EXAMINING THE RELATION BETWEEN NON-ENGLISH HOME-LANGUAGE, EXECUTIVE FUNCTIONING, AND SCHOOL READINESS

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THESIS ABSTRACT

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Self-regulation skills are key for students to succeed in school. Self-regulation is also closely related to executive functioning (EF) skills, which are cognitive abilities necessary for focusing attention and adapting to context dependent changes in pursuit of a goal. Bilingual children may have an advantage over their monolingual peers in EF. However, it is not clear if this is true among emergent bilingual students. This study examined whether exposure to a non-English language at home predicted impulsivity and inattention in the preschool classroom, and whether it does so indirectly through EF skills. Families where English is not the only language spoken at home, at least some of the time, with a three- to five-year-old preschooler were recruited for this study. The NIH Toolbox Dimensional Change Card Sort (DCCS) test and the NIH Toolbox Flanker Inhibitory Control and Attention test were used to measure EF. NIH Toolbox Picture Vocabulary Test (PVT) measured receptive vocabulary in English. Parent reports indicated what languages are spoken at home. Teachers completed the ADHD symptoms scale of the MacArthur Health and Behavior Questionnaire, which measured inattention and impulsivity. Non-English language exposure was not significantly related to DCCS, Flanker, or ADHD symptoms scale scores. PVT scores did not interact with Non-English language exposure to predict DCCS or Flanker scores. DCCS scores were positively related to ADHD symptoms scores. Methodological considerations regarding the results are discussed.

Introduction

The transition into school, whether preschool or kindergarten, marks a major shift from learning in an informal setting to a more formal one. To successfully make this transition, children need certain basic-learning skills (McClelland, Acock, & Morrison, 2006). Because of the role these skills have on later academic success, national and state education agencies are developing assessments to measure preschool students' school readiness. These assessments typically look at three domains of school readiness: self-regulation, early literacy skills, and early mathematics skills. Amongst the challenges in developing an assessment of school readiness is ensuring that it is equally valid for native-English speaking students and emergent bilingual students (Kindergarten Readiness Assessment Workgroup, 2012). However, few studies have investigated the unique ways emergent bilingual students develop these school readiness skills.

Self-Regulation, Executive Functioning, and School Readiness

To understand what emergent bilingual students need to succeed academically, researchers need to understand what skills are necessary for all students to succeed in the classroom. When asked what students need to transition into kindergarten, teachers frequently indicate the ability to follow instructions and the ability to work independently (Rimm-Kaufman, Pianta, & Cox, 2000). These behaviors require students to attend to a task even if it may cause stress and to cooperate with peers and teachers, which are behaviors that require self-regulation. Research on school readiness has echoed this sentiment. One study found that learning related behaviors, including self-regulation, independence, and cooperation, in kindergarten predicted math and reading skills into 6^{th} grade (McClelland, Acock, & Morrison, 2006). These skills allow students to be engaged in the learning process, which in turn leads to academic success. During preschool, children begin to show self-regulation through conscious control of their behavior (Blair & Razza, 2007). This occurs when children inhibit emotional responses, and engage in classroom activities. Preschool age children begin to develop the ability to employ effortful self-regulation more readily, and with fewer external cues.

Self-regulation is a contextually driven process in which automatic emotional response systems and higher-order executive function systems interact to guide behavior (Blair & Raver, 2015). Different contexts will elicit various amounts of arousal according to the stress response system of the individual. If a situation or task causes a moderate amount of arousal, the individual will more easily engage in higher-order processes, specifically attention. The individual's attention will be drawn to critical aspects of the situation that will allow the individual to successfully interact with it. Situations that elicit too little or too much arousal will inhibit attention processes, leading to unsuccessful interactions. Conversely, individuals may guide attention consciously in a manner that optimizes arousal levels.

Successful entry into school requires children to self-regulate in ways that allow them to engage in learning. The separation from caregivers, the introduction of new and more complex information, and interactions with peers and teachers provide students with many opportunities to experience usually normative levels of stress. Students with better self-regulation skills may guide their attention to engage in lessons and classroom activities, while maintaining prosocial interactions with others (Blair & Raver, 2015). Students who display poorer self-regulation will disengage from activities and display more negative emotions. Early self-regulation skills also provide an essential foundation onto which math and verbal skills are built. Self-regulation skills are generally associated with increases in math and reading ability over time (Cain, Oakhill, & Bryant, 2004; McClelland et al., 2006), and intervention research has found that teaching self-regulated learning strategies enhances mathematical problem solving (Fuchs et. al., 2003). Self-regulated learning strategies encourage students to reflect on their approach to problems, and their use of time, which in turn promotes cognitive flexibility (Zelazo, Blair, & Willoughby, 2016). This ability to engage in metacognition is critical, as students need to reflect on their school related behavior to develop academically.

Executive Function

Executive function (EF) abilities undergo rapid development in early childhood as children prepare to enter school. EF refers to a set of metacognitive abilities used to consciously direct behavior and, thereby, partially support self-regulation. These abilities include cognitive flexibility, working memory, and attention/inhibition. Cognitive flexibility encompasses thinking about problems in different ways and from different perspectives, as well inhibiting previously learned responses. Working memory is the ability to retain information for a small amount of time and manipulate it. Executive attention and inhibition simultaneously involve focusing on a specific stimulus while inhibiting distracting stimuli and responses (Zelazo, Blair, & Willoughby, 2016). Using large, cross-sectional studies, researchers have shown that the most rapid rate of EF development occurs between four and eight years old, at which point development begins to slow (Zelazo et al., 2013). Although EF skills continue to improve through adolescence, most children reach adult-like mastery of working memory, inhibition, and cognitive flexibility tasks around age 12 (Best & Miller, 2010). A steep improvement in cognitive flexibility occurs between the ages of five and seven.

Various studies have established a relation between EF in preschool and emerging mathematics and verbal skills in kindergarten and grade school. Preschoolers' accuracy on the Head-Toes-Knees-Shoulders Task, which requires cognitive flexibility, working memory, and attention and inhibition, has predicted early literacy and math abilities (McClelland et. al., 2007). Furthermore, one meta-analysis showed a moderate effect size (r = .27) regarding the relation between EF skills and academic performance (Allan et al., 2014). Regarding early literacy, working memory at age five predicts literacy at age ten as accurately as verbal IQ at age 10 (Alloway & Alloway, 2010), and other work has documented links between deficits in EF and specific deficits in reading comprehension (Cutting, Materek, Cole, Levine, Mahone, 2009).

Students in poverty are at increased risk for poorer self-regulation and EF (Blair, 2016). According to the family stress model, financial hardships put stress on parents which lowers their ability to engage in sensitive parenting (Conger & Donnellan, 2007). Children whose mothers displayed sensitivity and autonomy support during infancy showed better self-regulation in toddlerhood (Bernier, Carlson, & Whipple, 2010). However, cumulative risk associated with low socioeconomic status may inhibit mothers' ability to provide warm, sensitive parenting (David, Gelberg, & Suchman, 2012). One study found an indirect association between parent-child co-regulation and academic competence in the early school years, mediated by EF among homeless preschool age children (Herbers, Cutuli, Supkoff, Narayan, & Masten, 2014). Parent-child co-regulation refers to the process in which parents respond to children's signals, and children, in turn, respond to their parents' behavior. Positive interactions of this sort become a model for children to use to self-regulate.

Emergent bilingual students and language development

Emergent bilingual students are children who, with proper instruction, will reach fluency in English and in their native or home language. Despite the potential of these students to reach fluency in two languages, emergent bilingual status is associated with a number of academic risks. The most apparent area is literacy skills, with emergent bilingual students showing slower vocabulary growth and poorer text comprehension than their monolingual peers (August, Carlo, Dressler, & Snow, 2005). The academic risks associated with emergent bilingual status are not limited to language centered subjects; emergent bilingual high schoolers are also at risk for falling behind their monolingual peers in mathematics (Beal, Adams, & Cohen, 2010).

Despite the risks associated with emergent bilingual status, some findings indicate that emergent bilingual status may not be as detrimental as once believed. For example, many studies comparing later academic outcomes between English Learner students to monolingual students omit children who are reclassified as Fluent English Proficient from analyses. These students were classified as English Learner earlier in development, but reached fluency later. Including Fluent English Proficient students in analyses of academic achievement reduces the achievement gap between bilingual students and their monolingual peers (Saunders & Marcelletti, 2013). A related problem occurs when emergent bilingual students are misclassified as having a learning disability due to poor English proficiency (Bernhard at al., 2006). This problem can be alleviated when programs specifically target the educational needs of emergent bilingual students and avoid characterizing these students as learning disabled. In one study, researchers found that an early literacy program that fostered bilingual development and literacy skills positively impacted literacy skills, bilingual identity, and self-esteem amongst emergent bilingual students (Bernhard et al., 2006). The research to date shows that responsiveness to the distinct needs of emergent bilingual students can diminish the achievement gap between emergent bilingual students and their monolingual peers.

Educators and policymakers may be more concerned about emergent bilingual students' English language acquisition. This attitude is reflected in laws and policies that push for English-only education of emergent bilingual students (Arizona Proposition 203; Massachusetts Question 2). However, it is important that these students reach fluency in both languages so that they can be active participants in school and society, as well as within their families and culture (Garcia & Kleifgan, 2010). Despite research showing that emergent bilingual students succeed academically when their native language is fostered, English-only education programs are still implemented across the United States (Garcia & Kleifgan, 2010; Slavin & Cheung, 2005). A noteworthy finding by Slavin and Chueng (2005) was that literacy in English is best accomplished by reading programs which teach English and another language concurrently. This underscores the need to understand the cognitive development of emergent bilingual students who may be at risk for negative academic outcomes, in addition to typical bilingual development.

Bilingual language acquisition may improve children's EF (Bialystock & Martin, 2004; Calvo & Bialystock, 2014; Wimmer & Marx, 2014). As stated previously, EF is a critical aspect of school readiness. Children need to engage with classroom activities, while inhibiting inappropriate behavior. They need to apply different sets of rules depending on the classroom activity. They must also think about their own behavior from the perspective of their peers to develop social competency. In early research, bilingual children outperformed their monolingual peers on behavioral assessments of EF, particularly cognitive flexibility (Bialystock & Martin, 2004). Researchers theorized that repeatedly shifting languages in response to contextual factors, while inhibiting the contextually inappropriate language, enhanced EF through practice. Furthermore, repeated practice in activities that require cognitive flexibility, working memory, or attention have shown to improve overall EF in previous studies (Diamond & Lee, 2011; Fuchs et. al., 2003). These studies did not investigate bilingualism, but they did emphasize the importance of continuous practice to enhance EF.

Although initial evidence indicated a bilingual advantage for EF, the existence of this phenomenon has been a debated topic in developmental cognitive research. Numerous studies have alternatively found smaller or nonsignificant differences in EF between bilinguals and monolinguals (Morton & Harper, 2007; Paap & Greenberg, 2013). One explanation is that bilingual status could be confounded with socioeconomic status (SES). Bilingual children in early studies may have been from higher SES groups than their monolingual peers due to immigration policies that favor higher educated, higher skilled adults, for example. The bilingual children may outperform monolinguals due to higher SES in these samples, and the bilingual advantage in EF at least sometimes disappears in studies that control for ethnicity and SES (see Morton & Harper, 2007). In the United States, however, children raised in a home where at least one adult speaks a non-English language experience poverty at greater rates than children raised in monolingual households (Child Trends Databank, 2014). More recent research has addressed whether the bilingual advantage can be observed while controlling for socioeconomic status. One study found that higher SES and larger receptive vocabulary in two languages predicted better EF independently of one another (Calvo & Bialystock, 2014). Another study found better EF even amongst low-income, immigrant, bilingual populations compared to matched monolingual students (Engel de Abreu, Cruz-Santos, Tourinho, Martin, & Bialystock, 2012). Within populations that experience poverty, there is evidence that bilingualism is related to better EF.

Hispanic youth in the United States are more likely than their non-Hispanic peers to live in poverty, as well as speak another language at home. The poverty rate amongst Hispanic youth below the age of 18 is 33.8%, compared to the 24.6% rate in non-Hispanic populations (Pew Hispanic Center, 2012), which may put Hispanic youth at risk for performing poorly in school. Furthermore, the majority of Hispanic families likely live in some form of bilingual context, with only 36% of Hispanic families in the United States reporting only speaking English at home (Pew Hispanic Center, 2012). Although the quality of bilingual development varies across children and families, children from homes that provide an environment that fosters bilingualism may show better EF. The literature has revealed associations between EF and school readiness respectively, but there is no research on how bilingualism affects school readiness regarding children's self-regulation. The goal of this study was to investigate how these associations relate to one another.

The current study relied on data gathered from a larger study investigating school readiness. Data was collected from preschool administrative records regarding the home language environment of participating students, and this was analyzed for associations with preschool assessments of school readiness. Students completed a measure of receptive vocabulary, which refers to the number of words that a person can comprehend, but not necessarily speak. Measures of receptive vocabulary in kindergarten have predicted reading comprehension in third grade, which makes receptive vocabulary an key variable concerning school readiness (Sénéchal, Ouellette, & Rodney, 2006). Teacher ratings of learning related skills have been shown to predict academic achievement into grade school (Portilla, Ballard, Adler, Boyce, & Obradović, 2014). For the purpose of this study, teachers were asked to rate children's impulsivity and inattention, which are indicators of poor self-regulation in the classroom context. Links have previously been established between bilingualism and EF, and between EF and school readiness skills. This study will expand upon previous research by testing an indirect relation between bilingualism and school readiness skills, through EF. Cognitive flexibility and inhibitory control are the components of EF that were directly measured. Cognitive flexibility is the aspect of EF that allows individuals to adjust behavior depending on context. Inhibitory control is the aspect of EF that allows individuals to suppress inappropriate responses. This study will also help to understand how cognitive flexibility and inhibitory control are related to self-regulation in the classroom.

Hypotheses

This study aims to test whether preschoolers who are regularly exposed to two languages demonstrate an advantage in EF compared to monolingual peers within a preschool serving primarily low-income families. It will also test whether any observed advantage affects their ability to succeed in preschool and kindergarten.

Hypothesis 1: Home language will be positively related to EF scores, with non-English home language exposure predicting higher executive function scores.

Hypothesis 1a: This relation will be moderated by receptive vocabulary in English, with non-English home language exposure and more advanced receptive vocabulary predicting higher EF scores.

Hypothesis 2: Non-English home language exposure will be negatively correlated with teacher reports of impulsivity and inattention.

Hypothesis 3: EF scores will mediate the relation between non-English home language exposure and teacher reports of impulsivity and inattention.

Although preschool age bilingual students may have stronger EF than monolingual children (Bialystock & Martin, 2004), it is unclear whether this association is related to other variables, such as self-regulation in the classroom. There is a need to understand how observed differences in cognitive ability and inhibitory control may affect children's ability to apply cognitive strengths in real world settings. It is also necessary to shift research on bilingual development away from a deficits model, and towards a comprehensive understanding of the strengths and weaknesses of emergent bilingual children.

Methods

Data were drawn from a larger study investigating the processes of risk and resilience in the form of kindergarten readiness for preschoolers who experience adversity. Below I explain procedures relevant to the current analyses.

Participants

Researchers recruited families with a preschooler between the ages three and five from a local preschool in Camden, NJ. Students are chosen amongst Camden residents to attend the preschool after an application process and, often, a waitlist. For the purpose of this study, students who were attending the summer session of the participating preschool were recruited. Participating families had to speak English or Spanish fluently, and have a child attending the school with no previously identified developmental disabilities. Parents/guardians for each student consented to participate. Parents/guardians had the option to complete consent and parent-report forms in English or Spanish, which certified translators prepared. Parents had an opportunity to ask investigators questions about study procedures, and families whose preferred language is Spanish were able to speak to a fluent Spanish speaker.

The final sample consisted of 66 students attending the summer session of the participating preschool. Within the sample 61% of students were African American, 35% Latino; students of any other race made up 4% of the sample. Further demographic information can be found in Table 1.

Procedures

Trained research assistants conducted assessments with students one-on-one in the preschool. Research assistants guided each student through the measures which were all on an electronic tablet. The application is the NIH Toolbox, which provides a battery of tests that measure cognition, emotion, motor skills, and sensory function (NIH Toolbox Technical Manual, 2012). The three measures took no longer than 20 minutes to complete. Teachers were asked to complete questionnaires regarding school related behaviors of participating students.

Measures

NIH Toolbox Dimensional Change Card Sort Test. The Dimensional Change Card Sort (DCCS) Test is one of the mostly widely used measures of cognitive flexibility. During the test, children are shown two target images on an iPad screen. The two images differ from each other based on two dimensions, shape and color (e.g. blue ball, yellow truck). Children are then told to match each test image with one of the target images based on the test image's shape. After several trials, children are told to sort the images based on color. The change of rules forces children to engage in cognitive flexibility; after they have become accustomed to matching based one rule, they must comfortably switch to playing the same game with slightly different rules. If a child's accuracy on post-switch trials is less than 100%, the assessment ends and a score is calculated based on accuracy alone. If accuracy on the second half of trials is 100%, the children go through another thirty trials in which the rules may switch at any point. In this case, a final score is computed based on accuracy and reaction time. If children below the age of eight fail to perform at a certain threshold during the task, they complete developmental extension trials. These trials scaffold the difficulty of trials based on errors made in earlier trials (Slotkin et. al., 2012b). The NIH Toolbox calculates age-corrected scores based on performance on standard trials. However, age-corrected scores are not available for students who only complete the developmental extension. These age-corrected scores are set to have a population mean of 100, with a standard deviation of 15.

The DCCS was originally developed to test young children's ability to systematically use rules (Frye, Zelazo, & Palfai, 1995). The NIH Toolbox DCCS has been used in a study with a large sample (n = 4,859), to determine norms for different age groups (Slotkin et. al., 2012). A smaller study (n = 476) was done to confirm test-retest validity (ICC = .96), as well as convergent and discriminant validity. To measure convergent validity, the DCCS was tested against the Delis-Kaplan Executive Functions System (r = .51). To measure discriminant validity, it was tested against the Peabody Picture Vocabulary Test (r = .14) (Weintraub et. al., 2013).

NIH Toolbox Flanker Inhibitory Control and Attention Test. The NIH Toolbox Flanker Test measures inhibitory control by requiring individuals to suppress the impulse to respond to distracting stimuli. During each trial, children are shown five fish overlaid with arrows in a row on an iPad screen. On congruent trials, all five fish are pointing in the same direction. On incongruent trials, the middle fish is pointing in the opposite direction of the “flanker” fish. Children are instructed to indicate the direction that the middle fish is pointing by pressing one of two buttons. If a child responds correctly on less than 90% of 20 trials, the test ends and a score is calculated based on accuracy. Children who respond correctly on 90% or more of trials complete a second set of 20 trials, which display arrows without fish. The test provides a score based on accuracy and reaction time (Slotkin et. al., 2012b). The NIH Toolbox calculates age-corrected scores based on raw scores and norms for students’ age. These age-corrected scores are set to have a population mean of 100, with a standard deviation of 15. Developers conducted a study (n = 476) to test the NIH Toolbox Flanker Test for test-retest reliability (r = .96), as well as convergent and discriminatory validities. In order to test for convergent validity, developers compared performance on the Flanker with performance on the Wechsler Adult Intelligence Scale – 4th edition, and the Wechsler

Intelligence Scale for Children – 4th edition (r = .41). Developers tested for divergent validity by comparing performance on the Flanker to performance on the Peabody Picture Vocabulary Test – 4th edition (r = .15) (Weintraub et. al., 2013).

NIH Toolbox Picture Vocabulary Test. The NIH Toolbox Picture Vocabulary Test (PVT) indexes receptive vocabulary. In each trial, children hear a target word and are shown four images on an iPad screen. The child must choose the image that best fits the word. The Picture Vocabulary Test is an adaptive test, so that the difficulty of one trial is determined by the response to the previous trial. Succeeding trials converge on the highest difficulty level of vocabulary that the child is likely to respond to correctly. The scoring of the PVT is based on Item Response Theory, which is used to produce a theta score that reflects an individual's ability while accounting for item difficulty and the probability of guessing based on results obtained during measure development (Gershon et. al., 2014). The difficulty of a particular vocabulary level is indicative of the size of an individual's receptive vocabulary. Scores are scaled based on nationally representative norms (NIH Toolbox Technical Manual, 2012). The NIH Toolbox calculates age-corrected scores based on raw scores and norms for students' age. These age-corrected scores are set to have a population mean of 100, with a standard deviation of 15. A study was conducted (n = 476) to test the NIH Toolbox Picture Vocabulary Test for test-retest reliability (r = .94), as well as convergent and discriminatory validities. To measure convergent validity, the test was correlated with the Peabody Picture Vocabulary Test (r = .78). To measure discriminant validity, the measure was correlated with the Brief Visuospatial Memory Test (r = .08; Weinstraub et. al., 2013).

MacArthur Health and Behavior Questionnaire - Teacher. The MacArthur Health and Behavior Questionnaire (HBQ) is a measure of mental, physical, and school related health and positive behavior in middle childhood completed by teachers. The HBQ asks age-sensitive questions regarding impairment and symptomology experienced by four- to eight-year-olds. Investigators have successfully used the measure to identify internalizing and externalizing behaviors in children as young as two (Lenze, Pautsch, & Luby, 2011). For the purpose of this study, I will use the attention-deficit/hyperactivity disorder symptom scale. Subscales of this measure include inattention and impulsivity, which are indicators of poor self-regulation skills (Skogan et al. 2015). Items in this scale include "distractible, has difficult time sticking to an activity", and "has difficulty awaiting turn in games or groups." Each item is rated on a three-point Likert scale ranging from 0 = never or not true, to 2 = often or very true. Scores will be obtained for each subscale by calculating the mean of each response. An ADHD Symptoms Scale score will be calculated by taking the mean of the two subscales. Paying attention, persisting on difficult tasks, and inhibiting impulses are prerequisites to learning. Low scores on impulsivity and inattention subscales index a component of self-regulation, one aspect of school readiness. Teachers completed the questionnaires during the last half of the summer session. Several studies were conducted to assess the psychometric properties of the HBQ. These studies sampled from diverse populations who encompassed different ethnicities, income levels, and parental education levels. The impulsivity and inattention subscales showed good internal consistency (α = .90 and .91 respectively). The overall ADHD symptom scale showed good test-retest reliability in both community and clinical samples (spearman ρ = .94 and .95 respectively). In order to test discriminant validity, researchers administered the HBQ to clinical and community samples, which yielded results indicating a main effect of group (community versus clinical) on impulsivity and inattention subscale scores.

Demographic information. Upon enrollment in the preschool, families complete an entry questionnaire which includes items asking about demographic information. Parents indicate the race/ethnicity, gender, and birthday of their children. Age is calculated based on the day the child completed the battery of cognitive assessments. Race/ethnicity was coded as 0 = Non-Hispanic/Latino, and 1 = Hispanic/Latino. In this sample, the majority of non-English language users are Hispanic/Latino. This coding scheme for race/ethnicity allowed me control for cultural influences specific to Hispanic/Latino families that may be confounded with home language use. One item asks which languages are spoken in the home. Their responses will be coded as 0 = English is the only language spoken at home, and 1 = English is not the only language spoken at home.

Statistical Analyses

The first step of analyses included running descriptive statistics on demographic, predictor, and outcome variables. I used Pearson correlations to test the association between all of my variables. All analyses related to my hypotheses controlled for age, gender, and ethnicity. Although the NIH Toolbox provides age-corrected standardized scores, students who received a score based on the developmental extension of the DCCS did not receive an age-corrected score. All of the analyses were run with uncorrected DCCS scores to maintain compatibility of developmental extension scores with standard scores. Age was included as a control variable as a result. In order to maintain consistency, uncorrected PVT and Flanker scores were used in regression analyses. Gender was included due to its relation to behavioral measures of self-regulation, with boys often underperforming on behavioral tasks and teacher reports (Matthews, Ponitz, & Morrison, 2009). To test the association between home language and EF scores, I used multiple regression analyses. Several models were tested, beginning with a model containing gender, age, and ethnicity predicting DCCS scores. Following this, home language was added to the second model. Before testing the moderating effect of receptive vocabulary in English on home language, I conducted a multiple regression with PVT scores and control variables predicting DCCS scores. The home language variable was then added again to test the main effects of home language and PVT scores on DCCS scores. Finally a model was tested with PVT scores, home language, and their interaction term predicting DCCS scores. These statistical analysis procedures were then repeated with Flanker scores as the outcome variable.

To test the indirect association between home language and ADHD symptoms scale scores, I followed the steps laid out by Baron and Kenny (1968). Previously outlined multiple regressions tested the association of home language and DCCS and Flanker scores. I then conducted a multiple regression with control variables predicting ADHD symptoms scale scores. Home language was then added to the model with control variables. Finally, in two separate analyses, DCCS and Flanker scores were added in to the model in order to test for mediation.

Results

Executive Function

In the first model including control variables, age (Exp(B) = 2.67, 95% CI: 1.57 - 3.77, $p < .001$) and gender (Exp(B) = -1.63, 95% CI: -3.10 - -0.16, $p < .05$) had significant main effects on DCCS scores, with older children and girls performing better. Home language was then added to the next model. There was no significant relation between non-English home language exposure and scores on the Dimensional Change Card Sort after controlling for age, gender, and Hispanic ethnicity. In subsequent models, PVT scores did not interact with the non-English home language exposure to produce a significant association when added. A full report of models predicting DCCS scores can be found in Table 3.

When a model predicting Flanker scores was run with control variables alone, age (Exp(B) = 1.51, 95% CI: 0.55 - 2.46, $p < .01$) and Hispanic/Latino ethnicity (Exp(B) = 1.15, 95% CI: 0.08 - 2.23, $p < .05$) had significant main effects, with older children and Hispanic/Latino children performing better. The following model included home language as well as control variables. There was no significant relation between non-English home language exposure and scores on the Flanker Test after controlling for age, gender, and Hispanic ethnicity in this model. When PVT scores, home language, and their interaction term were included, PVT scores did not interact with the non-English home language exposure to produce a significant association. A full report of models predicting Flanker scores can be found in Table 4.

Inattention and Impulsivity

In the first model including control variables, there were no statistically significant associations between age, gender, ethnicity with ADHD symptoms. There was also no significant relation between non-English home language exposure and ADHD symptoms after controlling for age, gender, and Hispanic ethnicity. Unexpectedly, in the model in which DCCS scores were included with control variables, scores on the DCCS were positively related to teacher reports of impulsivity and inattention (Exp(B) = 0.05, 95% CI: 0.01 - 0.09, $p < .05$). In this same model, age also had a main effect on ADHD symptoms scale scores (Exp(B) = -0.24, 95% CI: -0.47 - -0.02, $p < .05$). No significant relation between scores on the Flanker Test and teacher reports of ADHD symptoms emerged in any model. A full report of models predicting ADHD symptoms scale scores can be found in Table 5.

Discussion

The current study found no association between non-English home language exposure and cognitive flexibility or inhibitory control among English-speaking preschoolers. Previous research has found a positive relationship between bilingual status and EF ability in early childhood (Bialystock & Martin, 2004; Calvo & Bialystock, 2014; Wimmer & Marx, 2014). It has been contested that this is due to socioeconomic disparities between monolingual and bilingual children (Morton & Harper, 2007). The purpose of this study was to investigate whether this relation could be found in a low-income community. It also sought to expand on previous research by examining whether the bilingual advantage extended to self-regulation in the classroom. One explanation might be that in previous studies, socioeconomic status was confounded with bilingual status. Early research that found a bilingual advantage regarding EF utilized samples of bilingual children the parents of whom had greater levels of educational attainment than their monolingual peers (Morton & Harper, 2007). After testing my hypotheses, I tested for associations between language and ethnicity and SES indicators. Although the participating preschool of this study is located in a low-income community, within this sample, home language and ethnicity were unrelated to income and parental educational attainment. Due to substantial amounts of missing data on educational attainment and income, these analyses were not included in the paper. If the bilingual advantage were better explained by socioeconomic status, a sample in which monolinguals and bilinguals were matched on indicators of SES should yield no evidence of an advantage. However, a study utilizing a large, nationally representative sample found that bilingual status ameliorated the negative relation between SES and EF (Hartanto, Toh, & Yang, 2018). This would indicate that in a low-income community, where monolingual and bilingual children are matched on indicators of SES, there would be a greater bilingual advantage.

Researchers have previously identified associations between high-quality preschool education and school readiness skills. These studies typically find stronger associations with early literacy and math skills than self-regulation skills (Burchinal, Vandergrift, Pianta, & Mashburn, 2010). However, it is necessary to note this sample was exclusively drawn from a single preschool. It may be that the enriching experience of attending a quality preschool has had an effect on self-regulation skills that diminished possible associations between home language exposure and EF

In addition to SES, few studies investigating the association between bilingualism and early EF skills have considered the impact of culture. Cross cultural comparisons have revealed that culture is associated with the development of self-regulation, after controlling for bilingualism (Tran, Arredondo, & Yoshido, 2018). Early research that found a bilingual advantage largely compared Chinese bilingual children to White monolingual children (Bialystock & Martin, 2004). The current investigation relied on a sample that was almost entirely African American or Hispanic/Latino. It may be that cultural factors that contribute to the development of EF are shared more between African American and Hispanic/Latino families than they are between Chinese and White Canadian families.

Previous studies investigating the association between bilingualism and EF have operationalized bilingualism in a number of ways (Morton & Harper, 2007; Paap & Greenberg, 2013; Tamis-LaMonda et al., 2014; Wimmer & Marx, 2014). It is unclear how different aspects of bilingualism relate to EF. The number of contexts in which, or people with which children raised in non-English speaking homes must interact in each language may be differentially related to cognitive flexibility demands. Whether preschool teachers and family members engage in language mixing with the child may reduce the necessity to make cognitive switches. Language mixing occurs when individuals incorporate words from two languages in the same sentence. Theories regarding the association between bilingualism and enhanced EF generally stress that children attend to cues that indicate a shift in language. They use these cues to shift their mindset to appropriately comprehend and engage in conversation in the appropriate language. This practice in set shifting enhances the ability of children to engage in cognitive flexibility in different ways (Bialystock & Martin, 2004). Although language mixing is associated with better language comprehension (Place & Hoff, 2016), this form of language input may reduce cognitive flexibility demands in children, leading to less practice.

Another concern is that Hispanic families in this community may be disproportionally likely make alternative summer plans that would exclude their children from enrolling in the summer program. Latino students and, as a result, students exposed to a non-English language at home, were less represented in the population of summer school students than in the population of students during the school year. Detection of a mean difference of DCCS or Flanker scores between children exposed to only English, and children exposed to some second language in this sample would require an effect size of 0.91. This exceeds the effect sizes reported in the literature on the bilingual advantage, which are generally small to modest effect sizes (Hartanto, Toh, & Yang, 2018). Future research in this vein needs to reflect true variability in non-English language exposure in this community.

This study also failed to find evidence that non-English home language exposure was related to lower levels of inattention and impulsivity in the classroom. Previous research has found that bilingual status in early childhood is positively related to teacher reports of attentional-focusing behaviors (Hartanto, Toh, & Yang, 2018). Bilingual status also proved to ameliorate the association between low-SES and attentional-focusing behaviors, in a pattern similar to cognitive flexibility. Similarly to analyses including EF measures, underrepresentation of bilingual students in our sample makes this analysis equally underpowered.

A surprising pattern did emerge with DCCS scores being positively related to teacher reports of inattention and impulsivity. This indicates that children with greater cognitive flexibility were reported as having poorer self-regulation behavior. However, scores on the Flanker test were unrelated to teacher reports of impulsivity and inattention. Previous studies have found a positive relation between various measures of EFand teacher reports of self-regulation (Lipsey et al., 2017). It is also widely held that EF skills play an essential role in self-regulating behavior. Due to the short length of this preschool's summer session, it may be that teachers have too few opportunities to observe child behavior to make accurate reports. The ability of children to smoothly transition from one activity to another may be perceived as a lack of persistence. Ideally teacher reports of behavior would be gathered after teachers have had more opportunities to observe students.

There are several limitations of this study that require consideration. The underrepresentation of non-English speaking families, and the brief nature of teachers' exposure to student behavior have been discussed. In addition, this study only included students whose proficiency in English allowed them to complete cognitive batteries in English. Data is missing on all students who required an assessment in Spanish. It is unclear how Flanker and DCCS data on these students would have affected the results of this study. However, low English proficiency may indicate that these children cannot effectively shift between English-dominant and Spanish-dominant contexts. In this case, including children with low English proficiency would be unlikely to yield significant results. However, to understand the relation between exposure to a non-English language at home and EF, children with low English proficiency require greater inclusion.

Although this study has limitations, it is successful in a number of ways. This study expands the idea that non-English language use in the home is associated with greater EF, and hypothesizes that non-English home language use may be indirectly associated with self-regulation behavior in the classroom. Careful recruiting of a more linguistically diverse sample during a school year, rather than a brief summer session, is essential for systematically answering these research questions. Future research should also include longitudinal data on children's self-regulation at later time points, to understand how any advantages found in preschool affect later EF and self-regulation. Doing so would provide more information on the development of school readiness skills within linguistically diverse communities.

Table 1:

Demographic characteristics and assessment scores by home language environment.

	Only English Exposure n = 54		Non-English Exposure n = 12	
Characteristic	%	*M* (SD)	%	*M* (SD)
Sex				
Male	53.7		66.7	
Female	46.3		33.3	
Race/Ethnicity				
African American	72.2		8.3	
Hispanic/Latino	24.1		83.4	
Other	3.7		8.3	
Age		4.6 (0.7)		4.3 (0.4)
DCCS - Uncorrected Score		0.8 (3.6)		-0.5 (3.2)
DCCS - Age Corrected [a]		97.74 (10.2)[b]		106.00 (6.7)[c]
Flanker - Uncorrected Score		2.8 (2.6)		2.3 (1.4)
Flanker - Age Corrected		102.04 (13.0)		104.92 (10.33)
PVT – Uncorrected Score		57.1 (6.8)		56.6 (6.5)
PVT – Age Corrected		97.08 (11.1)		98.90 (14.18)

ADHD	0.5 (0.5)	0.6 (0.5)

Note: DCCS = NIH Toolbox Dimensional Change Card Sort; Flanker = NIH Toolbox Flanker Inhibitory Control and Attention Test; PVT = NIH Toolbox Picture Vocabulary Test; ADHD = McArthur Health and Behavior Questionnaire – Teacher Attention Deficit/Hyperactivity Disorder Symptoms Scale.

[a] Age corrected DCCS scores were not available for children whose score was based on the developmental extension.

[b] n = 34

[c] n = 5

Table 2:

Zero order correlations for all tested variables.

Variable	1	2	3	4	5	6	7
1. Age							
2. Gender	-0.18						
3. Hispanic Ethnicity	-0.11	0.06					
4. Home Language	-0.23*	0.15	0.47***				
5. PVT	0.59***	-0.16	-0.13	-0.05			
6. DCCS	0.49***	-0.26*	-0.07	-0.15	0.44***		
7. Flanker	0.51***	-0.18	0.16	-0.02	0.46***	0.41***	
8. ADHD	-0.23†	0.32**	0.13	0.04	-0.29*	0.04	-0.07

Note: Gender was dummy coded such that male = 1 and female = 0; Home language was dummy coded such that non-English home language = 1, English only = 0; DCCS = NIH Toolbox Dimensional Change Card Sort; Flanker = NIH Toolbox Flanker Inhibitory Control and Attention Test; PVT = NIH Toolbox Picture Vocabulary Test; ADHD = McArthur Health and Behavior Questionnaire – Teacher Attention Deficit/Hyperactivity Disorder Symptoms Scale.
†$p < .1$. *$p < .05$. **$p < .01$. ***$p < .001$

Table 3:

Estimates and Standard Errors for Dimensional Change Card Sort Models

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Age	2.67 (0.55)***	2.65 (0.56)***	1.87 (0.68)**	1.84 (0.70)*	1.86 (0.72)*
Gender	-1.63 (0.73)**	-1.61 (0.74)*	-1.70 (0.73)*	-1.67 (0.75)*	-1.66 (0.76)*
Hispanic Ethnicity	-0.04 (0.76)	0.05 (0.87)	0.19 (0.76)	0.30 (0.87)	0.30 (0.88)
Home Language	-	-0.25 (1.09)	-	-0.31 (1.11)	-1.99 (8.94)
PVT	-	-	0.12 (0.07)†	0.12 (0.07)†	0.12 (0.08)
Language * PVT	-	-	-	-	0.03 (0.16)

Note: Gender was dummy coded such that male = 1 and female = 0; Home language was dummy coded such that non-English home language = 1, English only = 0; PVT = NIH Toolbox Picture Vocabulary Test.
†p < .1. *p < .05. **p < .01. ***p < .001

Table 4:

Estimates and Standard Errors for Flanker Models

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Age	1.96 (0.38)***	1.98 (0.39)***	1.50 (0.49)**	1.53 (0.49)**	1.52 (0.50)**
Gender	-0.56 (0.51)	-0.59 (0.51)	-0.61 (0.51)	-0.65 (0.52)	0.08 (0.06)
Hispanic Ethnicity	1.08 (0.53)*	0.96 (0.61)	1.15 (0.54)*	1.04 (0.61)†	1.04 (0.61)†
Home Language	-	0.30 (0.75)	-	0.30 (0.77)	0.94 (6.46)
PVT	-	-	0.08 (0.05)	0.08 (0.05)	0.08 (0.06)
Language * PVT	-	-	-	-	-0.01 (0.11)

Note: Gender was dummy coded such that male = 1 and female = 0; Home language was dummy coded such that non-English home language = 1, English only = 0; PVT = NIH Toolbox Picture Vocabulary Test.
†$p < .1$. *$p < .05$. **$p < .01$. ***$p < .001$

Table 5:

Estimates and Standard Errors for ADHD Symptoms Scale Models

Variables	Model 1	Model 2	Model 3	Model 4
Age	-0.14 (0.11)	-0.14 (0.11)	-0.24 (0.11)*	-0.17 (0.13)
Gender	0.17 (0.13)	0.16 (0.13)	0.26 (0.13)*	0.18 (0.13)
Hispanic Ethnicity	0.02 (0.14)	0.01 (0.15)	0.02 (0.13)†	0.01 (0.15)
Home Language	-	0.02 (0.19)	-	-
DCCS	-	-	0.05 (0.02)*	-
Flanker	-	-	-	0.01 (0.03)

Note: Gender was dummy coded such that male = 1 and female = 0; Home language was dummy coded such that non-English home language = 1, English only = 0; DCCS = NIH Toolbox Dimensional Change Card Sort; Flanker = NIH Toolbox Flanker Inhibitory Control and Attention Test.
†$p < .1$. *$p < .05$.

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