AN ABSTRACT OF THE THESIS OF

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Megan McClelland, PhD

Dual Language Learners (DLLs) represent a substantial subpopulation in United States preschool programs (Aikens, Kinas, Malone, Tarullo, & Harding, 2017). DLLs often come from low socio-economic backgrounds and encounter barriers to academic success (National Academies of Science, 2017; Thomas & Collier, 2002). One consistent predictor of academic success is executive function (EF; McClelland, Acock, Piccinin, Rhea, & Stallings, 2013), which includes components such as inhibitory control, cognitive flexibility, and working memory (McClelland, Geldhof, Cameron, & Wanless, 2015; Ursache, Blair, & Raver, 2012). It is still unclear which EF components are related to second language proficiency in preschool. The present study examined relations between EF and English proficiency (as measured by the preLAS; Duncan & De Avila, 1998), utilizing four measures of EF as well as a composite EF variable. A total of 74 Spanish-speaking DLL children were assessed during fall and spring of the preschool

year in either English or Spanish (depending on level of proficiency). Controlling for age and gender, results demonstrated that higher English proficiency in the fall predicted higher EF in fall via the working memory task (ß = .43, SE(ß) = .08, $p < .0001$). Higher English proficiency in spring predicted higher EF in spring via both the working memory task (ß = .29, SE(ß) = .14, $p = .04$), and the Head-Toes-Knees-Shoulders task (ß = .38, SE(ß) = .17, $p = .02$). Furthermore, regressions showed that increases in English proficiency from fall to spring predicted increases in spring EF on the HTKS task (ß = .33, $z(7) = 2.64$, $p < .01$) and the working memory task (ß = .42, $z(7) = 3.45$, $p < .001$), when controlling for fall EF and English proficiency variable. Results of this study inform both policy and practice related to instruction of DLL students, highlighting the need for EF interventions as well as equitable bilingual education programs in preschool- which research demonstrates are the most effective for long-term linguistic and academic success (National Academies of Science, 2017; Steele et al., 2017).

English Proficiency and Executive Function in Dual Language Learners Enrolled in

Head Start

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I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

Alexis Merculief, Author

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English Proficiency and Executive Function in Dual Language Learners Enrolled in Head Start

Dual Language Learners[1] (DLLs) are a rapidly growing subpopulation in United States Head Start preschool programs (Aikens, Knas, Malone, Tarullo, & Harding, 2017). To qualify for Head Start, families must be at or below the federal poverty threshold (U.S. Department of Education, 2019a, 2019b). Children from low-income backgrounds encounter numerous barriers to academic success in American classrooms, from instructional methodology to social barriers (National Academies of Science, 2017; Thomas & Collier, 2002). One consistent predictor of academic success is strong executive function (EF; McClelland, Acock, Piccinin, Rhea, & Stallings, 2013), defined in this paper as the interplay between inhibitory control, cognitive flexibility, and working memory (McClelland, Geldhof, Cameron, & Wanless, 2015; Ursache et al., 2012). Previous research has primarily focused on the relationship between bilingualism and EF, but there is less evidence for the specific role of second language proficiency in early childhood (Barac, Moreno, & Bialystok, 2016; Calvo & Bialystok, 2014; Hartanto, Toh, & Yang, 2018; Luo, Luk, & Bialystok, 2010; Rosselli, Ardila, Lalwani, & Velez-Uribe, 2016). Furthermore, it is not yet understood which specific aspects of EF are influenced by second language proficiency; particularly English proficiency. The present study examines relations between English proficiency and EF skills (measured both individually and as a unitary construct) in DLL preschool children enrolled in Head Start.

Theoretical Perspective: Developmental Systems

Developmental systems (DS) theories offer a unique lens through which to view both the development of executive function and language. The DS perspective, based on

[1] Researchers often use the term "English Learner," or EL as it is a legal term denoting academic privileges for children who speak another language at home. Others use the term "bilingual," (see Calvo & Bialystok, 2014). This paper follows the lead of the National Academies of Science (2017) to use the term "dual-language learner," acknowledging that preschool-aged children are still in the process of learning both their home language as well as English.

a process-relational worldview, centers on the assumption that environmental (nurture) and biological (nature) factors work in tandem to promote human development across the lifespan (Lerner, Theokas, & Bobek, 2005; Overton, 2015). Both components are so intertwined they cannot be considered separate entities. Relational theories like Developmental Systems emphasize holism and context, encouraging researchers to consider the whole child when addressing research questions. Taking into consideration the contextual influence of second language proficiency on EF development, DS theory guides the present study to examine how developmental trajectories of executive function operate with dual-language learning preschoolers.

Coaction. The development of language and EF is influenced by both biological and contextual factors. DS theories recognize that these factors are inextricably bound, a concept known as coaction (Lerner et al., 2005). This principle helps explain the vast inter and intra-individual differences seen in the development of language and EF. For example, while humans are biologically prepared to learn language (Tomasello, 2010), environmental input plays an equal role. When children do not have adequate environmental input (i.e., exposure to language and language instruction in both first and second languages), successful attainment of oral and written fluency cannot be achieved (Hoff, 2013; Mayberry & Locke, 2003; Rojas & Iglesias, 2013). The present study examines the relationship between EF and second language proficiency during the preschool year, a time when environmental input (i.e., classroom instruction) has significant power to influence the development of both skills (Schmitt, McClelland, Tominey, & Acock, 2015). The two skills interact in complex ways to influence development, and it is likely this relationship is bidirectional (Bohlmann, Maier, &

Palacios, 2015; Slot & von Suchodoletz, 2018; Weiland, Barata, & Yoshikawa, 2014). However, the present study focuses on language proficiency as a predictor of EF skills.

Relative plasticity. At any point in development, DS theorists agree there is potential for change (or plasticity; Overton, 2015). An example of plasticity is the concept of developmental "windows," periods where the capacity for change is quite large. However, the degree to which developmental plasticity is possible is bound by biological constraints (e.g., age, temperament) and environmental constraints (e.g., supportive care giving, exposure to language). This reflects a major tenant of developmental systems theories: relative plasticity (Lerner et al., 2005). Such windows exist in both the acquisition of language and EF. Most researchers agree that the period with the greatest potential for language growth is before three to five years of age (Mayberry & Lock, 2003; National Academies of Science, 2017). Likewise, from three to six years of age, children experience a period of rapid development in EF skills (Best & Miller, 2010; McClelland, Geldhof, Cameron, & Wanless, 2015; Montroy, Bowles, Skibbe, McClelland & Morrison, 2016). The present study capitalizes on the preschool period as an important developmental window through which to view the relationship between increasing second language proficiency and EF skills, both of which are highly influenced by coacting features of the child's environment during this time (in the form of classroom instruction).

Dual Language Learners in the United States

Data from the nationally representative Head Start Family and Child Experiences Study (FACES; Aikens, Knas, Malone, Tarullo, & Harding, 2017) show that 24% of preschoolers are dual language learners (DLLs), and the vast majority of these children

(89%) speak Spanish as a first language. Considering that most Head Start DLLs are children of immigrants (Aikens et al., 2017), their first exposure to the English language is often in preschool. After enrolling in kindergarten in the American school system, children who speak a language other than English at home are given a proficiency screener and are labeled “English Learners,” (ELs) if they do not meet proficiency standards. This entitles them to specific academic support, although there are fewer resources available as children progress through secondary school (National Academies of Science, 2017; Thomas & Collier, 2002).

In elementary school, DLLs are more likely to be in an English-only classroom with every passing year (Thomas & Collier, 2002). By the end of elementary school, DLLs who have been in English-only classrooms score ¾ of a standard deviation below the mean on reading and math state standards (Thomas & Collier, 2002). However, DLLs who participate in bilingual blended programs not only meet but often exceed state standards, although benefits may not appear until middle school (Valentino & Reardon, 2015). In a large-scale longitudinal study, children assigned by lottery in kindergarten to two-way dual-language immersion schools in Portland, Oregon scored 13% of a standard deviation higher than their peers in reading at 5th grade, and 22% of a standard deviation higher at 8th grade (the equivalent of nine months of school; Steele et al., 2017).

Beyond a lack of academic and language support, DLLs encounter other social and economic barriers to success. DLL children with lower English proficiency may experience less close relationships with teachers and peers (Niehaus & Adelson, 2014; Sullivan, Hedge, Ballard, & Ticknor, 2014). The majority of DLLs reside in low-income households (Bandel, Atkins-Burnett, Castro, Smither Wulsin & Putnam, 2012; Beech &

Keys, 1997; Hartanto et al., 2018). The 2014 Head Start FACES survey reports that 31% of DLLs live at or below 50% of the poverty threshold, and 48% live in a home where neither parent has completed high school (Aikens et al., 2017). The negative effects of low socioeconomic status (SES) on academic and socioemotional success are widely recognized (Hartanto et al., 2018; Reardon, 2011; Sektnan, McClelland, Acock, & Morrison, 2010). Low SES is related to lower overall standardized test scores in both reading and math at kindergarten entry (Reardon, 2011) and lower EF in early childhood (Hartanto et al., 2018; Sektnan et al., 2010; Wanless et al., 2011b). However, for children in poverty, higher EF skills act as a protective factor and predict higher academic success (Sektnan, et al., 2010; Ursache, Blair, & Raver, 2011). As such, it is important to examine the ways in which second language development- specifically English language development- may help or hinder the development of EF skills in early childhood.

Development of Language

Children are born with the biological capacity to learn any language (Tomasello, 2010), but the relative plasticity for multiple language learning decreases over the life span. A large body of work suggests that exposure to language is most effective when it occurs early in development (Hoff, 2017; Mayberry & Lock, 2001); however the exact age when language-learning capacity begins to decline is less understood (Birdsong & Molis, 2001; National Academies of Science, 2017). Most studies agree that lack of early exposure (before five years of age) hinders the mastery of phonology, grammar, and syntax into adulthood (Mayberry & Lock, 2003; National Academies of Science, 2017). Neurologically, children under the age of 10 show 60% greater activation in the brain regions associated with language development when compared with adults (Gaillard et al., 2000), echoing the general consensus that plasticity of language acquisition begins to solidify by middle childhood. Studies such as these provide evidence of a neurological window, but the wide variety of outcomes suggests a significant influence of coacting environmental factors like quantity, quality, and timing of language input.

Development of Executive Function

Executive function (EF) can be understood as the integration of working memory, inhibitory control, and cognitive flexibility (also called “shifting” in some studies; McClelland et al., 2015). Many researchers view EF as part of a larger self-regulatory system (McClelland, Geldhof, Cameron, & Wanless, 2015; Ursache et al., 2012), with both top-down and bottom-up influences able to affect the system at any point (McClelland et al., 2015). Top-down components include cognitive EF skills, while bottom-up components are more automatic processes (such as emotion reactivity; Blair & Raver, 2012; McClelland et al., 2015). Although individual EF components do not develop in isolation, the most rapid growth in inhibitory control and cognitive flexibility occurs around the ages of 3-5 years, while more complex skills like working memory emerge around 5-6 years of age (Best & Miller, 2010). Managing multiple cognitive demands, hierarchical rules or tasks that involve rule reversals requires even more effort, and children show improvements in these types of tasks into adolescence (Best & Miller, 2010).

The ability to utilize EF skills to control socially undesirable behaviors and produce appropriate behaviors is important in classroom settings (Diaz et al., 2017; McClelland et. al, 2013; McClelland et al., 2015; Sektnan et al., 2012; Ursache, Blair & Raver, 2012). For example, in American preschool classrooms, children are expected to sit quietly, listen to instructions, ignore distractions from friends, and respond appropriately to instructions. In these settings, children must engage top-down components of the self-regulatory system (e.g., EF skills) to manage the demands of the classroom. High EF in early childhood is associated with higher levels of academic achievement through age 21 (McClelland, Acock, Piccinin, Rhea, & Stallings, 2013; McClelland et al., 2015; Sektnan, et al., 2010; Ursache, Blair, & Raver, 2011), and in one study, children's attention and persistence at age four predicted college completion at age 25 (McClelland et al., 2013). High EF may even ameliorate some of the negative effects of low SES (McClelland, Geldhof, Cameron, & Wanless, 2015; Sektnan, et al., 2010), and some childhood interventions demonstrate moderate success in boosting EF in similar populations (Bierman et al., 2008; Diamond & Lee, 2011; Schmitt, McClelland, Tominey, & Acock, 2015). These interventions show promising positive effects on future academic and social trajectories. However, if EF skills are related to second language proficiency, this offers another avenue for policy and practice to influence academic outcomes for DLL children. In addition to interventions that directly influence EF skills, effectively increasing second language proficiency for DLL students could be another way to strengthen these important cognitive foundational learning skills. The present study seeks to explore how English proficiency relates to Head Start preschool children's EF skills.

EF and Language Development

The majority of research on the intersection between EF and language development almost exclusively focuses on bilingual individuals (Barac et al., 2016; Calvo & Bialystok, 2014; Hartanto, et al., 2018; Luo et al., 2010; Rosselli, Ardila, Lalwani, & Velez-Uribe, 2016). These studies apply the label “bilingual” either because participants are adolescents or adults (more experienced in both languages), or a determination is made that children concurrently learning two languages are “bilingual.” Some research shows bilingual children demonstrate higher EF than monolinguals, but the evidence is mixed (Calvo & Bialystok, 2014; Hartanto et al., 2018; Roselli, Ardila, Lalwani, & Velez-Uribe, 2016).

Other studies that primarily focus on EF sometimes covary or examine group differences for language minority children. Many of these studies find DLL status is associated with lower EF scores (Halle et al., 2014; Wanless, McClelland, Tominey, & Acock, 2011). However, this could be highly influenced by assessment language- for example, if EF assessments were given in English, this could negatively affect DLL children’s scores. To address this issue, the present study allowed DLL children to take EF assessments in either English or Spanish based on proficiency level (see Procedure below).

Existing research suggests proficiency in more than one language may be more closely related to some components of EF than others. A recent meta-analysis found scant evidence for advantages in inhibitory control (Paap, Johnson, & Sawi, 2015), but a few studies have found such advantages (Bialystok & Barac, 2012; Choi, Jeon, & Lippard, 2018). More studies suggest relations closely links with working memory (Barac et al., 2016; Calvo & Bialystok, 2014; Rosselli et al., 2016). Arguably the strongest evidence in the literature exists for advantages in cognitive flexibility (Barac et al., 2016; Calvo & Bialystok, 2014; Hartanto et al., 2018; Paap et al., 2015; Rosselli et al., 2016), but again, these results are mixed and solely based on bilingual individuals (Paap et al., 2015).

Importantly, evidence suggests these proposed advantages in EF may depend on the level of proficiency in both languages as well as SES (Bialystok & Barac, 2012; National Academies of Science, 2017; Paap et al., 2015; Rosselli et al., 2016). For example, Rosselli and colleagues (2016) found that bilingual children with balanced proficiency had higher EF than those with unbalanced proficiency. The majority of studies on the effects of proficiency on EF only included older children or adults. The issue is more complex when studying DLL children in preschool, who are still undergoing the process of learning in both languages.

In particular, DLL children's EF may be specifically dependent upon English proficiency, both assessed directly (Choi et al., 2018; Luo et al., 2010; National Academies of Science, 2017) and via teacher-rated EF (Diaz, 2106). This could be due to contextual factors such as the use of English in American classrooms, as well as cultural differences in the measurement of EF (i.e., utilizing Western measures of EF in unfamiliar testing environments; Esquinca, Yaden, & Rueda, 2005). English proficiency may also play an important role in fostering positive teacher and peer relationships for DLL children (Niehaus & Adelson, 2014; Sullivan, Hedge, Ballard, & Ticknor, 2014). Supportive teacher and peer relationships provide a crucial foundation for the development of EF skills and subsequent academic achievement (Caprara, Barbaranelli, Pastorelli, Bandura, & Zimbardo, 2000; McClelland, Cameron, Wanless, & Murray, 2007; Portilla, Ballard, Alder, Boyce, & Obradovic, 2014).

The present study uses a battery of EF assessments that measure a variety of skills; including inhibitory control, cognitive flexibility, and working memory and examines the development of these EF skills in relation to gains in English language proficiency among Spanish-dominant dual language-learning preschool children.

Measurement of Language Proficiency

Measurement of English proficiency in preschool children is difficult. There is currently no national definition of what constitutes "English proficiency" for this age group (National Academies of Science, 2017). Many widely used preschool language assessments are modified or shortened versions of assessments used for older children, such as the Pre-Idea Language Proficiency Tests (Pre-ITP), and the Pre-Language Assessment Scales (preLAS; Duncan & De Avila, 1998; Esquinca, 2005). A recent meta-analysis showed that 10 of the 14 most current research studies on EF in bilingual children only used one indicator of dual-language status: parent report (Halle et al., 2014). The present study adds to the literature by utilizing a measurement strategy that allows for more variation to emerge by using a continuous (rather than dichotomous) assessment of English proficiency (the preLAS; Duncan & De Avila, 1998). The preLAS is one of the most commonly used language screeners for preschool aged children (Aikens, et al., 2017; Bandel et al., 2012; Choi, Jean, & Lippard, 2018; Hartanto, et al., 2018).

Measurement of Executive Function

EF is a term with many interpretations in the research community (McClelland & Cameron, 2012; McClelland et al., 2015), and researchers use a wide variety of assessment tools to measure this construct in preschool aged children. Previous authors have suggested that future work utilize multiple measurements that are quantitative and grow in complexity, with a focus on attentional control (Barac et al., 2016). The measures used in the present study, especially the Head-Toes-Knees-Shoulders task (HTKS; Ponitz, McClelland, Matthews, & Morrison, 2009), increase in complexity, and are designed to capture variation in skills during the preschool to kindergarten transition. Research is also conflicted on whether the components commonly understood to constitute EF are actually separable constructs. In preschool, EF often presents as a single factor (Best & Miller, 2010; McClelland, Geldhof, Cameron, & Wanless, 2015; Weintraub, 2013). Several researchers seeking to explore this question have used confirmatory factor analyses to test how EF functions during the preschool years. Many of these studies came to the conclusion that EF components (primarily working memory and inhibitory control) loaded successfully onto a single-factor model representing one overarching unitary construct for EF (Denham, Warren-Khat, Hamada Bassett, Wyatt, & Perna, 2012; Hughes, Ensor, Wilson, & Graham, 2010; Wiebe, Andrews Espy, & Charak, 2008). However, with the addition of more components such as cognitive flexibility, other researchers have found that two and three-factor models fit equally well (Miller, Giesbrecht, Muller, McInerny, & Kerns, 2012). One explanation is that EF skills become more distinct as children mature, a claim supported by the fact that the unitary one-factor model identified by Wiebe and colleagues (2008) explained more variance for children under age four than children over age four.

Furthermore, second language development may be more related to some EF components than others (Barac et al., 2016; Calvo & Bialystok, 2014; Hartanto et al., 2018; Paap et al., 2015; Rosselli et al., 2016). For these reasons, the present study explores the influence of multiple components both individually and as a unitary construct via confirmatory factor analysis (CFA). The EF factor includes four components: inhibitory control (the Day/Night Stroop task; Gerstadt, Hong & Diamond, 1994), cognitive flexibility (the Dimensional Change Card Sort task; Frye, Zelazo, & Palfai, 1995; Zelazo, 2006), working memory (the Woodcock-Johnson Auditory Working Memory task; Woodcock, McGrew, & Mather, 2001), and an assessment that measures all three constructs (the HTKS; Ponitz, McClelland, Matthews, & Morrison, 2009).

The Present Study

The present study explores two research questions. First, does English proficiency among DLLs in Head Start at the fall and spring of preschool relate to executive function (EF factor and its components) at the fall and spring of preschool? Based on previous literature (Chen, Zhou, Uchikoshi, Bunge, & Yoshida, 2014; Halle et al., 2014; Yow & Li, 2015), it was hypothesized that higher English proficiency (measured continuously) would be associated with higher EF skills in both fall and spring of the preschool year. It was further hypothesized that the EF factor would be more strongly predictive than any single EF task, as EF skills often appear as a single construct in early childhood (Best & Miller, 2010; Denham et al., 2012; McClelland, Geldhof, Cameron, & Wanless, 2015; Weintraub, 2013). The second research question explored whether greater acquisition of English language proficiency among DLLs in Head Start over the preschool year (fall-spring) predicted change in EF (EF factor and its components) from fall to spring. It was hypothesized that increases in English proficiency from fall to spring would predict increases in EF (both EF factor and its components), after controlling for English proficiency and EF in fall.

Covariates. EF is correlated with child factors such as age and gender, as well as environmental factors such as family SES (Sektnan, McClelland, Geldhof, Cameron, &

Wanless, 2015; Schmitt, McClelland, Tominey, & Acock, 2015). Children undergo significant growth in EF over the preschool-kindergarten transition (Diamond, 2002; Schmitt, Geldhof, Purpura, Duncan, & McClelland, 2017). In addition, girls demonstrate slightly higher EF at young ages (McClelland et al., 2015; Ponitz et al., 2009, Wanless et al., 2013). The present study controlled for gender and age (see Results section for more information on covariates). Lastly, low family SES is consistently related to lower EF (Sektnan, McClelland, Acock, & Morrison, 2010; Wanless, McClelland, Tominey, & Acock, 2011). This was not controlled for in the present study because the present sample was primarily low-income (all children enrolled in Head Start).

Method

Participants

Participants were drawn from two cohorts of a larger, four-year longitudinal measurement study (McClelland et al., in preparation) focusing on the development of a measure of self-regulation for children at-risk. The current subsample is comprised of Spanish-dominant low-income DLL preschool children, who were assessed during the 2016-2017 or 2017-2018 school year. All children attended Head Start preschool centers where the primary language of instruction was English, although some classrooms had bilingual assistants. In the present study, only children whose parents indicated Spanish as their home language on the child's consent form were included in the sample. The subset has a sample size of 74 children in fall (41.89% female) and 56 children in spring (42.86% female). Attrition was due to participants leaving the study, moving to a preschool center out of the area, and end of year closures that prevented data collection in Spring of 2018. The average age at fall of preschool was 4.71 years (*SD* = 0.31), and 5.19

years at spring (*SD* = 0.31). The ethnicity of the sample is as follows: 76.47% Hispanic/Latino, 8.82% White, 11.76% Mixed Race (Hispanic/Latino and another race) and 2.94% Other. Of the 43% of parent demographic forms returned, 65.6% of parents had less than a high school degree. The average parent education was 10.72 years (*SD* = 3.99). During the child's preschool year, 78.79% of the children's parents were married or partnered, and 45.45% were employed full or part time.

Procedure

Research assistants were trained and certified on a battery of EF and early academic assessments. Children were assessed in fall and spring of preschool in the school or center where they were enrolled. Children were tested during free play and were taken to a quiet spot in the room, the hallway, or another classroom for testing. Assessors received verbal assent from each individual child; and worked with children in two to three sessions for no more than 15-20 minutes per session. Bilingual assessors were trained on the proficiency assessment (the preLAS) and the English and Spanish versions of the complete battery. Children who received 15 out of 20 on the preLAS were given the rest of the EF assessments in English, while those who scored 14 or lower were given the EF assessments in Spanish (see below for more information on cut scores).

Measures

English Proficiency. The present study uses two subtests of the preLAS (Duncan & De Avila, 1998), Simon Says (10 items, receptive language) and Art Show (10 items, expressive language) as a language screener to decide whether to administer direct assessments in English or Spanish. Reliability for the full assessment was $\alpha = .90$ in fall and $\alpha = .85$ in spring. Assessors begin by playing a brief game of Simon Says, in which the child is asked to respond to verbal commands: “Simon says point to the door,” “Simon says pick up the paper.” In the second subtest, assessors use a picture book to ask children to name different items in English (e.g., apple, dog, bee) and describe what you can do with those items (e.g., Assessor: “What is this?” Child: “A book.” Assessor: “What can you do with it?” Child: “Read it.”). Children were given 0 points for an incorrect answer, and 1 point for a correct answer. Items where children did not provide a response were coded as missing. The total points possible was 20 points and children must score 15 to pass and receive the rest of the cognitive and self-regulation battery in English. Publisher recommended scoring criteria is only available for the battery as a whole (Duncan & De Avila, 2000b), thus, the present study utilized ceiling rules in alignment with current literature as well as supported via cut score analyses of “Simon Says” and “Art Show” subtests, performed on a nationally representative sample of four-year-old DLLs (Rainelli, Bulotsky-Shearer, Fernandez, Greenfield, & Lopez, 2017).

Executive Function Measures.

Head-Toes-Knees-Shoulders-Revised (HTKS-R). The HTKS-R is an interactive direct assessment of EF (McClelland et al., 2014), involving both the mind and body. It assesses multiple domains of EF, particularly inhibitory control, working memory, attentional flexibility, and cognitive switching (Cameron Ponitz et al., 2008). Additionally, the HTKS-R has been utilized cross-culturally as a measure of EF (Wanless et. al., 2011a). During the game, the assessor asks children to do the opposite of what they are told, for example; if told to touch their head, they must touch their toes (Cameron Ponitz et al., 2009). The task grows in complexity until children must remember opposing rules involving four body parts (head, toes, knees, and shoulders) and switch between them. Children are given 0 points for incorrect or no response, 1 point for a self-correct, and 2 points a correct response. Scores range from 0 to 116, where higher scores indicate stronger EF. Reliability estimates for the current study were $\alpha = .96$ in the fall and $\alpha = .94$ in the spring.

Cohorts two and three received two different versions of the HTKS measure, the main difference being the order of administration for the “opposites” section. The “opposites” section requires children to respond verbally to requests, while the rest of the HTKS measure (Parts 1-3) requires children to indicate the opposite body part physically. Children are given 0 points for an incorrect or no response, 1 point for self-correct, and 2 points for a correct response. In the first version, children were initially given the opposites section, and if they received a score of 4 or more, they moved on to Parts 1-3. The second version was a drop-back version, where children who did not do successfully complete the initial practice items for Part 1 (6 points) “dropped back” to the opposites section, and after getting at least 4 points, they jumped forward again to Part 1. Because the opposites version of the task was shown to be psychometrically stronger (Gonzales, et al., in preparation), children who did not receive the opposites section (Cohort 3) were treated as missing. All missing data was handled via full information maximum likelihood estimation (FIML; for more details, see Results section).

Dimensional Change Card Sort (DCCS). This is a direct assessment of EF that primarily measures cognitive flexibility (Frye et al., 1995; Zelazo, 2006). Children are asked to sort the cards according to color, then by shape. The last stage adds an attentional flexibility and cognitive switching component as children are asked to follow different rules depending on whether the cards have a black border or not. (Frye et al., 1995; Zelazo, 2006). Scores on the DCCS range from 0 to 24, where children are given 0 points for an incorrect response and 1 point for a correct response. Scale reliability was α = .78 in the fall and α = .79 in the spring.

Day-Night Stroop. The Day-Night Stroop task is a direct assessment of EF that primarily measures inhibitory control (Gerstadt, Hong & Diamond, 1994). Children are shown cards with pictures of either a sun or a moon and asked to say the opposite of what they see. When children see the sun, they say: "night," and when they see the moon, they say: "day." (Gerstadt, Hong, & Diamond, 1994) Scores range from 0 to 32. Children are given 0 points for an incorrect or no response, 1 point for self-correct, and 2 points for a correct response. Reliability estimates for the present study were α = .93 in the fall and α = .90 in the spring.

Woodcock-Johnson (WJ III) Auditory Working Memory. (Woodcock, McGrew, & Mather, 2001; Muñoz-Sandoval, Woodcock, McGrew, & Mather, 2005)**.** This EF task measures auditory working memory. The assessor verbally states a mixed list of things and numbers (e.g., seven, cat, orange) and children are asked to repeat back the things (cat, orange) first, then the numbers (seven). The items grow in length and difficulty as the task progresses. Reliability for both English and Spanish versions of the task is high. Reliability estimates for the current sample were moderate at α = .75 in fall and α = .76 in spring. Multiple studies verify that the Spanish and English versions measure the same constructs (Schrank, McGrew, & Woodcock, 2001; Schrank, et al., 2005).

Results

Analytic Software and Missing Data

Data were analyzed using STATA 15 software (StataCorp, 2017). Analyses revealed that children in cohort 3 (missing on the HTKS variable) did not significantly differ from children in cohort 2 on any demographic or self-regulatory measures, so these data were assumed to be missing at random (MAR). All missing data was handled via full information maximum likelihood (FIML) estimator. Sensitivity analyses obtained similar directionality and evidence of statistical significance for regressions when performed on the data without the use of FIML.

Nested Data

Children were nested in 33 classrooms, 17 of which contained only one child. Because some children in the study shared a classroom environment, intra-class correlations (ICCs) were examined to explore the necessity of multi-level modeling. Between-classroom variation accounted for less than 5% of the variation for all EF variables, with the exception of working memory in fall of preschool only (ICC = .16). Thus, all models examining working memory in fall controlled for classroom-level clustering. Clustering was not deemed necessary for all other models (Hox, Moerbeek, & van de Schoot, 2010).

Descriptive Statistics.

Children began at fall of preschool with an average score of 11.08 out of 20 on the preLAS (*SD* = 6.16). By spring, the average score increased to 14.39 (*SD* = 4.45). In the fall of the preschool year, 41.89% of the sample passed the preLAS (a score of 15 or higher) and were assessed in English. By spring, 55.36% of the sample were assessed in

English. Fall and spring preLAS scores were correlated at r =.75 (p < .0001). Children's EF also improved from fall to spring of the preschool year. Scores on the HTKS-R task started at 36.81 (out of 116; SD= 26.89) in fall and increased to 53.51 (SD = 30.23) by spring. HTKS-R scores in fall and spring were also highly correlated at r = .76 (p < .0001). For descriptive statistics of the other EF measures, refer to Table 1. Outliers were examined using leverage scores, externally studentized residuals, and Cook's D. All extreme scores were determined to represent real data in this sample, and thus were retained. However, sensitivity analyses using robust regressions obtained similar evidence of directionality and significance when removing outliers on the preLAS and each EF measure.

In the fall, scores on the preLAS correlated significantly with Woodcock-Johnson Auditory Working Memory scores (r = .44, p < .0001). In the spring, the preLAS was correlated with the HTKS-R task (r = .43, p < .04) and the working memory task (r = .30, p = .05). Gender and age did not correlate with the preLAS at either time point (for full correlation matrices, see Tables 2 and 3).

EF Composite Variable

Based on theoretical understanding of EF during the preschool years, and previous research (Denham et al., 2012; Hughes, Ensor, Wilson, & Graham, 2010; Wiebe, Andrews Espy, & Charak, 2008), a confirmatory factor analysis (CFA) was performed to explore whether a composite "EF Factor" emerged as a latent variable in the data. Observed variables included all four EF tasks in our assessment battery: the DCCS, Day-Night Stroop, HTKS-R, and Woodcock-Johnson Working Memory. The model did not converge in fall of preschool, and demonstrated impossible fit statistics (via χ^2, CFI/TLI and RMSEA) in spring. Based on the number of indicators and amount of missingness in the models, the present study did not meet the general minimum guidelines for sample size (*n* > 200; Wolf, Harrington, Clark, & Miller, 2013), so a lack of power may have contributed to non-significant findings.

In order to fully answer the current research questions, which sought to understand how English proficiency relates to EF skills both individually and as a group, a composite EF score was instead obtained by averaging standardized z scores for each of the four EF measures. This "composite z score" was utilized in place of a factor score. See Tables 2 and 3 for correlations between EF measures in fall and spring.

Primary Analyses

1) Does higher English proficiency among DLLs at the fall and spring of preschool relate to high EF (EF composite and its components) at the fall and spring of preschool?

To answer this question, regressions were performed for the EF composite variable and each EF measure separately, accounting for child age and gender as covariates (classroom clustering was adjusted for in models involving working memory). Regression models for both fall and spring were fully saturated. Higher English proficiency at fall of preschool predicted higher EF in the fall, but only for the working memory task (ß = .43, SE(ß) = .08, $p < .0001$; see Table 4). Higher English proficiency at spring of preschool predicted higher EF in the spring; but only for the HTKS-R task (ß = .38, SE(ß) = .17, $p = .02$) and working memory task (ß = .29, SE(ß) = .14, $p = .04$). It was further hypothesized that English proficiency would be more strongly related to the EF Composite than any single EF task, as executive function skills often appear as a unitary construct in early childhood. However, the composite EF score was not significantly associated with English proficiency scores in fall or spring of preschool. See Table 4 for full regression results.

2) Does greater acquisition of English language proficiency among DLLs in Head Start over the preschool year (fall-spring) predict change in EF (EF composite and its components)?

To answer this question, regressions were performed to examine the effect of residualized change in English proficiency on change in EF (see Figure 1). Spring English proficiency was examined as a predictor of spring EF separately for each component while simultaneously controlling for fall scores. Age and gender were retained as covariates. Higher spring English proficiency significantly predicted higher spring HTKS-R scores when controlling for fall scores for each variable (ß = .33, $z(7) = 2.64$, $p < .01$). For every one-point increase on the preLAS, children also increased 1.84 points (*SE*= .71) on the HTKS-R task. In addition, change in English proficiency from fall to spring predicted change in working memory from fall to spring (see Figure 2) when controlling for age, gender, and classroom clustering (ß = .42, $z(7) = 3.45$, $p < .001$). Since the residualized change models controlled for the autoregressive effects of fall scores on both constructs, any remaining variability in spring EF was explained by change in English proficiency over the preschool year

English proficiency did not significantly predict change in any other EF task across the preschool year. It was further hypothesized that English proficiency would be more strongly related to the EF Composite than any single EF task. However, English proficiency was not related to change in composite EF score in the residualized change model.

Post-Hoc Analyses

The preLAS is an English proficiency screener, such that children who score 15 out of 20 are given the battery of EF assessments in English, and those score less than 15 are assessed in Spanish. To examine the possible impact of the switch in assessment language from Spanish to English, post-hoc regression analyses tested the effect of passing the preLAS on EF scores- maintaining the child's preLAS score as a continuous variable, but separating those who scored less than 15 into a "Spanish" group and those who scored more than 15 into an "English" group. Both groups of children made gains on the preLAS from fall to spring. For those still assessed in Spanish by spring, preLAS scores increased from 7.75 to 10.33 (*SD* = 5.03 and *SD* = 2.75 respectively) and for those assessed in English by spring, scores increased from 15.41 to 17.79 (*SD* = 3.82 and *SD* = 1.78 respectively).

Further examination utilizing separate regressions at each time point showed that preLAS scores did not predict any EF assessment in fall of preschool (see Table 5). In the spring, higher English proficiency significantly predicted higher scores on the HTKS-R task and the Day/Night Stroop task- but only for those children assessed in English (see Table 6).

Discussion

Results of the present study provide evidence that higher second language proficiency is associated with higher EF for low-income DLL students during the preschool year. The present study supports previous work suggesting a link between second language proficiency and EF, and in particular, working memory (measured by the HTKS-R and the Woodcock-Johnson Auditory Working Memory). However, the current study was not fully able to tease apart specific EF skills as more or less influential. This is in part due to task impurity- the measures used in the present study, while primarily aimed at capturing a specific EF skill, also tap other components of EF in the process. Nevertheless, several promising findings emerged.

RQ1: English Proficiency and EF at Fall and Spring of Preschool

There was some evidence that children who enter preschool with higher second language proficiency in the fall also demonstrate higher working memory at the start of preschool, a finding seen in other literature (Barac et al., 2016; Calvo & Bialystok, 2014; Rosselli et al., 2016). After one year of classroom experience, preschool DLL children who demonstrate higher English proficiency also show higher scores on the HTKS-R task, a measure of inhibitory control, working memory, and cognitive flexibility (McClelland et al., 2014). These results provide evidence that higher second language proficiency is associated with higher EF for low-income DLL students during the preschool year. However, task impurity limits the conclusions that can be drawn regarding which EF skills are more or less influential for DLL students. For example, previous literature suggests a particularly strong relationship between dual language ability and both cognitive flexibility and working memory (Barac et al., 2016; Calvo & Bialystok, 2014; Hartanto et al., 2018; Paap et al., 2015; Rosselli et al., 2016). Because the HTKS task taps into both of these EF skills, it is difficult to determine which component is more strongly related to increasing English proficiency in the present study (or if they are equally related). In addition, it is important to note that English proficiency at preschool entry is likely influenced by exposure to English in the child's home or by other relatives and caregivers- factors that are beyond the scope of the present study but which should be the focus of future research.

RQ2: Does greater acquisition of English language proficiency among DLLs in Head Start over the preschool year (fall-spring) predict change in EF (EF composite and its components)?

Results demonstrated that increases in second language proficiency from fall to spring significantly predict increases in EF (as measured by the HTKS-R and the WJWM tasks) across the preschool year; in particular, increases in working memory and cognitive flexibility. In addition, it is important to note that the results for the first research question showed fall English proficiency did not predict HTKS-R scores. This suggests the effect of English proficiency on eventual EF in spring may depend specifically on the change in English proficiency that takes place across the preschool year, rather than baseline English proficiency. These results highlight how influential the preschool years are, as they represent a biological stage where relative plasticity is high and developmental change is rapid for both language development and EF simultaneously (Best & Miller, 2010; Lerner, et al., 2005; National Academies of Science, 2017; Overton, 2015). This rapid neurological development is heavily impacted by the environmental influence of the preschool classroom- especially for DLL children.

Considering the fact that children in the present study attended preschool centers where English was the primary language of instruction, these findings align with two existing conclusions in the literature. Some studies suggest that children who are more proficient in English are better able to engage with American preschool classroom instruction and form positive teacher and peer relationships (Niehaus & Adelson, 2014; Sullivan, Hedge, Ballard, & Ticknor, 2014), skills which are foundational to the development of executive function and academic achievement (Caprara et al., 2000; McClelland et al., 2007; Portilla, Ballard, Alder, Boyce, & Obradovic, 2014). Other literature suggests that children's ability to be assessed in English in the spring is reflective of increasing bilingual proficiency, which may be related to higher executive function (Bialystok & Barac, 2012; National Academies of Science, 2017; Paap et al., 2015; Rosselli et al., 2016). Without measuring Spanish language proficiency, the present study cannot fully support this conclusion; however, these results are in alignment with current bilingual literature that claims children proficient in more than one language sometimes display higher levels of working memory and cognitive flexibility (Barac et al., 2016; Calvo & Bialystok, 2014; Hartanto et al., 2018; Paap et al., 2015; Rosselli et al., 2016).

Post-Hoc Analyses

Because the preLAS was used as an English screener in the larger study from which these data were collected, children's scores for this assessment determined whether they received the rest of the EF assessments in Spanish or English. Post-hoc analyses examined the possible influence of these assessment language groupings on each of the research questions in the present study. Although both groups of children demonstrated growth on the preLAS, only children who were able to be assessed in English by spring of their preschool year showed higher EF in spring (via the HTKS-R task and Day/Night Stroop task). These findings further support the idea that gains in second language proficiency made across the preschool year (from fall to spring) and a DLL child's eventual ability to be assessed in English at the end of preschool could be more strongly related to higher EF skills than baseline English proficiency at preschool entry.

It is important to note however, that the relationship between proficiency and EF may look qualitatively different for children assessed in English versus Spanish, and cut scores may not adequately capture these differences. In particular, there may be weaknesses in using a cut score to establish proficiency with the preLAS. In addition, some studies suggest assessments such as the preLAS lack validity and practical application to real-world language usage of preschool age children (Esquinca et al., 2005; Macswan, Rolstad, & Glass, 2000; Solano-Flores, 2008). Another possible explanation for the findings is that the EF measures utilized in the present study require certain a level of vocabulary in order to perform the tasks in either language. Children’s vocabulary and literacy skills were not measured by the present study, but could be contributing to the findings as a mediator. In other words, children increasing in second language proficiency may be demonstrating higher levels of vocabulary and literacy which aid in their understanding of the EF tasks and their subsequent performance.

Composite EF Variable

Another aim of this study was to see if the impact of second language proficiency on EF could be examined via the creation of a singular construct, since literature states that in early childhood, these executive function components may appear as a unitary construct. Previous literature found evidence for an overarching latent variable of EF in this age group (Best & Miller, 2010; McClelland, Geldhof, Cameron, & Wanless, 2015; Weintraub, 2013; Wiebe, Andrews Espy, & Charak, 2008); but attempts to measure the effect of English proficiency on a composite variable of the four EF measures in the current study led to non-significant results. This is most likely explained by small sample size and a lack of power, but further research is needed with larger samples.

Policy and Practical Implications

The results of this study emphasize the importance of the preschool year as a foundational language-building experience for young DLLs; as well as provide important information on how second language proficiency and EF might develop concurrently for low-income DLLs attending school in the United States. For DLLs in the present study, their ability to achieve proficiency in English by the end of their preschool year predicted higher EF scores. This has clear policy implications. Preschool centers may be able to positively influence DLL's second language proficiency, as preschool children are in a developmental window where the capacity to learn language is strong (Birdsong & Molis, 2001; Gaillard et al., 2000; Hoff, 2017; Mayberry & Lock, 2003).

In order to affect change and appropriately prepare DLL children for elementary school entry, policymakers should focus on supporting DLL children's language skills and EF. To achieve this, it is essential that policy dictate more clear guidelines as to what constitutes high-quality instruction and academic achievement for DLL children. Although the U.S. Department of Education now oversees early learning, there have been no professional evaluations of the English-language support services offered at the preschool level (National Academies of Science, 2017). In addition, the academic growth and development for the majority of DLL students is measured in comparison to their monolingual peers (Solano-Flores, 2008). Researchers should continue to contribute new evidence to guide practitioners in what "typical growth" looks like for children who are learning two languages at once; and utilize this trajectory as a better reference to measure growth for DLL children in both preschool and beyond.

Once researchers and practitioners determine what typical growth looks like, the next step is to implement tools to help DLL children successfully achieve second language proficiency in preschool. There is debate in the literature, but many studies have shown the most effective way to strengthen second language proficiency is to ensure that the first language is also supported (Diaz, 2016; National Academies of Science, 2017; Steele et al., 2017.; Valentino & Reardon, 2015). Moreover, EF is also strongest when dual-language learners are strong in both of their languages (National Academies of Science, 2017). However, the majority of studies on bilingual curriculum utilize K-12 samples, so more research needs to be done with preschool populations.

Another way to strengthen English skills in preschool could be to strengthen children's EF upon preschool entry and throughout the preschool year. There are several EF and self-regulation interventions that are evidence-based and highly effective for this age-group, including the Head Start REDI project (Bierman et al., 2008) the Red-Light Purple-Light intervention (RLPL; McClelland, et al., 2019; Schmitt, McClelland, Tominey, & Acock, 2015), and many more (Diamond & Lee, 2011). Some interventions, such as the RLPL intervention, demonstrate even larger effects for low-income DLL children (Schmitt, McClelland, Tominey, & Acock, 2015). Policymakers and preschool providers should explore ways in which EF interventions can be incorporated into their curriculum if they serve these specific populations.

Limitations and Future Directions

The present study is not without limitations. First, the small sample size leads to diminished statistical power in analyses. However, in developmental research with DLL students that specifically centers on EF, sample sizes of 50 to 60 participants are common (Barac et al., 2016; Beech & Keys, 1997; Bialystok & Senman, 2004; Bialystok & Shapero, 2005; Calvo & Bialystok, 2014; Hoff, 2017b; Singh et al., 2015). Second, although Spanish-dominant DLLs represent the largest proportion of DLLs in the United States (Aikens et al., 2017), it is unclear whether the results of the present study would be generalizable to children who speak other languages at home.

A third limitation is due to lack of accurate measures of English language proficiency for preschool-aged children. There have been many critiques regarding the accuracy and reliability of common language screeners such as the Pre-IPT, the LAB and the preLAS (Esquinca et al., 2005; Macswan, Rolstad, & Glass, 2000; Solano-Flores, 2008). These assessments are generally shortened and simplified versions of their counterparts designed for older students. The directions can be confusing for children and there are issues with dialectical differences. Due to the novelty and intimidation of the testing setting, these types of assessments may not be accurately reflecting preschool aged children's second language proficiency; but remain some of the only validated tools accessible to researchers.

Another limitation is that children were only given one proficiency assessment: a measure of English proficiency. Their Spanish abilities were not measured. Furthermore, children who passed the screener went on to complete the rest of their assessments in English. This means that we will never be able to know how they would have performed had they also been given these assessments in Spanish. Furthermore, both English and Spanish proficiency are highly dependent on outside factors not measured in this study, such as quantity and quality of language exposure in the home, especially during preschool.

The present study did not seek to explore the effect of EF on second language proficiency. However, the development of language proficiency and EF is complex, and it is possible the relationship between the two constructs is bidirectional for both monolingual and DLL populations (Bohlmann, Maier, & Palacios, 2015; Slot & von Suchodoletz, 2018; Weiland, Barata, & Yoshikawa, 2014). Given this information, the results of the present study can be interpreted in multiple ways. It is possible that children who make gains in English proficiency across the preschool year are better able to access classroom resources that improve their EF skills. An equally likely conclusion is that children who begin preschool higher in EF have greater self-regulatory capabilities, which make them better able to access classroom resources that in turn improve their English abilities. A third conclusion could be that increasing English abilities mean children are approaching more equal levels of fluency in both their languages, which some research suggests can boost EF skills (Bialystok & Barac, 2012; National Academies of Science, 2017; Paap et al., 2015; Rosselli et al., 2016). However, without also measuring children's Spanish abilities, it is impossible to provide enough evidence to support this third conclusion with the scope of the present study.

Future directions include creating proficiency assessments that allow children to show researchers what they can do in naturalistic settings, such as using language during play with peers, expressing their feelings, or asking for help. Previous authors also strongly recommend researchers use more than one measure when attempting to capture proficiency (Esquinca et al., 2005). Furthermore, future studies should attempt to procure larger and more diverse DLL samples so that children can be tested for proficiency in both English and Spanish, as well as given both English and Spanish EF assessments. Procuring larger samples, as well as utilizing children who speak languages other than Spanish and English, will allow more variability to emerge and give research a clearer picture of true population characteristics for dual language-learning children. This way, more accurate conclusions can be drawn regarding the relationship between their initial proficiency level (measured continuously, and possibly, by individual language skills) and their EF skills.

Conclusion

EF and second language proficiency are two skills that develop rapidly for dual-language learners during the preschool year. The present study provides evidence that English proficiency predicts aspects of EF (e.g., working memory) in fall of the preschool year, but the majority of the influence of English proficiency on executive function may be due to the increases in proficiency that children make over the preschool year. However, the directionality of the relationship between these two skills was not fully examined in this study. It is likely EF skills in preschool could also be working to influence second language proficiency across the preschool year. Policymakers and preschool providers can foster positive outcomes for young dual-language learners by encouraging the use of teaching methods such as evidence-based bilingual instruction as well as executive function and self-regulation interventions in the classroom.

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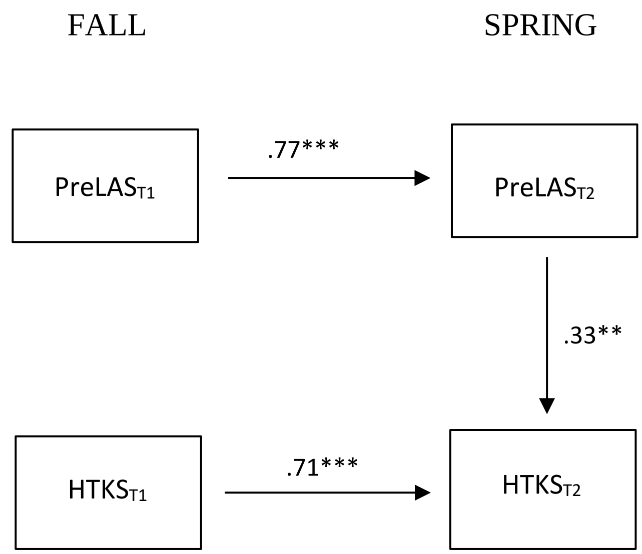

Figure 1. Results of residualized change regressions for English Proficiency and EF (as measured by the HTKS-R task). Standardized coefficients are presented, adjusted for age and gender. ($\chi^2(7) = 8.58$, $p = .28$) ** $p \leq .01$, *** $p < .0001$

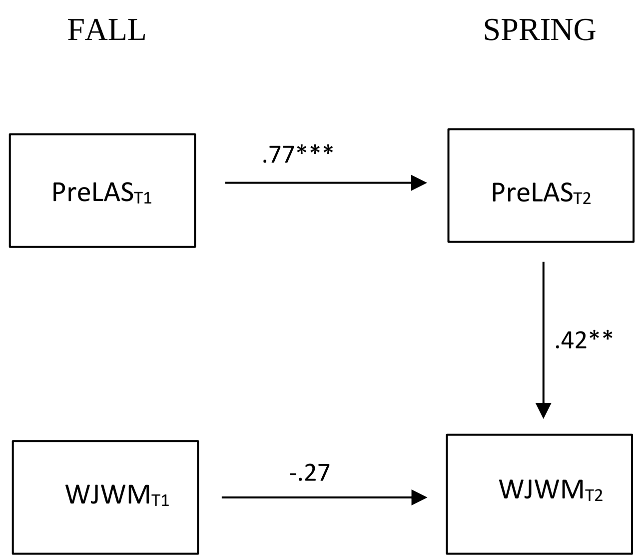

Figure 2. Results of the residualized change regressions for English Proficiency and EF (as measured by the WJWM task). Standardized coefficients are presented, adjusted for age, gender, and clustering ($\chi^2(7) = 17.18$, $p = .02$). ** $p \leq .01$, *** $p < .0001$

TABLE 1.
Scoring Range of Executive Function Assessments, Fall and Spring of Preschool

	Fall of Preschool					Spring of Preschool				
EF Skill	Obs	*m*	*SD*	min	max	Obs	*m*	*SD*	min	max
HTKS-R	44	30.77	23.55	0	94	25	45.04	26.58	2	92
preLAS	74	11.08	6.16	0	20	53	14.42	4.37	4	20
Day/Night	70	21.94	9.73	0	32	45	24.49	7.97	2	32
DCCS	66	9.73	5.35	5	21	44	12.66	6.18	6	23
WJWM	66	442.52	10.21	425	468	42	441.55	12.30	425	484

TABLE 2.
Correlations and Observations, Fall of Preschool

	PreLAS	Gender	Age	HTKS-R	Day/Night	DCCS	WJWM
PreLAS	1.00						
	74						
Gender	-0.05	1.00					
	74	74					
Age	0.14	-0.03	1.00				
	73	73	73				
HTKS-R	-0.07	-0.14	0.16	1.00			
	44	44	44	44			
Day/Night	-0.12	-0.07	-0.04	0.30^{t}	1.00		
	70	70	70	42	70		
DCCS	0.12	0.21	0.33**	0.50***	0.20	1.00	
	66	66	66	41	65	66	
WJWM	0.44***	0.03	0.17	-0.11	0.02	0.06	1.00
	66	66	66	40	66	64	66

Note. * $p < .05$, ** $p < .01$, *** $p < .001$, ^{t} $p < .07$

TABLE 3.
Correlations and Observations, Spring of Preschool

	PreLAS	Gender	Age	HTKS-R	Day/Night	DCCS	WJWM
PreLAS	1.00						
	53						
Gender	-0.19	1.00					
	53	74					
Age	0.09	0.02	1.00				
	52	53	53				
HTKS-R	.43*	-0.23	0.36	1.00			
	24	25	25	25			
Day/Night	0.02	-0.15	0.06	0.23	1.00		
	43	45	44	23	45		
DCCS	0.11	-0.04	0.27	.48*	0.01	1.00	
	43	44	44	23	40	44	
WJWM	0.30*	-0.06	-0.12	0.35	0.00	0.23	1.00
	41	42	42	22	41	38	42

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

TABLE 4.
RQ1. PreLAS as a Predictor of Fall and Spring Executive Function

		Fall of Preschool			Spring of Preschool		
EF Skill	Predictor	B	SE (B)	ß	B	SE (B)	ß
HTKS-R	preLAS	-.37	.57	-.10	2.31*	1.11	.39*
	Age	11.10	10.74	.15	27.24*	13.81	.32*
	Gender	-6.42	6.96	-.14	-1.82	9.88	-.03
Day/Night	preLAS	-.19	.19	-.12	-.04	.27	-.02
	Age	-.49	3.78	-.02	1.18	3.84	.05
	Gender	-1.50	2.32	-.08	-2.35	2.45	-.15
DCCS	preLAS	.07	.10	.09	.14	.20	.10
	Age	5.78**	1.99	.33**	5.37	2.90	.27
	Gender	2.27^{t}	1.21	.21	-.28	1.80	-.02
WJWM	preLAS	.72***	.13	.43***	.82*	.41	.29*
	Age	3.58	4.30	.11	-5.25	5.91	-.13
	Gender	.72	1.71	.03	.28	3.74	.01
Composite	preLAS	.01	.01	.09	.03	.02	.19
	Age	.42	.25	.20	.47	.32	.20
	Gender	.08	.15	.06	-.13	.20	-.09

Note. Regression models were run separately for each EF skill. * $p < .05$, ** $p < .01$, *** $p < .001$

TABLE 5.
Post-Hoc Analyses: Fall Regressions Across PreLAS Assessment Groups

		Spanish (*n*=43)		English (*n*=31)	
EF Skill	Predictor	B(SE)	ß	B(SE)	ß
HTKS-R	preLAS	-1.07(1.43)	-.17	1.90(2.92)	.13
	Age	23.48(17.78)	.26	4.20(12.30)	.07
	Gender	1.64(10.83)	.03	-13.32(8.51)	-.32
Day/Night	preLAS	-0.39(0.42)	-.16	1.04(1.19)	.16
	Age	-0.54(5.53)	-.02	0.28(5.16)	.01
	Gender	-0.98(3.16)	-.05	-2.54(3.48)	-.13
DCCS	preLAS	-0.06(0.21)	-.05	-0.27(0.67)	-.07
	Age	5.89(2.86)*	.33*	5.80(2.82)*	.35*
	Gender	3.06(1.55)*	.30*	1.62(1.94)	.15
WJWM	preLAS	0.38(0.32)	.17	1.21(1.21)	.17
	Age	7.56(5.30)	.25	0.25(5.67)	.009
	Gender	0.74(2.63)	.04	1.42(2.83)	.07
Composite	preLAS	-0.004(0.03)	-.02	0.09(0.08)	.19
	Age	0.45(0.37)	.19	0.45(0.33)	.23
	Gender	0.11(0.21)	.08	0.03(0.22)	.02

Note. Regression models were run separately for each EF skill. * $p < .05$

TABLE 6.

Post-Hoc Analyses: Spring Regressions Across PreLAS Assessment Groups

		Spanish (*n*=24)		English (*n*=29)	
EF Skill	Predictor	B(SE)	ß	B(SE)	ß
HTKS-R	preLAS	0.79(2.92)	.08	5.95(3.21)*	.42*
	Age	22.62(24.83)	.27	36.73(17.48)*	.42*
	Gender	-15.74(20.44)	-.29	4.72(11.13)	.09
Day/Night	preLAS	-0.81(0.65)	-.25	1.81(0.66)**	.43**
	Age	4.41(6.07)	.16	5.83(3.92)	.23
	Gender	-4.85(4.13)	.27	-7.47(2.32)**	-.51**
DCCS	preLAS	0.45(0.45)	.21	0.70(0.67)	.19
	Age	3.61(4.25)	.20	7.93(4.16)^{t}	.36
	Gender	-1.84(2.70)	-.15	-0.09(2.43)	-.007
WJWM	preLAS	1.17(0.95)	.27	-0.17(1.36)	-.03
	Age	-0.24(9.03)	-.006	-6.70(8.44)	-.16
	Gender	4.49(6.15)	.19	-1.66(4.90)	-.07
Composite	preLAS	0.02(0.04)	.09	0.04(0.08)	.09
	Age	0.54(0.37)	.29	0.62(0.52)	.23
	Gender	0.20(0.25)	.17	-0.36(0.29)	-.23

Note. Regression models were run separately for each EF skill. * $p < .05$, ** $p < .01$