as a dichotomous variable. Paths of the covariates were constrained equal across groups.

With the covariates in the model, mean differences were interpreted between the monolingual and bilingual groups. With monolinguals as the reference group, the intercept for the bilingual group was interpreted. When covariates are added to the model, the intercept acts as an adjusted mean, such that it represents the estimate of that variable when the predictors equal 0 (for the centered covariates, this is the mean). The intercept of EF for the bilingual group was significant (β=0.283, p=.020), indicating that there was a significant positive difference between the bilingual and monolingual groups on EF, such that bilinguals had higher EF than monolinguals. Age was a significant covariate, such that older children had higher EF (β=0.511, p<.001). Processing speed was also a significant covariate (β=-0.294, p<.001), such that children with faster processing speed (thus, lower scores) had higher EF. Gender was not a significant covariate across groups. These findings replicate previous research that shows that bilingual children have higher executive functioning when compared to monolingual children.

Further analyses were run to examine differences between the individual monolingual groups and the bilingual group as a whole, controlling for the aforementioned covariates. A model was run in which the bilingual group was set as the reference group, and means for the monolingual English group and monolingual Spanish group were estimated, separately. The intercept for the mean difference on the latent of EF was significant and in the expected direction for the monolingual English group only (β=-.313, p=0.022), suggesting that monolingual English children performed significantly lower than the bilingual group on EF skills, controlling for age, gender, and processing speed. The monolingual Spanish group did not perform significantly different from the bilingual group, although a negative coefficient represents an estimated difference in the expected direction (β=-.285, p=0.119). Once again, age and processing speed were both significant covariates, while gender remained non-significant in these group comparisons.

Lastly, group differences were also examined between the monolingual English and monolingual Spanish participants. Controlling for age, gender, and processing speed, there were no significant differences between these two groups, as indicated by the insignificant intercept of EF that was estimated for the Spanish-only group (β=-.132, p=0.620).

Index of Bilingualism

To create a continuous measure of bilingualism, children's raw scores on the English and Spanish versions of the Woodcock Muñoz Picture Vocabulary subtest were multiplied. Descriptives of the product term are presented by the total sample, and also broken up by language group (see Table 3).

Structural Regression Model

Once the index of bilingualism was created for all participants, this score was used in a structural regression model. The latent of EF was regressed on the index of bilingualism, to determine the extent to which bilingual ability predicted EF, controlling for age, gender, and processing speed across the entire sample (see Figure 2). Bilingual ability did significantly predict EF, as indicated by the regression coefficient for bilingualism, as displayed in Figure 3 (β=.239, p>.001). Thus, a continuous measure of bilingual ability significantly predicted EF in the entire sample. Results suggest that the greater one’s ability in both English and Spanish, suggesting a high degree of bilingualism, the greater one’s executive functioning.

CHAPTER FOUR

DISCUSSION

The purpose of the current study was to examine the relationship between bilingualism and executive functioning in a sample of predominantly Latino preschoolers attending Head Start, using both a categorical and a continuous approach to bilingualism. Results from this study confirm previous research showing that bilingual children have higher EF when compared to their monolingual peers (Bialystok et al., 2001). The current study is the first to extend these findings to a low-income sample of Spanish- and English-speaking preschoolers attending Head Start. It also provided a comparison of two distinct monolingual groups to a bilingual group, all from the same socioeconomic background. Results indicated that the bilingual children outperformed the monolingual group as a whole. In addition, the current study explored a continuous approach to bilingualism by using a gradient of bilingual ability to demonstrate the relationship between bilingualism and EF. Findings using this measure indicated that a higher level of bilingualism predicts greater EF across the entire sample.

While the bilingual advantage was found when compared to the monolingual English group, alone, the same effects were not found with the Spanish monolingual group, indicating no significant differences in EF between bilinguals and Spanish monolinguals when conducting group comparisons. This finding could be explained by the formation of language groups and the nature of language learning processes for these Spanish monolingual children. Children in this group failed to obtain a raw score of five or above on the Woodcock-Muñoz Picture Vocabulary subtest, however they likely have some initial English ability, which is most likely receptive for these emerging bilinguals

(Paradis, Genessee, & Crago, 2011). These children come from Spanish-speaking families, but live in the United States, and are therefore likely exposed to English, at school, in the media, or in the community. Therefore, despite the fact that they had not yet reached enough competency in English (using a 2-year age equivalent) to be considered “bilingual” when forming the language groupings, they are emerging English language learners, indicating that they are not fully monolingual.

This finding, therefore, further supports the use of a continuous measure of bilingualism, rather than a categorical approach. A continuous approach offers more sensitivity to account for the varying levels of bilingualism that may be crucial, especially in these rising bilinguals. It is widely accepted that there is extensive variability in bilingual language development, and early childhood educators have moved towards procedures such as conceptual scoring and dual language administration of assessments to account for this range of ability in both languages (Bedore, Peña, Garcia, & Cortez, 2005). Given these advances in the field, more research should use approaches that treat bilingualism on a continuum, rather than as a fixed grouping variable.

Further support for a continuous approach to bilingualism using a product score for vocabulary in each language is supported by the findings for the second aim, showing that this index of bilingualism significantly predicted EF in the entire sample. This study is one of the first to attempt using a continuous approach to explain the impact of bilingualism on EF. To date, most of the studies looking at the relationship between bilingualism and EF create discrete groups (e.g. Bialystok & Martin, 2004). While some do attempt to account for varying levels of bilingualism by comparing more than two groups (e.g. Carlson & Meltzoff, 2008; Bialystok & Majumder, 1998), these are still categorical measures. Despite the consensus that bilingualism is affected by variability in environmental and individual factors and thus does not develop uniformly in all children (Place & Hoff, 2011), most research continues to aggregate bilinguals into groups, rather than examining them on a continuum. Given this reality, and the literature on bilingualism and EF that consistently supports the fact that the earlier the experience with active bilingualism the better the cognitive benefits (Luk et al., 2011), it is imperative that future studies examining this relationship in different populations account for this degree of variability.

The use of a product score between children's ability in both languages is a novel approach to the measurement of bilingualism that offers several advantages to the creation of ratio or difference scores, which have been used in the past in an attempt to create a continuous measure of bilingualism (Gollan et al., 2011, Lee & Kim, 2011). These scores represent a measure of balance between the two languages, which offers useful information, but at the expense of accounting for the full range of variability in bilingualism. Two balanced children, one on the high end and the other on the low end, could receive the same difference or ratio score, although they clearly have different competencies. Contrastingly, the product score takes into account children's increasing ability in each language. It also provides a substantial amount of variability in the sample and is not subjected to a restricted range, giving it more ability to predict out to other constructs, in this case, EF. The findings from this study suggest that children who have high competency in both languages experience the greatest benefit for their EF. Research and theory already support this idea, but this comes from work using a categorical framework, by, for example, comparing children who became bilingual before or after the age of 10 (Luk et al., 2011), or looking at balanced vs. partial bilinguals (Bialystok & Majumder, 1998). The current study supports this conclusion statistically by using a continuous measure of bilingualism in a sample that ranges from no bilingualism at all, to a high level of bilingualism. Thus, this approach to bilingualism can be used in entire samples, regardless of language grouping.

Results from this study highlight a strength in a specific population of children that are often at-risk for falling behind due to their language learning status. Latino children from low-income backgrounds are consistently at-risk for falling behind in academic outcomes already at entry to kindergarten (Han, 2012). Some attribute this falling behind to their bilingualism, claiming that bilingualism is a risk factor for poor academic outcomes (Snow, Burns, & Griffin, 1998; Federal Interagency Forum on Child and Family Statistics, 2002). While traditionally it was thought that learning two languages was confusing for children and had harmful effects for children's development (Portes & Schauffler, 1994), a growing body of literature is showing the positive effects that bilingualism can have for a whole range of cognitive abilities. Findings from the current study support the fact that learning two languages is not a hindrance, but rather has major cognitive advantages that hold true for this specific sample of dual-language learners.

This benefit should not be underestimated considering the research that shows the importance of EF for school achievement (Blair & Razza, 2007). These EF skills are crucial domain-general skills that support higher-order thinking skills and abstract thinking, which foster learning across domains (Nayfeld et al., 2013). Not only do children who have higher EFs early on show greater academic performance in math and language throughout formal schooling, they are also able to be flexible, creative, and disciplined in a variety of situations, leading to advantages for their academic, social, and emotional development (Blair & Razza, 2007; Diamond & Lee, 2011, Gathercole, Pickering, Knight, & Stegmann, 2004; Riggs, Jahromi, Razza, Dilworth-Bart, & Mueller, 2006). Considering that this sample of Latino preschoolers from disadvantaged backgrounds is displaying an inherent strength in these skills has the potential to act as a protective factor for their academic success.

Given that the relationship between bilingualism and executive functioning has been established, steps need to be taken in the field of early education to apply these results to children's early learning experiences. Findings from this study have implications for instruction when thinking about educating Latino dual language learners in preschool, both in terms of fostering EF and the learning of two languages. Teachers can structure experiences in the classroom that support their development in these domains. For example, when instructing DLLs, teachers can create opportunities in which children need to switch between languages to help prime cognitive shifting. In addition, asking children to respond in a certain language will help them practice their inhibition of the other language. Considering research that shows that EF is malleable and that teachers can create experiences in the early childhood classroom that help develop these skills (Diamond & Lee, 2011), these approaches could be particularly useful in helping Latino children experience the benefit of their higher executive functions for achievement across domains.

Not only are bilingual children performing better, but there is evidence from this study to support that the more bilingual one is, the greater one's EF. Considering this relationship, it is important for these children to develop their skills in both languages simultaneously, rather than losing one and gaining another. These findings support a dual language approach in the classroom. More and more scholars and policy makers are advocating for the development of both the home language and the mainstream language alongside each other, especially at an early age (Goldenberg, Hicks, & Lit, 2013). Promoting development in the home language as well is not only important in itself, for purposes of maintaining one's familial language, but also for promoting multiple facets of cognitive and social development (Genese, Paradis, & Crago, 2004). It has been shown that in classrooms with instruction in both the home language and English, especially those that implement a 50-50 English-Spanish bilingual approach, children not only improve their home language skills, but also attain English language skills that are comparable to children in English-only contexts (Barnett, Yarosc, Thomas, Jung, & Blanco, 2007; Rodriguez, Diaz, Duran, and Espinosa, 1995; Winsler, Diaz, Espinosa, & Rodriguez, 1999). Findings from this study support the evidence that suggests that dual language education is the optimal approach for the cognitive, language, and social development in Latino preschoolers.

Limitations and Future Directions

While this study was able to replicate and extend previous research on bilingualism and EF, it did so by using vocabulary as the sole measure of bilingualism. Vocabulary offers an objective measure of children's language ability and is one of the most widely used measures of language development (Read & Chapelle, 2001), however, there is no single component of language that can determine proficiency in a language considering the complexity of the language system (Treffers-Daller, 2011). It was beyond the scope of this study to assess additional measures of language development, but future studies should include a variety of constructs in language development, such as lexical diversity, phonology, grammatical skills, and metalinguistic awareness, to get a more holistic view of a child's bilingual ability. In addition, external factors, such as percentage of exposure to first and second languages in the home and at school, could be measured to add richness to the construct of bilingualism.

The current study was able to replicate previous research in a very specific population of DLLs – Spanish- and English-speaking Latino preschoolers from low-income backgrounds. While this study was the first to assess the relationship between bilingualism and EF in this population, other language groups were excluded (e.g. Creole-speaking), due to a lack of linguistically and culturally sensitive measures in languages other than English that are available for young children (Snow & Van Hemel, 2008). Therefore, these findings should be replicated and confirmed with preschool populations of other language groups from low-income backgrounds. In addition, while the majority of the children in the current sample were Latino, about 16% of the population was African American. Statistically, putting ethnicity in as a covariate in the model would have made it impossible to determine effects in the bilingual group, because there was virtually no variability of ethnicity in this group. Given that not all children were matched on ethnicity, this could be a potential factor contributing to the relationship. However, existing studies have found no differences on effortful control between ethnic groups (specifically African Americans and Latinos) in preschool samples when they are matched on income (e.g. Aikens, Coleman, & Barbarin, 2008; Li-Grining, 2007), suggesting that even in preschoolers from varied ethnic backgrounds, it is low-income status, rather than ethnicity, that contributes to differences in effortful control (Li-Grining, 2012). Therefore, it is unlikely that the results of the current study are due to differences in ethnicity. Children in this study were all matched on SES. Regardless, future studies should attempt to minimize differences between participants by matching them on income status *and* ethnicity.

Findings from this study suggest that a unique relationship exists between executive functioning and bilingualism. However, identifying the exact mechanisms for this relationship was beyond the scope of the current study. While previous research has provided theories for this relationship, an operationalization of the mechanisms explaining this relationship is difficult. However, there may be ways to assess these mechanisms, grounded in theory. For example, one theory suggests that it is the constant switching back and forth between languages that results in better EF in bilinguals (Green, 1998; Soveri et al., 2011). One way to assess if this is in fact the mechanism would be to examine children's spontaneous language switching in the classroom. If children who switch more fluidly display higher EF, this could be evidence to suggest that the flexibility in one's language system may explain the relationship. Most of the studies done on this topic are quantitative in nature. However, using a qualitative approach to examine children's navigation between two languages, as suggested above, could provide rich and novel information that could deepen an understanding of the relationship between bilingualism and EF.

In addition to identifying potential mechanisms, the directionality of the effect should also be examined. Considering that executive functions are malleable and highly susceptible to environmental influences (Garon, Bryson, & Smith, 2008), theory suggests that it is the environmental experience of bilingualism that promotes higher EF. However, it could be that the relationship is bidirectional, such that higher EF also promotes more bilingualism. Future research should implement rigorous statistical techniques such as latent class growth modeling with cross-lag analyses to tease apart the directionality of this relationship. A more in-depth understanding of how bilingualism affects EF can help inform how to structure opportunities for DLLs that best promote their development across domains.

Conclusion

The current study extends existing literature suggesting that bilinguals possess an advantage in executive functioning processes (Carlson & Meltzoff, 2008; Poulin-Dubois et al. 2011; Bialystok & Viswanathan, 2009; Riggs, Shin, Unber, Spruijt-Metz, Pentz, 2013), by assessing this relationship in low-income bilingual Latino preschoolers, a group of critical importance in the United States. It was found that bilingual children in this population outperformed monolingual children as a whole on a battery of EF tasks, and that a continuous measure of children's bilingual ability significantly predicted EF across the entire sample.

Findings from this study have profound implications for Latino DLLs from low-income backgrounds, who are often seen as lagging behind their peers in academic achievement. This study, taken together with extant literature, may suggest that these children's daily experience with language is priming their executive control processes in a way that leads to enhanced cognitive functioning. One consideration that emerges from these findings is that if these bilingual Latino children do in fact have higher EF, then why are they still falling behind? This phenomenon could be due to a couple of things, for example, how children are currently being assessed on school readiness. Perhaps the widely-used direct assessments of school readiness do not tap into domain-general skills such as executive functioning or approaches to learning, thus obscuring any advantage that these children may have in other more general skills. In addition, perhaps teaching strategies that are being used in the early childhood classroom teach domain-specific skills in ways that do not encourage the active use of EF, for example rote memorization or learning. These EF skills may be particularly important for DLL children in particular to engage in while learning.

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Figure 1

Baseline CFA of a Single Latent Variable of Executive Functioning. All loadings presented are standardized and significant at p<.001.

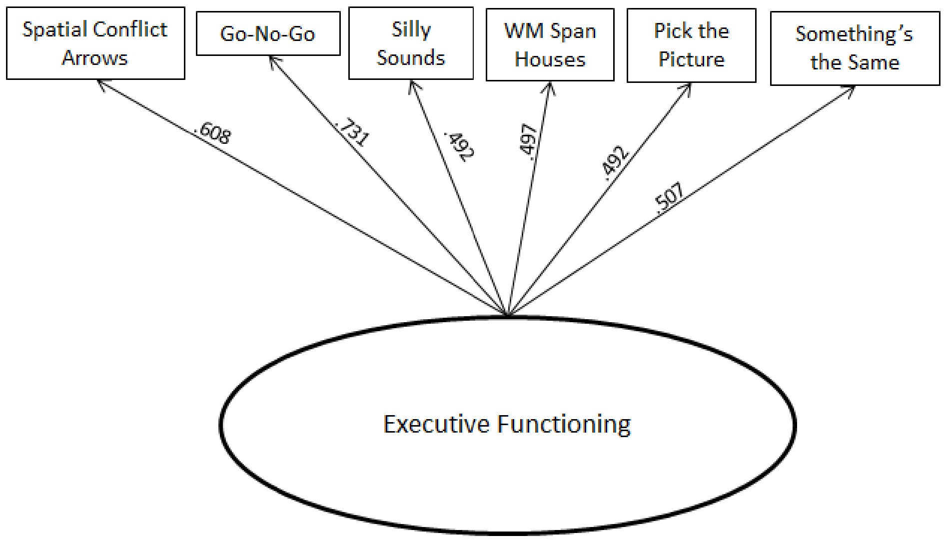

Figure 2

*Structural Regression Model using Bilingualism to predict Executive Functioning, controlling for age, gender, and processing speed. Standardized loadings are presented. Loadings with a * are significant at p<.001.*

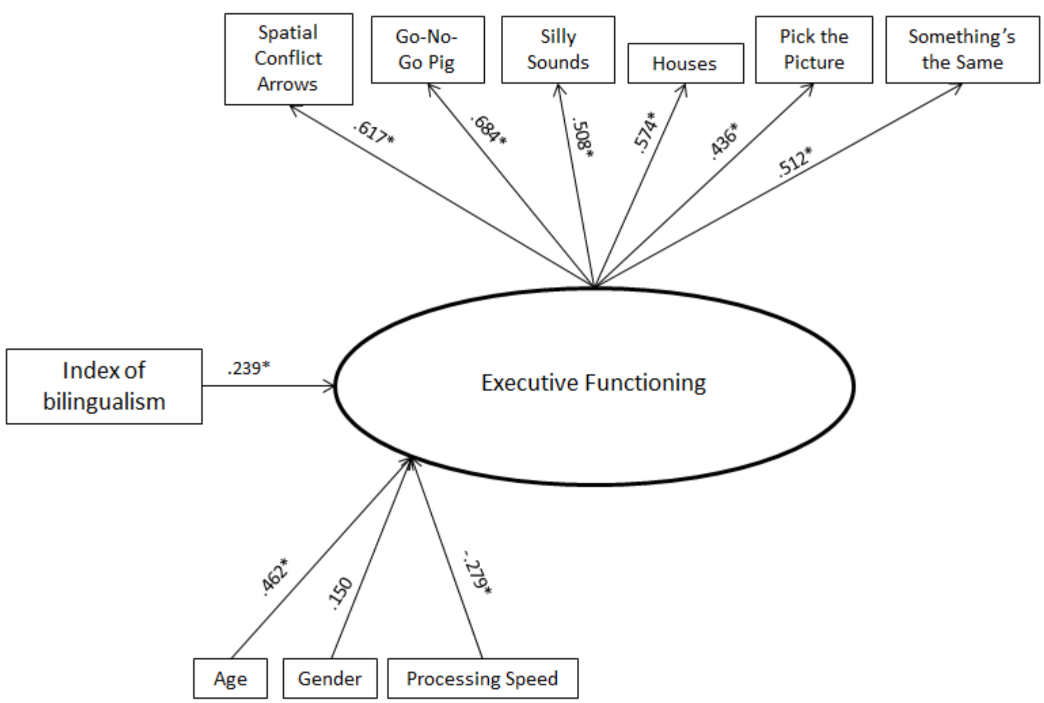

Figure 3

*Structural Regression Model using Bilingualism to predict Executive Functioning, controlling for age, gender, and processing speed. Standardized loadings are presented. Loadings with a * are significant at p<.001.*

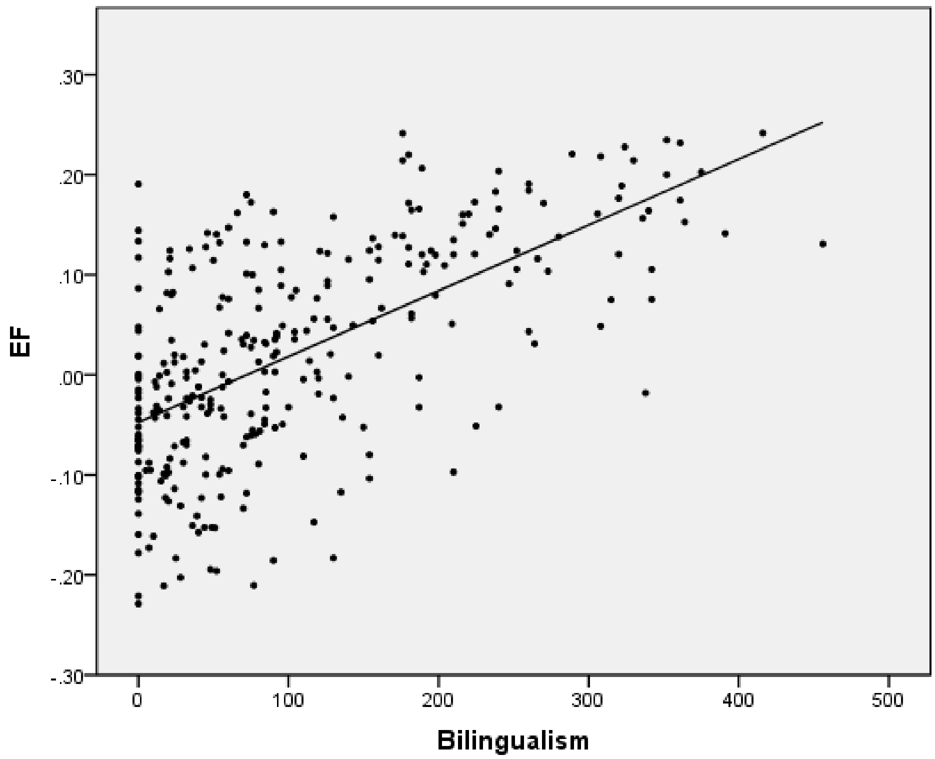

Table 1

Group	N	Age	Gender	Processing Speed
Bilingual	148	54.72 (6.55)	Girls – 75 Boys – 73	1260.425 (310.296)
Monolingual English	83	51.71 (7.09)	Girls – 43 Boys – 40	1351.081 (313.263)
Monolingual Spanish	72	47.97 (5.85)	Girls – 47 Boys – 25	1537.160 (348.699)
Total Sample	303	52.29 (7.07)	Girls – 165 Boys – 138	1351.02 (338.20)

Note: Age was significantly different across all three groups, such that the bilingual group was older than the monolingual English group ($p \leq .001$), which was significantly older than the monolingual Spanish group ($p \leq .001$). Processing speed was also significantly different across groups, such that bilinguals had faster processing speed than monolingual English participants ($p < .05$), and the monolingual Spanish group had the slowest processing speed compared to the other two groups ($p \leq .001$).

Table 2

Number of Participants, Means, and Standard Deviations for Variables Assessed

	N	Mean	Standard Deviation
Executive functioning			
Spatial Conflict (Inhibition)	292	0.57	0.19
Go-No-Go (Inhibition)	259	0.82	0.15
Silly Sounds Stroop (Inhibition)	268	0.54	0.26
Houses (Working Memory)	240	0.43	0.21
Pick the Picture (Working Memory)	298	0.65	0.12
Something's the Same (Flexibility)	286	0.65	0.12
Language			
Picture Vocabulary (English)	303	11.73	7.11
Picture Vocabulary (Spanish)	303	10.37	6.89

Note: Age is measured in months. Executive functioning scores are represented by proportion scores indicating the percentage of items correct on a particular subtest. Processing speed is measured in milliseconds. The language scores presented are the raw scores.

Table 3

Index of Bilingualism

Group	N	Mean index score	Std. Deviation	Range
Bilingual	148	181.06	93.16	40-456
Monolingual English	83	36.72	28.14	0-104
Monolingual Spanish	72	20.40	22.70	0-85
Total Sample	303	103.35	101.88	0-456

Note: Index scores were calculated by multiplying the raw score on English vocabulary by the raw score on Spanish vocabulary tests.