The Influence of Bilingual Ability on Pathways to Academic Achievement in Latino Children

by

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ABSTRACT

Dual language use is thought to afford certain cognitive advantages to bilingual children and may function as an additional resource to help low-income Mexican-American children achieve academically. Emotion regulation and executive functioning (e.g., inhibition) have been found to be particularly important in studies investigating pathways to early academic achievement. Understanding how we can capitalize on children's bilingual abilities to strengthen their executive functioning and emotion regulation, or to offset problems in these domains, may be important to promote better educational outcomes and inform policy. Thus, the current study investigated the relation between emerging bilingualism, inhibition, emotion regulation, and academic achievement across early childhood in sample of 322 low-income, Mexican-American children. Data were collected in a laboratory space at child ages 36-, 54-, and 72-months. Bilingualism was indexed as the interaction of Spanish and English vocabulary, and a mediated moderation model was examined. Results provided further evidence that inhibition positively predicts academic achievement during early childhood. Greater Spanish language vocabulary indirectly predicted academic achievement while controlling for English language vocabulary, suggesting that children from immigrant families may benefit from maintaining their Spanish language abilities as they begin to immerse themselves in an English-speaking classroom. Advancing our understanding of the development of self-regulatory abilities within bilingual, immigrant populations could have significant implications for educational policy.

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TABLE OF CONTENTS

Page

Page

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

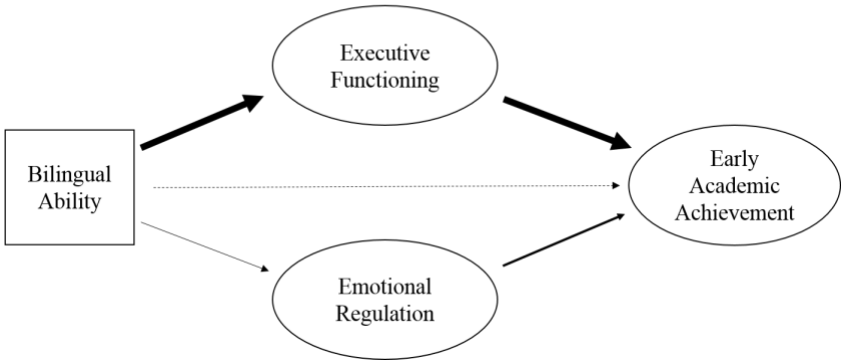
The pathways to early academic achievement have been studied extensively, likely due to the societal value placed on educational success. Control, in one form or another, has emerged as a central feature of these various pathways, wherein a child's ability to achieve academically hinges on the development of attentional, emotional, inhibitory, and behavioral control. The emergence of emotion regulation and executive functioning, both of which represent control mechanisms, are essential for later socio-emotional competence and academic achievement. Further, the utility of these emerging skills can be seen in classrooms every day (e.g. working with classmates, remembering the teacher's instruction, focusing on completing a task, calming down after falling at recess).

Emotion regulation and executive functioning operate in an integrated fashion to facilitate the developmental processes that underlie academic achievement (Calkins & Marcovitch, 2010). The mechanisms by which these two competencies interact continue to be a central focus of developmental and clinical research given the implications for educational policy and practice as well as for current interests in intervention and prevention programming. Nevertheless, the extent to which these key competencies of emotion regulation and executive functioning can be augmented by other factors is not currently well understood, but represents an important extension of previous research that could further explicate the pathways that lead towards early academic achievement. Bilingualism is one such factor that has begun to gain traction in recent years due

particularly to its proposed connections to executive functioning (see Figure 1) and growing commonality.

The disproportionate academic underachievement of Mexican Americans is a pressing national concern, especially given the growth of the Mexican-American population in the United States (U.S. Census Bureau, 2017). Fortunately, studies show that low-income Hispanic kindergartners are reducing the decades old gap in academic achievement (Reardon et al., 2016), and that achievement gaps between Whites and Hispanics have been narrowing marginally for the past 15 years (NCES, 2013). Notably, bilingual students enter school with numerous cognitive advantages (Barac & Bialystok, 2012), and socio-emotional skills (Kim et al., 2014). The extent to which bilingual abilities may account for the recent trend offers a compelling question, as it is important to identify the driving forces behind early academic achievement for Hispanic populations so this positive trend can be sustained and even amplified.

Figure 1. Full Conceptual Model



BACKGROUND LITERATURE

Bilingualism as a Determinant of Executive Functioning

Bilingualism may be best understood as a spectrum. People who are bilingual vary based on their level of proficiency and context of proficiency, and the wide range of

experiences that lead to bilingualism has made a standard definition difficult. Subgroup definitions that delineate the context of proficiency or manner of acquisition (e.g. productive bilinguals are those who can produce speech in both languages while additive bilinguals are those who learned one language after becoming dominant in the other) are useful but do not solve definition challenges as a whole. Due to the increased flexibility of the brain during early development, age of acquisition and amount of exposure to a second language have been shown to affect emerging executive function. Early and intensive exposure to, and mastery of, more than one language is likely to manifest greater benefits in aspects of executive functioning (Carlson & Meltzoff, 2008). Research with language immersion programs shows that more positive cognitive effects are observed in bilinguals with a high proficiency in both languages compared to bilinguals who are dominant in one language over another (Bialystok, 2011).

Executive functioning is not a single phenomenon but rather a collection of supervisory neuro-cognitive processes that are necessary for self-regulated and purposeful behavior. Executive functions are deliberate cognitions that are relied upon in situations when automatic processes are not sufficient (Blair & Ursache, 2011). Executive skill emerges over time, and dramatic increases in executive functioning between the ages of three and five years have been reported (Carlson, Davis, & Leach, 2005; Zelazo, Müller, Frye, & Marcovitch, 2003). For example, because children are continuously surrounded by and encounter novel stimuli in their environments, the ability to pay attention to selected stimuli (e.g. the interaction with their caregiver) over nonessential stimuli (e.g. the passing cars outside the window) is foundational to

learning. Executive functions allow for the integration and control of information to influence behavior.

The aspects of cognition encompassed by executive function most often include working memory, inhibitory control, and cognitive flexibility. *Working memory* involves the maintenance and manipulation of information over a short period. For example, completing a computer task as a part of a study requires the participant to hold the instructions for the task in mind throughout the completion of the task. *Inhibitory control* is characterized by the flexible activation and inhibition of selected information and responses. The Go/No-Go Task is a well-known example of inhibitory control in which participants have to make a binary decision on a stimulus based on instructions (e.g. press the space bar when they see a P) while withholding the response at other times (e.g. not pressing the spacebar when they see a R). Inhibitory control has been found to uniquely predict achievement for disadvantaged children (Blair & Razza, 2007). *Cognitive flexibility* involves the ability to adapt to new and unexpected conditions by shifting the focus of attention. For example, if the instructions of the Go/No-Go Task were to be switched from making a motor response when a P appears on the screen to making the response when a R appears instead, participants would have to shift the focus of their attention. Together, these processes are instrumental for orchestrating thinking, planning, action, and goal-directed behaviors (Blair & Ursache, 2011).

When examining the growing literature on executive functioning of people who are bilingual, it is important to indicate how "bilingual" has been operationalized and what individual differences in experiences might have been addressed. Typically, it is

considered best practice to have a well-defined and homogenous group of bilingual speakers while accounting for specific forms of training that can shape how individuals perform on executive functioning tasks. Research has shown, for example, that aspects of cognitive performance can be influenced by a range of experiences such as playing the piano (Bialystok & Depape, 2009) or playing video games (Green and Bavelier, 2003).

Most studies investigating the relation of executive functioning and bilingualism focus on children because, compared to adults, they have had significantly less experiences that could impact their cognitive functioning and confound the effect of bilingualism. In addition to identifying the age of bilingual participants in the study, it is also important to consider socioeconomic status and gender differences as these have been found to be related to executive functioning abilities. Higher socioeconomic status at child age six months predicted higher executive functioning at 48 months of age (Kuhn, Willoughby, Wilbourn, Vernon-Feagans, & Blair, 2014), and studies also show that girls tend to outperform boys on executive function and language skills in U.S. samples (Matthews et al., 2009; Wanless et al., 2013). There is also some evidence that the relation between bilingualism and executive functioning may be bidirectional (White & Greenfield, 2017) meaning that not only does bilingualism increase executive functioning, but higher executive functioning may also promote bilingualism over time.

A central aspect of the bilingual experience is attentional control. The parallel activation of both languages creates competition in which the two language systems compete with each other in the brain. “The need to control attention to the target system in the context of an activated and competing system is the single feature that makes

bilingual speech production most different from that of monolinguals and is at the same time responsible for both the cognitive and linguistic consequences of bilingualism (Bialystok, 2009, p. 4)." This suggests that the continual need to monitor language choice and suppress a commonly used language requires bilinguals to hold linguistic information in mind while manipulating another language. This, in turn, strengthens their executive functioning skills (Bialystok, 2009).

The consistent suppression of a commonly used language is thought to benefit inhibitory control processes in particular. The development of inhibitory control across childhood is well documented (Diamond, 2002, for review) and is implicated in many theories of cognitive development (e.g., Dempster, 1992; Tipper, 1992). Deficits in inhibitory control increase the likelihood that a response will be executed rather than withheld (Schachar, Tannock, & Logan, 1993). With this in mind, it is not surprising that insufficient inhibition is associated with many different childhood psychopathologies such as attention deficit hyperactivity disorder (ADHD; Schachar, Mota, Logan, Tannock, & Klim, 2000). According to the 2016 National Survey of Children's Health (NSCH), Hispanics and Latinos have the lowest prevalence rate of ADHD for children age 2-17 in the United States (Danielson, Bitsko, Ghandour, Holbrook, Kogan, & Blumberg, 2018). Furthermore, prevalence rates broken down by primary home language were reported to be 10.4% for English, 3.8% for Spanish, and 1.3% for other language (Danielson et al., 2018). While there are many possible explanations for these findings, a bilingual advantage in inhibitory control should be considered as a protective factor against the development of ADHD in children. However, further exploration is needed.

Although the literature exploring the relation between bilingualism and executive functions has experienced significant growth in recent years, no clear consensus has emerged for an advantage across the range of processes that executive functions subsume. Bilinguals have been found to be at a disadvantage when it comes to lexical retrieval and language processing, but consistently outperform monolinguals on nonverbal measures of executive control abilities throughout the lifespan (Bialystok, Craik, & Luk, 2008; Bialystok & Feng, 2009). Bilingual children are advanced in the ability to selectively attend to a stimulus in the presence of distracting information and are more proficient than monolingual children and children in a language immersion program on conflict measures of executive functioning (Carlson & Meltzoff, 2008).

Of interest, research suggests that a working memory advantage is more likely to manifest when people transition from one 'level' of bilingualism to another (e.g. being more dominant in one language and transitioning to being equally dominant across both languages) (Kudo & Swanson, 2014). Subgroups who maintained a stable vocabulary knowledge did not show an advantage in working memory tasks (Kudo & Swanson, 2014). These findings suggest that longitudinal studies that can monitor changes in bilingual balance and proficiency over time should produce an observable advantage in executive functioning.

When evaluating changes in balance and proficiency over time, researchers should also consider the nature of the bilingual population from which they are sampling. Very few of the studies investigating a bilingual advantage have focused on populations who become bilingual out of necessity versus those who chose to pursue a second

language for some perceived additional advantage. Consequently, low SES immigrant populations are underrepresented in the existing literature on this topic. It is possible that the debated bilingual advantages manifest differently in minority populations who maintain their native language while adapting to another culture.

Research on the bilingual advantage has been controversial. There are a number of researchers who question the existence of an advantage at all, calling attention to methodological issues and biases in the studies supportive of a bilingual advantage. Paap and colleagues (2015) report that since 2011, 80% of the studies investigating bilingual advantage have produced null results. The studies that found a bilingual advantage in executive functioning were critiqued for having small sample sizes, failing to control for confounding variables between groups (i.e. SES), and were unable to be replicated (Paap et al., 2015). Furthermore, there is debate surrounding the directionality of causation: does bilingualism enhance executive functions or are those with enhanced executive functions more likely to become bilingual? The bilingual advantage debate has sparked a drive to uncover better methods to verify its existence such as employing longitudinal designs, investigating moderating factors, and providing more detailed methodological information to increase the possibility of later replication (Woumans & Duyck, 2015). There remains a clear need for a better understanding of the nature and limits of bilingual advantage in executive functions.

Inhibitory control, working memory, and attention shifting, are key cognitive processes that are fundamental to later adaptive behavior. These processes are enhanced by, and enhance, bilingual ability. In the larger context of control mechanisms, these

executive function processes are evoked every day in emotional situations to aid in the regulation of behavior, emotion, and attention. Indeed, there is considerable theoretical support for an integrative framework combining cognitive and emotion processes (Bell & Deater-Deckard, 2007; Calkins & Fox, 2002).

Emotion Regulation

Emotion regulation, in essence, is the ability to control one's emotions in relation to the contextual and environmental demands encountered every day. Emotion regulation can be divided into up-regulation, which involves the maintenance or enhancement of emotional arousal, and down-regulation, which involves the inhibition or subdual of emotional arousal (Gross, Richards, & John, 2006). For example, someone who is feeling lonely may up-regulate their emotions by calling a friend and making plans for that evening. In a different manner, someone who is feeling stressed and anxious may down-regulate their emotions by going for a run to relieve some of their stress. Three core features of emotion regulation include 1) that both positive and negative emotions can be increased as well as decreased, 2) emotion regulation processes can range from conscious, effortful, and controlled to unconscious and automatic regulation, and 3) emotion regulation can be both adaptive and maladaptive based on the context (Gross & Thompson, 2007). Eisenberg and Spinrad (2004) propose a working definition for emotion-related self-regulation as "the process of initiating, avoiding, inhibiting, maintaining, or modulating the occurrence, form, intensity, or duration of internal feeling states, emotion-related physiological, attentional processes, motivational states, and/or

the behavioral concomitants of emotion in the service of accomplishing affect-related biological or social adaptation or achieving individual goals (p. 338)."

In many ways, quality of life is dependent upon the ability to successfully regulate emotions, and consequently, the failure to regulate appropriately is implicated in many different forms of psychopathology. Emotional dysregulation, the failure to regulate appropriately, can take the form of over- or under-regulation (Cole, Michael, & Teti, 1994). For example, an under-regulated child might not be able to control their silliness and giddiness in a classroom setting. A child who shows a blunted emotion expression after falling at recess and scraping their knee would likely be considered over-regulated.

Emotion regulation is a dynamic process that matures across development (Gross, 1998). Although innate regulatory mechanisms such as sucking or rocking are present from birth, the infant remains heavily dependent on the caregiver for regulation until the emergence of sustained self-regulation during the preschool years (Cole, Michael, & Teti, 1994). A significant amount of infancy research emphasizes the importance of the regulatory aspects of emotion given the findings that emotion organizes the development of social relations (Sroufe, Schork, Motti, Lawroski, & LaFreniere, 1984). The capacity to purposefully self-regulate emotion is learned through development and the parent-child relationship (Calkins & Marcovitch, 2010) and the period between infancy and adolescence is considered a crucial developmental period for emotion regulation due to advancing temperamental, neurobiological, conceptual, and social processes (Gross & Thompson, 2007). The evolution of these processes in concert with ongoing contextual

factors (e.g. caregiving) are foundational for the emergence of individual differences in emotion regulation that are observed in adulthood (Cole, Michael, & Teti, 1994).

Although infants are not able to self-regulate behavior and emotion at such a young age, displays of infant emotion and behavior can, however, affect the behavior and emotions of the caregiver. Infants communicate information about their emotional state (e.g. crying) to signal and direct the behavior of the caregiver (Tronick, 1989). In turn, the caregiver aids the infant in their regulation of emotions through things like soothing, rocking, or holding. This process is referred to as co-regulation and functions as a feedback-loop (Calkins & Marcovitch, 2010). Whereas the importance of co-regulation continues throughout development and into adulthood, the ability to self-regulate emotions typically emerges as early as three years of age (Cole, Michael, & Teti, 1994). Children begin to generate emotion expression during play and mimic emotions around three years of age (Dunn, 1988), and individual differences in emotional regulation begin to become identifiable during the preschool years. Effortful control, the ability to flexibly adjust the intensity and duration of an emotional experience to best aid in the accomplishment of a goal, is fundamental to success in later childhood and adulthood.

The judgment of an emotional response as regulated or dysregulated is context dependent (Campos, Campos, & Barrett, 1989; Izard, 1977). Emotions are implicit in achieving goal directed behaviors (e.g. furthering a relationship or overcoming an obstacle), and as such, regulatory abilities serve an important purpose. Further, it is critical to consider both emotion and behavior in the context of their functional relation to a goal to differentiate regulated and dysregulated states (Cicchetti et al., 1991). As

children age and transition into formal education (e.g. preschool), emotion regulation can become context-bound. Children are expected to adhere to the expectations, or goals, set by the teacher (e.g. sitting in their seat). Once a child enters the classroom, the development of attention and inhibitory control processes becomes exceedingly important. Children who struggle to modulate attention and inhibit impulses diverge from their peers in terms of the latency, intensity, duration, and quality of shifts in emotional states (Cole, Michael, & Teti, 1994). These suggestions support the importance of studying growth of self-regulatory abilities during a child's early school years. Given the extensive literature on the growth of emotion regulation and executive functioning during the preschool years, it is not surprising that psychologists have sought to better understand the interdependence of these two constructs.

Executive Functioning and Emotional Regulation

The origins of emotion regulation and executive functioning are not only intertwined in their complexity, but their relation has been firmly established in the literature (e.g., Carlson & Wang, 2007). Studies have found evidence of shared underlying neural mechanisms for executive functioning and emotion regulation (Zelazo & Muller, 2007; Zelazo & Cunningham, 2007). Executive functions help modulate emotional reactivity. Conceptually, it is reasonable to expect that executive functioning should take a stronger role in predicting early academic achievement because of the cognitive nature of academics. In more statistical terms, bilingual ability will operate through executive functioning, with executive functioning taking the shared variance

with emotion regulation to create the strongest pathway to early academic achievement (see bolded pathway in Figure 1).

The observable manifestations of emotional, behavioral, and attentional regulation are dependent upon non-observable cognitive or executive processes. Both developmental neuroscience and psychophysiological perspectives (Calkins & Marcovitch, 2010; Geva & Feldman, 2008) support the notion that executive functioning and emotion regulation are developmentally linked and functionally interdependent. The established relations between cognitive processes and bilingual ability and between cognitive processes and emotion processes suggest that these three constructs influence each other along the pathways to academic achievement.

Current Study

Prior research supports the importance of emotion and cognitive processes in establishing the pathways to early academic achievement as well as in the relation between executive functioning and bilingual ability. However, the interdependence of bilingual ability, emotion regulation, and executive functioning as well as the extent of their predictive power to early academic achievement requires further exploration. Specifically, this study will test a set of hypotheses reflected in the proposed conceptual model (see Figure 1). First, greater bilingual ability at 36 months will predict greater early academic achievement at 72 months *(hypothesis 1)*. Second, the relation between level of bilingualism and early academic achievement will be mediated by inhibition (a component of executive functioning) and emotion regulation abilities, such that

bilingualism will be associated with inhibition and emotion regulation, which in turn will be associated with better academic achievement *(hypothesis 2).* Third, the increase in bilingual ability from 36 months to 54 months will predict better inhibition at 54 months than will bilingual ability at 36 months alone *(hypothesis 3)*. Fourth, the mediated paths between bilingualism and early academic achievement will be stronger for inhibition than emotion regulation *(hypothesis 4;* see bolded pathway in Figure 1*).*

METHODS

Participants

The participants in the current study are 322 Mexican-American mother-child dyads. Six participants were removed due to missing data at all time points. Therefore, the final sample size was 316 pairs. Women who self-identified as Mexican-American were recruited to participate in the Las Madres Nuevas (LMN) project, a longitudinal study spanning the prenatal period to six years after birth. Study participation was contingent on self-reported Mexican-American identity, annual income below $25,000 or considered eligible for Medicaid funding, fluency in English or Spanish, at least 18 years old, and were expected to deliver a healthy, singleton baby. At the start of data collection 14% of mothers reported an estimated total income of less than $5,000, 19.4% reported an income between $5,001 and $10,000, and 26.7% reported between $10,001 and $15,000. Of the infants included in the sample, 53.8% were female. The current study included data from the 36 months, 54 months, and 72 months' time points. At the time of each study visit, children were within 3 months of the target age. At the 36-month time point, 90% of mothers chose to complete their portion of the interview in Spanish. At the

Table 1. *Descriptive Statistics for All Study Variables (*N = *316)*

Variable Name	Min	Max	Mean	SD	%	*n*
Mother's Age	18	42	27.77	6.49		315
Mother's Education	0	18	10.17	3.22		316
Mother's Country of Birth						
United States					13.3	42
Mexico					86.4	273
Child's Gender						
Male					45.6	144
Female					53.8	170
Marital Status						
Married					30	61
Separated					4.4	14
Living with Partner but not Married					46.8	95
Number of other Biological Children	0	9	1.91	1.64		314
Estimated Total Income						
≥ $5,000					13.3	42
$5,001 – 10,000					18.7	59
$10,001 – 15,000					27.2	86
Mother language for 36-month interview						215
Spanish					90.2	194
English					9.8	21
Mother language for 54-month interview						230
Spanish					79.1	182
English					20.9	48

54-month time point, 79% of mothers chose to complete their interview in Spanish. See Table 1 for additional sample characteristics.

Procedures

Mothers were recruited to participate in the project through local clinics offering prenatal care in the Phoenix metro area. During the first year postpartum, data were collected during home visits in the participant's home. The 36 months, 54 months, and 72 months data were collected in a psychology lab space at Arizona State University.

Lab visits. Mother and child came to campus for two to four hours to complete each lab visit. The visits were carried out by female, bilingual interviewers who were fully trained according to a specified protocol. The interviewers collected physiological measurements such as height, weight, body fat, and blood pressure for both mother and child. Additionally, salvia samples and a measure of heart rate were collected from the child only. The lab visits included structured interviews, physiological data collection, questionnaire presentations, interaction tasks between mother and child, and child socioemotional and cognitive assessment measures. All questions for the mothers were read out loud in the mother's preferred language and responses were recorded through Blaise Survey Software. The child assessment measures were administered in the child's strongest language as determined by their scores on the Woodcock-Muñoz English and Spanish versions. The interaction tasks were modified at each time point to be developmentally appropriate for the child's age and abilities. Transportation costs were covered and monetary compensation for the mother's time was provided.

Interaction tasks. At the 54-month lab visit, mothers and their child participated in three filmed interaction tasks. The tasks were designed to vary in the amount of stimulation

required and frustration elicited. The first interaction task was an unstructured free play that lasted for five minutes. During this time, mother and child played together using toys of their choice from a provided selection. At the end of the five minutes of free play, the mother received a call from the interviewer directing her to work together with her child to clean up the toys. The clean-up lasted a maximum time of two minutes. The third task was a teaching task in which the mother was asked to have her child complete a challenging task, drawing a line from the outside of a maze to the center without picking up the pen or crossing any walls. This task was designed to elicit at least mild frustration from the child and allow for the observation of differing emotion expression and parenting behaviors.

Data coding. Child dysregulation was coded using a global dysregulation coding system (Lin, Crnic, Luecken, & Gonzales, 2015) that was conceptually and empirically informed by relevant research (Thompson, 1994; Cole, Michel, & O'Donnell Teti, 1994). For each of the interaction tasks the child received a score based on the extent to which they evidenced signs of dysregulated emotion, behavior, and attention. Scores ranged from 1 to 5; with scores of 5 indicating very high levels of child dysregulation. When evaluating instances of dysregulation, duration, intensity, frequency, lability, and recovery time were considered. At 54 months of age, children can be expected to be able to respond to parent prompts and commands. Defiance (i.e. refusal to follow through with prompts) and noncompliance (i.e. failure to follow-through with prompts) are factored into scores of dysregulation given that the ability to respond to reasonable adult requests is considered adaptive for long-term adjustment. Attentional dysregulation is considered when the child

is unable to sustain attention on the activity at hand for more than a few seconds at a time. In order for a child to receive a dysregulation score of 5, for example, they would have to exhibit many signs of emotional, behavioral, or attentional dysregulation throughout the task. A score of 3, for comparison, might be given if the child evidenced several instances of moderate emotional dysregulation or defies mom's prompts a few times throughout. A dysregulation rating of 1 would be given if the child never evidenced signs of dysregulation.

Measures

Language. The child's level of bilingualism was indexed using the Picture Vocabulary subtest of the Woodcock Muñoz Language Survey – Revised (WMLS-R). Children were administered the Picture Vocabulary subtest in English and Spanish (children were assessed in their dominant language first, as indicated by the mother). The child was asked to name the pictures shown to him or her by the interviewer in the language corresponding to the test version. The measure has been established as reliable and valid and is normed in both English and Spanish (α= .91; Alvarado, Ruef & Schrank, 2005). The language in which the child obtained a higher raw score was used as the language of administration for the tasks and measures during the lab visit.

- Bilingual ability was represented using an interaction term, which combined Spanish and English vocabulary performance at each time point.

Inhibition. Kiddie Continuous Performance Test (K-CPT). The K-CPT (Connors, 2006) was used to measure inhibition. The tasks required the child to view a series of pictures

which appeared in the center of a computer screen and to press the spacebar after observing a fish, the target stimuli. The presentation sequence consists of a small number of occurrences of the target stimuli (e.g. fish) interspersed with a large number of nontarget stimuli included as distractors. The child completed a practice session before starting the test. The full test consisted of 3 blocks with each block containing 24 targets and 12 decoys. There were 120 stimuli total in each block resulting in 360 stimuli over the entire task. The average duration of the task was 7 minutes. CPT performance was measured in terms of inhibition, indexed by a ratio of the number of correct target responses (i.e., hits) divided by the number of total response (i.e., hits plus commission errors).

Emotion Regulation. The child's emotion regulation ability was assessed using both a well-established parent-report measure and an observational rating system. Emotion regulation is represented as a composite formed using the following two measures as indicators.

- *Child Behavior Checklist (CBCL).* Child emotional and behavioral problems were assessed during the 54-month lab visit using the Child Behavior Checklist for ages 1.5 - 5 (CBCL; Achenbach & Rescorla, 2000). The CBCL provides normed indices of children's internalizing and externalizing behavior problems. Mothers were read 99 questions in their preferred language describing possible behavioral and emotional problems of their child and were asked to rate each item on a 3-point scale; not true (0), sometimes true (1), or very true (2) of their child. Five subscales were used

to create a composite variable: emotionally reactive (9 questions), anxious/depressed (8 questions), withdrawn (8 questions), attention problems (5 questions), and aggressive behavior (19 questions).

- *Observed Child Dysregulation.* The child's behavior was rated for each of the three interaction tasks based on the extent to which they evidenced signs of globally dysregulated affect or behavior. Global ratings were indexed by levels of appropriateness, lability, intensity, duration, frequency, and recovery time that children displayed during the individual episodes. Scores ranged from 1 to 5, with 5 signifying a very high degree of emotional dysregulation. Undergraduate research assistants were trained in teams of two by a graduate student and had to attain an inter-rater reliability above 70% exact match and 100% within one rating point of the master code before the team could begin to code independently of the graduate student. The interclass correlation for the child codes was .82 for the 54 months' time point. Weekly reliability meetings were held to prevent observer drift. For the current study, an average dysregulation score was calculated for the child across all three tasks. The ICC for the 54-month time point was 0.82.

Early Academic Achievement. Early academic achievement was measured using the *Kauffman Test of Educational Achievement, Third Edition (KTEA-3).* Interviewers administered the KTEA-3 (Kaufman, 2014) to the child to obtain an in-depth assessment of key academic skills. Children were assessed, in English, on letter and word recognition (N=100) as well as math computation (N=87) subtests. Standardized scores were used for

all analyses. Higher scores are reflective of greater achievement or skill in reading and math. The completion of the KTEA-3 in the current study took approximately 10-15 minutes.

Data analysis

Preliminary analyses. Frequency and descriptive statistics were examined for the following variables: demographics, bilingual ability, inhibition, emotion regulation, and academic achievement. Observed means, standard deviations, outliers, skewness, and kurtosis were examined for all variables. Correlational analyses were run for all variables to identify possible covariates and to understand the nature of relations between the central variables of interest.

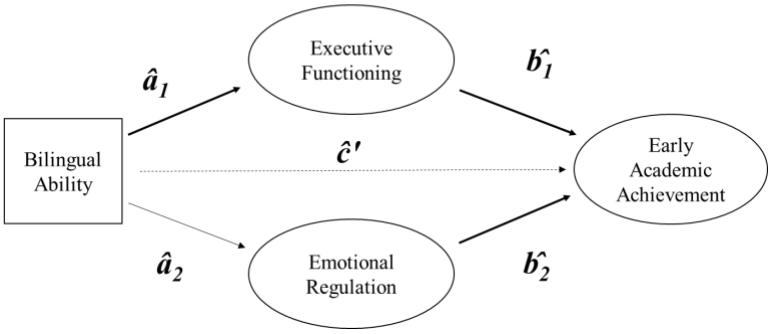
Hypotheses testing. Hypotheses for the proposed model were tested using structural equational modeling (SEM) in Mplus 7 (Muthén & Muthén, 2012). Mediated moderation models were evaluated for the interaction of child Spanish vocabulary and English vocabulary on early academic achievement via inhibition and behavioral problems. Variables contributing to the interaction term were centered at zero. Mediation was tested by examining the statistical significance of the indirect path $\alpha\beta$ (i.e., the mediated effect) from the interaction effect to early academic achievement via inhibition and behavioral problems. Significant interaction effects were probed by (a) testing the significance of the simple slopes of the regression of inhibition on academic achievement at average (mean), low (-1 SD) and high (+1 SD) levels of Spanish and English vocabulary (Aiken & West, 1991).

Three separate models were tested. The first model included bilingual ability at

36-months, inhibition and emotion regulation at 54-months, and early academic achievement at 72-months to test the pathways as a function of early bilingual ability. The second model replaced bilingual ability at 36-months with bilingual ability at 54-months, to assess the pathways with a more proximal indicator of bilingualism. The third model examined the effect of change in bilingual ability on academic achievement, as mediated by inhibition and emotion regulation. Change in Spanish and English vocabulary was measured by the increase in raw scores between 36 and 54 months on the Woodcock-Munoz Picture Vocabulary subtest. An interaction term reflecting change in Spanish vocabulary and change in English vocabulary was created to capture the change in bilingual ability. Model fit indices, parameter estimates, and residuals were examined to determine how well the data fit the proposed models.

Findings from the first SEM analysis addressed the first two hypotheses. Namely, the *first hypothesis* that greater bilingual ability at 36-months would have a positive association with academic achievement at 72-months was tested by examining the significance and valence of the regression coefficient ($\hat{c}'$) that estimates the direct effect of bilingualism on academic achievement. With more than one mediator, each mediated effect needs to be specified (MacKinnon, 2008), $\hat{b}_1$ is the parameter relating inhibition to academic achievement, $\hat{b}_2$ is the parameter relating emotion regulation to academic

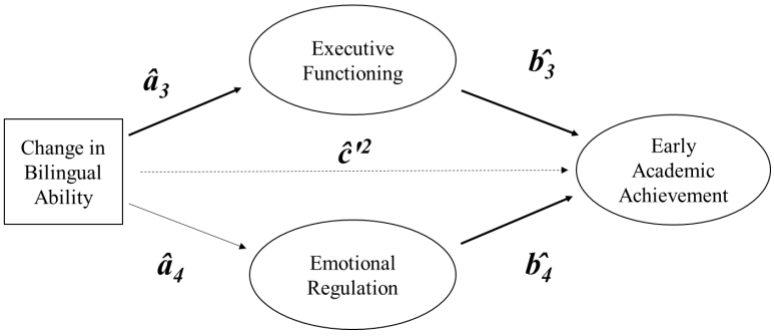
Figure 2. Statistical Notation for SEM 1 (36 mo) and SEM 2 (54 mo)



achievement, $\hat{a}_1$ is the parameter relating bilingualism to inhibition, and $\hat{a}_2$ is the parameter relating bilingualism to emotion regulation (see Figure 2). First, the mediated effect $\hat{a}_1\hat{b}_1$ represents the individual mediated effect of bilingualism on academic achievement through inhibition. Second, the mediated effect $\hat{a}_2\hat{b}_2$ represents the individual mediated effect of bilingualism on academic achievement through emotion regulation. Thus, the *second hypothesis* was addressed by examining the total indirect effect ($\hat{a}_1\hat{b}_1 + \hat{a}_2\hat{b}_2$). If the direct effect is not significant, then full mediation is supported (MacKinnon, 2008). Partial mediation would be supported if the direct effect maintains significance despite the presence of mediators.

The third hypothesis was addressed using the results from the third SEM. The *third hypothesis* that the change in bilingual vocabulary from 36- to 54-months would be more predictive of academic achievement at 72-months than bilingual status at 36-months alone was tested by comparing the direct effect of change in Spanish and English vocabulary on academic achievement ($\hat{c}'^2$; see Figure 3) to the direct effect found in the first model ($\hat{c}'$). The *fourth hypothesis* that the mediated path would be stronger for inhibition than emotion regulation was tested, using bootstrap methods, by comparing the strength of the indirect effect of bilingual ability on academic achievement through inhibition (with emotion regulation partialed out; $\hat{a}_3\hat{b}_3$) versus the

Figure 3. Statistical Notation for SEM 3



strength of the indirect effect of bilingual ability on academic achievement through emotion regulation (with inhibition partialed out; $\hat{a}_4\hat{b}_4$; see Figure 3.2) in all three SEM models.

RESULTS

Preliminary results

Descriptive statistics and zero-order correlations for all primary study variables are presented in Table 2. The dysregulation composite did not significantly correlate with any of the primary study variables. English vocabulary at 36-months was leptokurtic, as expected with this population ($\gamma 2$ = 2.82; *SE* = .379). Observed dysregulation was also leptokurtic ($\gamma 2$ = 4.89; *SE* = .44), however, the dysregulation composite was normally distributed. All other variables were normally distributed. Each variable in the interaction was centered at the grand mean for all three models. Missing data were accounted for using Full Information Maximum Likelihood (FIML). With respect to potential covariates, maternal level of education and child sex were tested but not included as covariates in the final models due to lack of significant correlation with the outcome variable.

A composite dysregulation variable was tested combining scales of the CBCL and observed dysregulation coding. Five conceptually relevant CBCL subscales were included: emotionally reactive, anxiety and depression, withdrawn, attention problems, and aggressive behavior. Observed dysregulation held together well with the attention problems subscale of the CBCL (r = .227, $p < .05$). Inter-item correlations are presented in Table 3. The final dysregulation composite proved reliable (α = .758).

Table 2. *Descriptives and Bivariate Correlations between Study Variables (*N = *316)*

Variable	1	2	3	4	5	6	7	8	9	10	11
Mean	6.79	3.62	10.64	12.03	5.05	8.07	.76	15.61	93.23		
S.D.	*4.97*	*12.6*	*6.17*	*6.51*	*3.82*	*4.77*	*.18*	*11.23*	*13.41*		
N	181	182	203	211	133	139	158	183	76	316	316
1. Span. Vocab 36m	-										
2. Eng. Vocab 36m	**-.35****	-									
3. Span. Vocab 54m	**.78****	**-.38****	-								
4. Eng. Vocab 54m	**-.25****	**.68****	**-.34****	-							
5. Δ Span. Vocab	-.04	**-.20***	**.60****	**-.26****	-						
6. Δ Eng. Vocab	-.01	-.12	-.10	**.65****	-.11	-					
7. CPT Ratio 54m	**.24***	.07	**.26****	.11	-.02	.17	-				
8. Dysreg. 54m	-.01	.14	-.10	.13	-.18	-.01	-.01	-			
9. KTEA 72m	.23	.18	.15	**.44****	-.05	.14	**.57****	.19	-		
10. Child Gender	**.21****	-.08	**.27****	.01	.00	.06	**.19***	-.09	.01	-	
11. Maternal Education	-.08	**.26****	-.09	**.33****	-.08	**.20***	.05	.04	.13	.03	-

Note. **p < .01. *p < .05.; Span. = Spanish; Eng. = English; Dysreg.= Dysregulation

Table 3. *Inter-Item Correlation Matrix for Dysregulation Composite*

Variable	1	2	3	4	5	6
1. Observed Dysregulation	-					
2. CBCL Emotionally Reactive	-.05	-				
3. CBCL Anxiety & Depression	.04	**.70**	-			
4. CBCL Withdrawn	.06	**.57**	**.54**	-		
5. CBCL Attention Problems	**.23**	**.48**	**.39**	**.39**	-	
6. CBCL Aggressive Behavior	.11	**.80**	**.64**	**.51**	**.61**	-

Note. Bold indicates correlation is significant at the 0.05 level.

Primary results

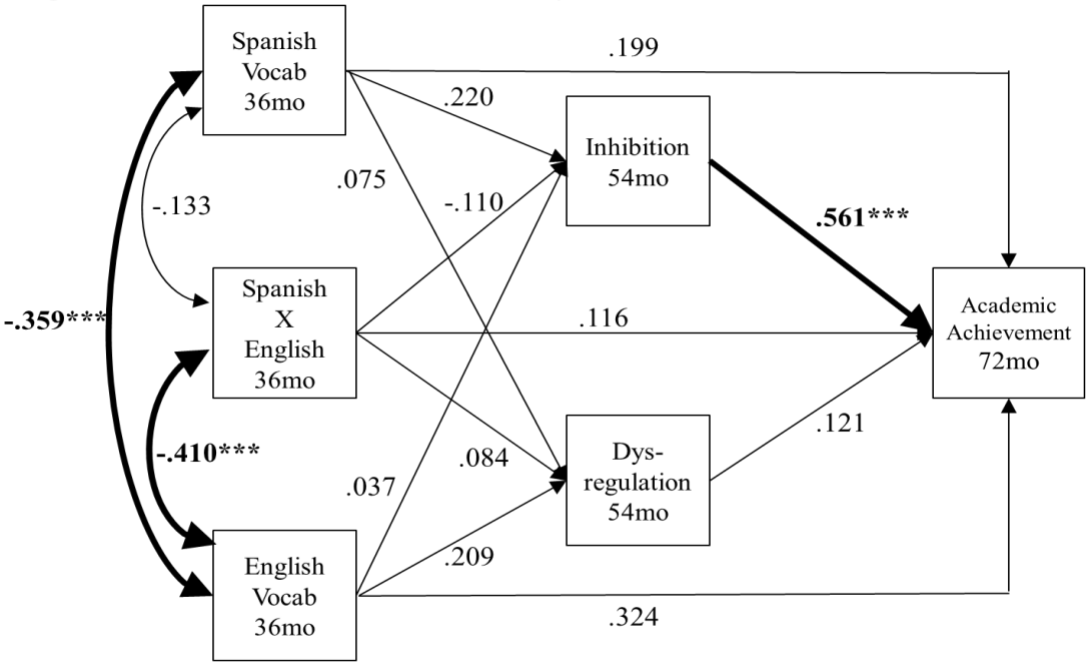
The mediated moderation model predicting academic achievement at 72 months from Spanish and English vocabulary at 36 months via emotion regulation and inhibition at 54 months fit the data well, χ^2 (1) = 0.003, p = 0.954, RMSEA = 0.000 (90% CI: 0.000, 0.000), CFI = 1.000. The Spanish and English vocabulary interaction at 36 months did not significantly predict inhibition and emotion regulation at 54 months or academic achievement at 72 months. Inhibition significantly predicted academic achievement (ß= 0.561, S.E.=0.135, p <.001). Spanish and English vocabulary at 36 months, emotion regulation, and inhibition accounted for approximately 45% of the variance in academic achievement, R^2 = .445, p <.01. See Table 4 and Figure 4 for full model results.

Table 4. *Model 1: Predicting Academic Achievement from 36 Month Vocabulary*

DV	IV	B	SE B	*p*	95% CI	R^2
KTEA						.445**
	CPT Hit Ratio	**.561**	**.135**	**.000**	**.270, .792**	
	Dysreg composite	.121	.193	.533	-.257, .497	
	English Vocabulary	.324	.176	.066	.067, .745	
	Spanish Vocabulary	.199	.137	.148	-.041, .505	
	English x Spanish	.116	.164	.479	-.203, .461	
CPT Hit Ratio						.066
	English Vocabulary	.037	.127	.769	-.181, .327	
	Spanish Vocabulary	.220	.098	.059	.024, .479	
	English x Spanish	-.110	.119	.418	-.341, .183	
Dysreg composite						.029
	English Vocabulary	.209	.127	.099	-.030, .466	
	Spanish Vocabulary	.075	.098	.442	-.118, .276	
	English x Spanish	.084	.119	.480	-.152, .318	

Note. ** indicates statistically significant, p < .05.

Figure 4. SEM 1 Results: 36 month Vocabulary



Note. Standardized coefficient pathways. ***$p < .001$

The second model predicting academic achievement at 72 months from child vocabulary, inhibition, and emotion regulation at 54 months fit the data well, χ^2 (1) = 0.100, p = 0.752, RMSEA = 0.000 (90% CI: 0.000, 0.121), CFI = 1.000. The interaction of Spanish and English vocabulary at 54 months did not significantly predict academic achievement at 72 months. Academic achievement was, however, significantly predicted by inhibition (ß= 0.501, S.E.=0.121, p <.001) and English vocabulary at 54 months (ß= 0.438, S.E.=0.104, p <.001). There was also a significant association between inhibition and Spanish vocabulary at 54 months (ß= 0.331, S.E.=0.088, p <.001) as well as English vocabulary (ß= 0.218, S.E.=0.085, p <.01). Whereas inhibition fully mediated the effect of Spanish vocabulary on academic achievement (αß= 0.166, S.E.=0.056, p = .003), the

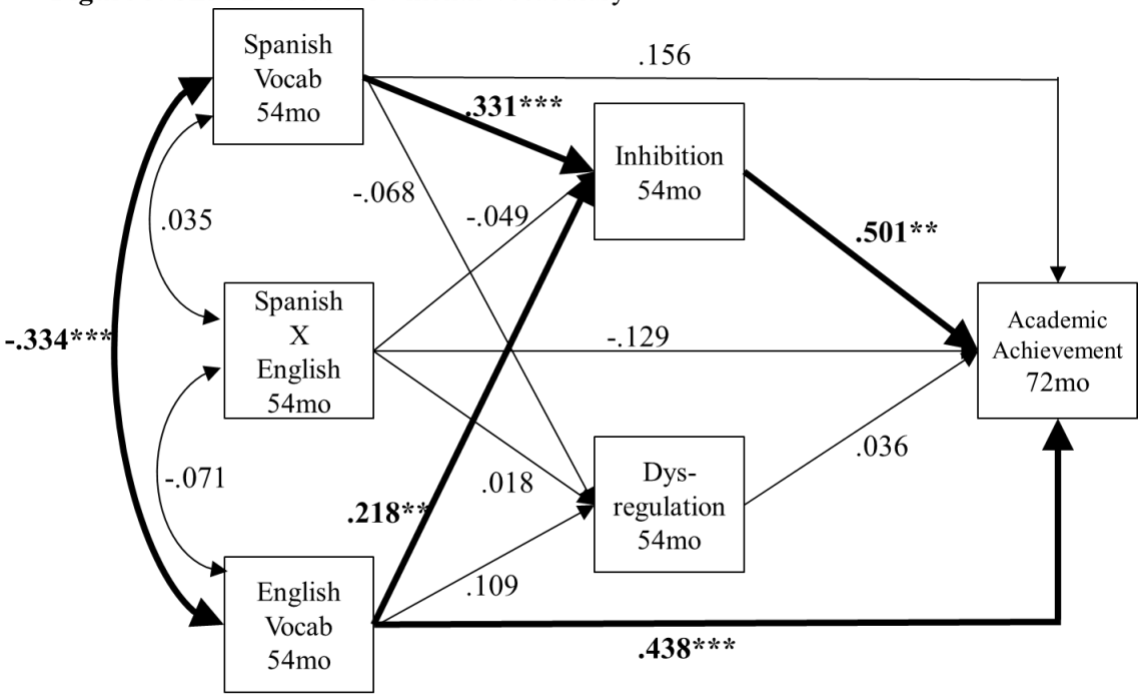
specific indirect effect from Spanish vocabulary to academic achievement via emotion regulation was not significant, $p = .870$. The effect of English vocabulary on academic achievement was partially mediated by inhibition (αß= 0.109, S.E.=0.050, $p = .028$), Spanish and English vocabulary, emotion regulation, and inhibition accounted for approximately 54% of the variance in academic achievement, $R^2 = .544$, $p < .001$. See Table 5 and Figure 5 for full model results.

Table 5. *Model 2: Predicting Academic Achievement from 54 Month Vocabulary*

DV	IV	B	SE B	*p*	95% CI	R^2
KTEA						.544***
	CPT Hit Ratio	**.501**	**.121**	**.000**	**.225, .700**	
	Dysreg composite	.036	.140	.798	-.270, .320	
	English Vocabulary	**.438**	**.104**	**.000**	**.225, .635**	
	Spanish Vocabulary	.156	.109	.151	-.036, .396	
	English x Spanish	-.129	.100	.196	-.306, .086	
CPT Hit Ratio						.111*
	English Vocabulary	**.218**	**.085**	**.010**	**.045, .382**	
	Spanish Vocabulary	**.331**	**.088**	**.000**	**.148, .496**	
	English x Spanish	-.049	.091	.591	-.276, .136	
Dysreg composite						.022
	English Vocabulary	.109	.115	.342	-.114, .338	
	Spanish Vocabulary	-.068	.080	.392	-.222, .092	
	English x Spanish	.018	.106	.869	-.181, .230	

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

Figure 5. SEM 2 Results: 54 month Vocabulary



Note. Standardized coefficient pathways. **$p < .01$, ***$p < .001$

The final model tested the effect of change in vocabulary between 36 and 54 months on academic achievement, mediated by inhibition and emotion regulation. Model fit was acceptable, χ^2 (1) = 0.032, p = 0.859, RMSEA = 0.000 (90% CI: 0.000, 0.098), CFI = 1.00. None of the constructed change factors (change in Spanish vocabulary, English vocabulary, and English change X Spanish change) significantly predicted academic achievement, inhibition, or emotion regulation. See Table 6 for full model results.

Table 6. *Model 3: Predicting Academic Achievement from Change in Vocabulary*

DV	IV	B	SE B	*p*	95% CI	R^2
KTEA						.430***
	CPT Hit Ratio	**.604**	**.097**	**.000**	**.408, .785**	
	Dysreg composite	.189	.175	.297	-.156, .534	
	Δ English Vocabulary	.064	.118	.589	-.188, .284	
	Δ Spanish Vocabulary	-.091	.154	.555	-.395, .207	
	Δ English x Δ Spanish	-.165	.135	.224	-.479, .059	
CPT Hit Ratio						.026
	Δ English Vocabulary	.139	.104	.180	-.066, .341	
	Δ Spanish Vocabulary	.020	.108	.851	-.192, .232	
	Δ English x Δ Spanish	.063	.111	.609	-.187, .307	
Dysreg composite						.032
	Δ English Vocabulary	-.023	.132	.862	-.250, .262	
	Δ Spanish Vocabulary	-.184	.100	.065	-.367, .024	
	Δ English x Δ Spanish	-.016	.111	.882	-.252, .184	

Note. *** $p < .001$.

Post-hoc Analyses

Given the significant correlation between child gender and inhibition (r =.19, p <.05), multiple group analyses were used to compare pathways to academic achievement across gender. The multiple group analyses did not fit the 36-month model or the change model well. Fit statistics for the multiple group analyses in the 54-month model were acceptable, χ^2 (10) = 15.342, p = 0.120, RMSEA = 0.070 (90% CI: 0.000, 0.136), CFI = .887. However, it is important to note that the model fit met criteria that are more

stringent when gender was not included in the 54-month model. The association between inhibition and academic achievement was significant for females (ß= 0.515, S.E.=0.174, p <.01) but only marginally significant for males (ß= 0.420, S.E.=0.214, p = *.05*). English vocabulary remained a significant predictor of academic achievement for both males and females. Spanish vocabulary at 54 months significantly predicted academic achievement for males (ß= 0.370, S.E.=0.095, p <.001) but not for females (ß= 0.212, S.E.=0.150, p =.158). Interestingly, English vocabulary was positively associated with emotion dysregulation for females (ß= 0.332, S.E.=0.141, p <.05) although this relation was not found in any of the previous models. See Tables 7 and 8 for full model results by gender.

Table 7. *Predicting Girl's Academic Achievement from 54 Month Variables*

DV	IV	B	SE B	*p*	95% CI	R^2
KTEA						.514**
	CPT Hit Ratio	**.515**	**.174**	**.003**	**.117, .792**	
	Dysreg composite	-.132	.358	.712	-.774, .527	
	English Vocabulary	**.477**	**.145**	**.001**	**.135, .690**	
	Spanish Vocabulary	.172	.129	.184	-.061, .448	
	English x Spanish	-.119	.098	.225	-.273, .127	
CPT Hit Ratio						.049
	English Vocabulary	.179	.117	.125	-.040, .418	
	Spanish Vocabulary	.212	.150	.158	-.078, .513	
	English x Spanish	.068	.153	.657	-.205, .386	
Dysreg composite						.095
	English Vocabulary	**.332**	**.141**	**.019**	**-.054, .617**	
	Spanish Vocabulary	.036	.125	.773	-.223, .271	
	English x Spanish	.090	.142	.526	-.185, .381	

Note. ** p < .01

Table 8. *Predicting Boy's Academic Achievement from 54 Month Variables*

DV	IV	B	SE B	*p*	95% CI	R^2
KTEA						.614***
	CPT Hit Ratio	.420	.214	.05	-.128, .709	
	Dysreg composite	.070	.195	.718	-.519, .503	
	English Vocabulary	**.530**	**.170**	**.002**	**.148, .785**	
	Spanish Vocabulary	.191	.146	.191	-.065, .502	
	English x Spanish	-.162	.134	.228	-.370, .160	
CPT Hit Ratio						.201*
	English Vocabulary	.255	.135	.059	-.031, .504	
	Spanish Vocabulary	**.370**	**.095**	**.000**	**.162, .536**	
	English x Spanish	-.202	.134	.130	-.452, .080	
Dysreg composite						.015
	English Vocabulary	-.001	.174	.996	-.123, .346	
	Spanish Vocabulary	-.084	.118	.476	-.235, .163	
	English x Spanish	-.096	.175	.583	-.180, .226	

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

Attrition Analyses

From the initial sample of 316 participants, 215 were re-assessed at the 36-month time point and 229 (72.5%) were re-assessed at the 54-month time point. Those children that had dropped out at 54-months were compared on all baseline variables of the study with those children who completed the interview at 36-months. Results showed no differences in 36 month English vocabulary, 36-month Spanish vocabulary, or gender. Attrition analyses were unable to be completed for the 72-month time point due to ongoing data collection.

DISCUSSION

The current study sought to better understand the role of bilingualism, inhibition, and emotion dysregulation in pathways to early academic achievement- among low-income Mexican-American children. It was hypothesized that greater bilingual ability would be predictive of greater academic achievement and that this relation would be mediated primarily by inhibition. Contrary to expectations, bilingual ability at 36- and 54-months did not meaningfully account for child inhibition, emotion dysregulation, or academic achievement. Similarly, change in bilingual ability from 36- to 54-months was also not predictive of the outcomes of interest. Although bilingual ability and change in bilingual ability were not predictive of inhibition, as previous literature has indicated, findings did suggest that Spanish vocabulary, in particular, was predictive of greater executive functioning and linked to greater academic achievement.

Language Vocabulary and Inhibition

It was not surprising to find that, in this sample, Spanish vocabulary was much more advanced than English vocabulary at 36-months. This is likely due to the heavy influence of maternal language choice and the language used in the home. Given that 90% of participating mothers preferred Spanish for their portion of the 36-month interview, Spanish was likely the primary language used during mother-child interactions. Additionally, 63% of children knew two words or less on the English vocabulary subtest of the Woodcock-Munoz, indicating that the majority of children at the 36-month time point were in fact not bilingual and should instead be considered

monolingual Spanish. As such, effects of bilingualism on inhibition would not be expected because few children in this sample met the definition of "bilingual" at this time point in the study. During the 54-month lab visit, 80% of mothers chose Spanish as their language preference and the discrepancy between child Spanish and English language vocabulary was less apparent. At the 54-month time point, 48% of the children were enrolled in preschool and scored, on average, two points higher on the English vocabulary subtest compared to those who were not enrolled in preschool. The reduced discrepancy between English and Spanish vocabulary may reflect the increased exposure to English language during preschool or head start programs combined with the maintenance of Spanish language vocabulary through its central role in the home.

The quality of the home environment during early years is often dependent on socioeconomic status, and is an exceedingly important contributor to child development (Bradley & Corwyn, 2002). Of note, the current sample was significantly below the norming sample of the English Form (6,359 English-speaking subjects in the United States) and Spanish Form (3,911 native Spanish-speaking subjects from both inside and outside the United States) in terms of vocabulary development, both at the 36 month and 54 month time points. Research shows that the effects of socioeconomic status on children's language development are substantial and based in different language-learning experiences (Hoff, 2006; Hemphill & Tivnan, 2008; Hoff & Tian, 2005). Vocabulary size is particularly sensitive to SES (Hart & Risley, 1995). Across cultures, higher SES mothers have been found to speak more to their children and for the purpose of eliciting conversation compared to lower SES mothers (Hoff, Laursen, & Tardif, 2002).

Socioeconomic status has also been found to have negative effects on child executive function (Hackman & Farah, 2009; Ayoub, O'Connor, Rappolt-Schlictmann, Vallotton, Raikes, & Chazan-Cohen., 2009; Daneri et al., 2018) and academic achievement (Lengua,Moran, Zalewski Ruberry, Kiff, & Thompson., 2015). In combination with extant research, the findings from this study suggest that any interpretation of the results must account for the SES of the participants and its likely influence on children's linguistic competence.

One possible explanation for the discrepant findings in regards to bilingualism and inhibition in the current study compared to existing literature may be that the task in this study was not cognitively demanding enough to elicit a difference between participants with varying levels of bilingual ability. In a study investigating different levels of working memory using the Simon task, the reaction time of bilingual children was found to be faster than monolingual children on all conditions with the greatest difference occurring in conditions that placed a higher demand on executive functioning (Morales, Calvo, & Bialystok, 2013). Although the current study did not measure working memory, it is possible that differences in inhibition would follow the same pattern found by Morales and colleagues (2013). Future studies investigating a bilingual advantage in inhibition should incorporate more cognitively demanding tasks which may be more likely to produce an observable advantage in executive functioning.

Another possible explanation for the discrepant results is that the demand required by the inhibition task (the CPT) did not tap into the same type of inhibitory control used in managing two language systems. Martin-Rhee and Bialystok (2008) theorize that the

two linguistic systems activated in the bilingual mind function as bivalent representations, meaning each linguistic system offers different and competing response options to achieve the same goal. Fluency in speech production is achieved by attending to the relevant language system and ignoring the unsolicited system (Kroll and Stewart, 1994; La Heij, 2005). The current study however assessed response inhibition to a univalent display. This may be less relevant to the bilingual experience given that bilinguals do not refrain from speaking (compared to the manner of response inhibition measured in this study), but rather must select between two language systems in competition when producing speech (Martin-Rhee & Bialystok, 2008).

Tasks that include a bivalent display, such as the commonly used Simon Task, require children to attend to one feature of the stimuli (color) and ignore the other (position on the screen). The Simon task is based on stimulus-response compatibility and requires participants to indicate the color of a presented shape by pressing a corresponding response key. Martin-Rhee and Bialystok (2008) examined these two types of inhibitory control (interference suppression using bivalent displays and response inhibition using univalent displays) and found that bilingual children performed better than monolingual children on tasks that require control of attention but performed equally well as monolingual children on tasks that required inhibition. This may help to explain why bilingual ability was not a significant predictor of inhibition in this study.

Language Vocabulary and Emotion Dysregulation

Neither Spanish nor English language vocabulary at 36 months were predictive of

emotion dysregulation. The same was true for vocabularies assessed at 54 months. These findings are surprising given the theoretical utility of language for emotion regulation. The phrase "use your words" stems from knowledge that the ability to express desires, needs, or feelings helps children regulate their behavior to achieve their goals (Vallotton & Ayoub, 2011). Instead of acting out in frustration, children learn that their goals can be more easily accomplished through communication. Expressive language in particular is closely integrated with the development of regulation abilities (Cole, Armstrong, and Pemberton, 2010). However, the type of language vocabulary measured in the current study was not specific to *emotional* expressive language, which may explain why the link between children's language skills and self-regulation was not evident in the current study.

Language Vocabulary and Academic Achievement

Academic achievement was not significantly predicted by bilingual ability at 36- or 54-months, thus the first hypothesis was not supported. It is possible that the lack of findings concerning bilingual ability reflects both difficulties defining and measuring the construct experienced by bilingualism researchers across fields (e.g., Kester & Peña, 2002). Cognitive and developmental researchers have struggled to agree upon a gold standard index of bilingualism. As such, it is approached in different ways across sub-disciplines which likely contributes to the inconsistent findings regarding a potential bilingual advantage. Lack of measurement consistency creates difficulty for comparisons across studies and construct consensus becomes an improbable task.

Only English vocabulary at 54-months was significantly associated with the measure of academic achievement at 72-months. Given that by 54-months most children are in English speaking schools within the state of Arizona, it is not surprising that their English language ability is most closely aligned with their academic abilities. Given the low English vocabulary of the current sample at the 36-month time point noted previously, it is not surprising that English vocabulary at 36 months was not connected with academic achievement. Future studies should investigate the role of English language ability at earlier ages within a more proficient, low-income, immigrant population.

Inhibition, Emotion Dysregulation, and Academic Achievement

A clear link was found between inhibition and academic achievement, such that greater inhibition corresponded to greater academic achievement. These findings corroborate other findings in the literature (Blair & Razza, 2007; Bull & Scerif, 2001). Inhibitory control is considered a central feature of developing executive functioning in early childhood (Diamond, 2013), and inhibition is essential to meet the demands asked of a child in an elementary classroom. For example, children are often asked to inhibit motor activity and to stay in their seats so that the teacher can present the class with information.

In contrast, emotion dysregulation was not related to academic achievement in the current study. Although there is significant evidence supporting the role of regulatory processes in academic performance, many existing studies are not specific to the

regulation of emotions and instead incorporate aspects of executive functioning (e.g., effortful control in behavioral self-regulation tasks). Not only has self-regulation been conceptualized as a multifaceted construct, but emotional and behavior self-regulation have been found to show unique developmental patterns (Edossa, Schroeders, Weinert, & Artelt, 2018). Edossa and colleagues (2018) found that emotion regulation had an indirect effect on academic achievement through behavioral self-regulation; however, this pathway was not explored in the current study. Amongst previous studies that have found a positive relation between emotion regulation and reading and math scores, the constructs were measured at more contiguous time points (Hill & Craft, 2003; Graziano, Reavis, Keane, & Calkins, 2007). Given that emotion regulation is still an emerging construct across development, the chances of finding a connection in the current study would likely increase if the constructs were measured at more contiguous time points instead of across a 1.5-year prediction period. Further consideration should be given to the overlap among dimensions of self-regulation (i.e., inhibition and emotion regulation) and the relation of each to academic outcomes.

Pathways of Influence to Academic Achievement

Between the two dimensions of self-regulation examined, inhibition was more strongly linked with Spanish language vocabulary and academic achievement. Findings of the current study supported the hypothesis that executive functioning would take a stronger role in predicting early academic achievement than emotional dysregulation given the centrality of cognitive processes to academic competence. However, the lack of association between inhibition and emotion dysregulation was unexpected and is

inconsistent with prior research that found significant relations between preschool children's inhibitory control and emotion regulation, even after controlling for verbal ability (Carlson & Wang, 2007). The finding that Spanish language vocabulary indirectly predicted academic achievement even while controlling for English language vocabulary suggests that children may benefit from maintaining their Spanish language abilities as they begin to immerse themselves in an English-speaking classroom.

The advantage for maintaining Spanish language found in this study raises the possibility that the benefits of bilingualism may become stronger over time. While bilingual children may initially lag behind their monolingual peers in terms of vocabulary development, this gap closes as they advance in their education (Hoff & Core, 2015). English-learners enrolled in dual-immersion or bilingual programs were found to surpass their English-immersion peers at the middle school level in reading, writing, speaking, and listening proficiency (Steele, Slater, Zamarro, Miller, Li, Burkhauser, & Bacon., 2017). Given that Hispanic children constitute the "majority minority" ethnic group of students in U.S. public schools (U.S. Department of Education, 2014), further evidence supporting these findings across different populations would help inform educational policy across the country. For example, the public school system in Arizona does not endorse dual language classrooms despite significant research suggesting that children from multilingual backgrounds benefit from such a learning environment (reviewed in Gándara & Hopkins, 2010; Hoff, 2013). Replication of these findings will be exceedingly important to convince policy makers of the benefit that can be gained from encouraging bilingual education programs.

Gender Differences from Post-Hoc Analyses

In the current study, gender was not considered a central focus of study given that it was not associated with academic achievement, the primary outcome. Gender was, however, significantly associated with inhibition. Post-hoc analyses suggest that there are some interesting, albeit confusing, differences when the results are evaluated by gender rather than by the full sample. Further examination of the pathway of influence from Spanish vocabulary to academic achievement through inhibition suggests that different paths are stronger for each gender, effectively nullifying the mediated pathways found in the full sample. The link between Spanish vocabulary and inhibition at 54-months was still present, but was only significant for males. Furthermore, the link between inhibition and academic achievement found was stronger for females than males. Some research has found faster rates of language acquisition for females (Eriksson et al., 2012; Galsworthy et al., 2000) and larger vocabularies in young females than males (Lutchmaya, Baron-Cohen, & Raggat, 2001). It is possible that cultural practices are, in part, responsible for gender differences in vocabulary. If female language acquisition occurred before that of their male counterparts, it is possible that the connection between vocabulary and inhibition would have been stronger during an earlier prediction period than the one utilized for the males. Interpretation of these results is highly speculative and replication is needed to increase confidence in interpretation of the gender differences.

Analyses by gender also revealed a positive association between female English vocabulary and emotional dysregulation, meaning the highest amounts of dysregulation were seen in girls with the largest English vocabulary. Gender has long been considered a

source of variation in studies of early self-regulation (Weinberg, Tronick, Cohn, & Olsen, 1999; Raikes, Robinson, Bradley, Raikes, & Ayoub, 2007). Additionally, Mexican-origin girls have been found to be at a higher risk for internalizing distress compared to their Mexican-origin male counterparts (Polo & López, 2009. It is possible that increased dysregulation is a result of this internalized distress in conjunction with conflict in developing ethnic identity. Studies suggest that females may be more at psychological risk for acculturation problems than males (Berry, Phinney, Sam, & Vedder, 2006). If English language use and growth is not valued in the household, perhaps this causes greater distress to young girls in terms of identity and familial relationships. These interpretations are also highly speculative and require that gender be further investigated to better understand the nature and implication of the differences that emerged in these post-hoc analyses.

Strengths and Limitations

There are multiple strengths as well as several limitations to the current study. The focus of the current study was to evaluate the proposed bilingual advantage in executive functioning within a sample of low-income, Mexican-American children. However, the hypotheses were made under the assumption that the population sampled would be bilingual; meaning, all children would have been exposed to some level of both English and Spanish language from birth and on a daily basis. Unfortunately, the low English vocabulary of this sample at 36 months did not align with the working definition of "bilingual." Despite the minimal English vocabulary, the homogenous socioeconomic status of this sample was a relative strength of the study given that socioeconomic status

is known to affect children's language development (Hoff, 2013; Hoff, 2006).

This study had multiple methodological strengths such as the use of observational coding, parent-report measures, and a clinical interview format. Nonetheless, sufficient multi-method measurements were not available to be able to examine executive functioning as a unitary construct (i.e. a latent variable). The composition of executive functioning and the tasks used to measure it are not clearly understood within the field. There is debate as to whether executive functioning should be considered a unitary construct or a heterogeneous set of dissociable processes (Garon, Bryson, & Smith, 2008; Jurado & Rosselli, 2007). Some researchers argue that inhibitory control cannot be effectively discerned from other executive function processes (e.g., working memory; Roberts & Pennington, 1996). Future studies might better consider investigating executive functioning as a unitary construct in pathways to academic achievement.

The observable measure of emotion dysregulation was assessed in the context of a dyadic interaction task that was intended to illicit mild frustration. Accurate measurement of emotion dysregulation was contingent on the child experiencing distress during the task. However, it seems apparent that the maze task selected did not produce enough distress to create sufficient variability in level of observed dysregulation. This may have been partly due to the varied approach taken by mothers during the interaction task. Although some mothers were very involved and tried to teach the child how to complete the maze, others completed the maze themselves or did not correct the child when the child did not complete the maze according to the directions given. This observation suggests that parenting and co-regulatory processes may be important determinants of

dysregulation.

Conclusions

In summary, the current study examined early childhood processes that influence success in an academic setting among a sample of low-income Mexican American children. Bilingual ability, a central focus of the current study, was not a significant predictor of inhibition, emotion dysregulation, or academic achievement. However, the benefit of Spanish language ability above and beyond English language vocabulary indicated by the study results is particularly meaningful within the cultural context of the population sampled. Arizona is one of several states that has passed a restrictive language policy within the educational system. Furthermore, this study provided further evidence that inhibition positively predicts academic achievement during early childhood. The findings of the current study are important because they inform our understanding of areas for intervention and prevention efforts that can help enhance the quality of early educational experiences to reduce the disparity in academic underachievement of Mexican American children. Finally, future studies should continue to investigate the development of self-regulatory abilities within bilingual, immigrant populations to further inform educational policy. With Hispanic children constituting the "majority minority" ethnic group of students in U.S. public schools (U.S. Department of Education, 2014), more efforts should be placed on helping low-income Hispanic kindergartners continue to reduce the decades old gap in academic achievement.

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