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Self-Regulation Abilities and Spanish-Speaking Preschoolers' Vocabulary and Letter-Word Skills in Spanish and English

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ABSTRACT

Research Findings: This study examined the heterogeneity in Spanish-speaking children's (N = 117; M age = 53 months; SD = 5 months; 57% boys) vocabulary and letter-word skills in English and Spanish after one year of preschool and the extent to which early self-regulation abilities (i.e., executive function and effortful control) were associated with that variability. Data were gathered via teacher and parent surveys and standardized assessments. Three distinct profiles of Spanish-speaking preschoolers were identified using cluster analysis. One group exhibited high levels of Spanish and English vocabulary and letter-word skills (a.k.a. high-balanced bilinguals). The other two groups exhibited predominantly Spanish or English vocabulary and letter-word skills (a.k.a. Spanish- or English-dominant). Multinomial logistic regression analyses (controlling for children's nonverbal cognitive ability) revealed that effortful control skills enhanced children's probability of being classified as high-balanced bilinguals versus Spanish-dominant; however, this was evident only for the children whose parents reported speaking exclusively Spanish at home. Executive function abilities appeared to be unrelated to preschoolers' bilingual classification, and thus their English vocabulary and letter-word skills. *Practice or Policy*: The findings have implications for early education programs working to increase the school readiness of Spanish-speaking children by highlighting the key role that effortful control may play in supporting their learning of English skills, particularly for those whose parents speak exclusively Spanish at home.

From 1995 to 2010, the proportion of English language learner (ELL) students in U.S. schools increased by 64% compared to only a 4% increase in overall student enrollment (National Clearinghouse for English Language Acquisition, 2010). The majority (71%) of ELL students speak primarily Spanish (Soto, Hooker, & Batalova, 2015). Many Spanish-speaking children lag behind English monolinguals academically in school because of limited English proficiency, with the performance gap widening over time and a heightened risk of dropping out of school (Mancilla-Martinez & Lesaux, 2011; U.S. Department of Education, 2014). Limited English proficiency hinders Spanish-speaking children's school performance by interfering with their ability to comprehend teachers' instructions, engage in classroom content, and participate in discussions. Thus, it is critical to identify the factors that foster Spanish-speaking children's English skills *prior* to entering school.

Spanish-speaking children enter kindergarten with varying levels of Spanish and English proficiency: Those who are proficient in English are able to keep pace academically with English monolinguals over time, whereas those who exhibit limited English proficiency are likely to lag behind (Halle, Hair, Wandner, McNamara, & Chien, 2012). Preschool represents the first

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time that many Spanish-speaking children are exposed to an English learning environment, and it is an ideal setting to prepare them to meet the academic demands of school by enhancing their English skills and providing a foundation for later learning (Hammer, Lawrence, & Miccio, 2007; Magnuson, Lahaie, & Waldfogel, 2006). It is important to note that recent research has raised the possibility that self-regulation abilities may facilitate Spanish-speaking preschoolers' building of English knowledge. For example, Bohlmann, Maier, and Palacios (2015) and Winsler, Kim, and Richard (2014) reported positive associations between Spanish-speaking children's self-control and behavioral regulation abilities in preschool and their English language skills in kindergarten. Self-regulation abilities are known to underlie children's academic learning (Blair, 2002; Liew, 2012). Yet the extent to which self-regulation associates with Spanish-speaking children's language and academic skills in Spanish and English is unclear because of a lack of research. The present study addressed this gap by examining the extent to which key components of self-regulation (i.e., executive function [EF] and effortful control [EC]) associate with low-income Spanish-speaking preschoolers' English and Spanish vocabulary and letter-word skills, which are fundamental skills that shape children's academic performance in school (Hammer et al., 2007; National Institute of Child Health and Human Development Early Child Care Research Network, 2005).

EF and EC

Self-regulation abilities enable children to engage in optimal learning and achieve academic success by coordinating cognitive and behavioral processes that regulate attention and mental effort while inhibiting negative emotions, impulses, and distractions that interfere with learning (Blair, 2002; Rothbart & Bates, 2006). Although there is debate about the specific components of self-regulation, investigators have traditionally studied it from two approaches: cognitive/neuroscience or behavioral/temperament. The cognitive/neuroscience approach has focused on *EFs*, whereas the behavioral/temperament approach has focused on *EC*. EFs are interrelated cognitive control processes, such as inhibitory control (i.e., the ability to suppress dominant responses in favor of subdominant ones and to ignore irrelevant information), attention shifting/cognitive flexibility, and working memory (Miyake et al., 2000). EF involves higher order thinking that develops mostly from infancy to adolescence, with significant gains occurring between 3 and 5 years of age alongside the maturation of the prefrontal cortex (Center on the Developing Child at Harvard University, 2011; Garon, Bryson, & Smith, 2008). On a related note, EC is a component of temperament, conceptualized in part as the efficiency of executive attention (Rothbart & Bates, 2006). EC is involved in the regulation of emotions, attention, and behavior according to environmental demands by suppressing dominant/impulsive behaviors (i.e., inhibitory control), shifting, and focusing one's attention. Individual differences in EC are evident in infancy, remain relatively stable across the life span, and are shaped by both hereditary and environmental factors (Goldsmith et al., 1987; Lemery, Goldsmith, Klinnert, & Mrazek, 1999).

Conceptually speaking, EF and EC partially overlap given that attentional and inhibitory control mechanisms underlie both constructs. Moreover, positive linkages have been found between parent- and teacher-reported measures of EC and children's performance on EF tasks (Blair & Razza, 2007; Simonds, Kieras, Rueda, & Rothbart, 2007). However, EF and EC are not the same. They associate independently with children's vocabulary, literacy, and math skills (Blair & Razza, 2007). The conceptual overlap between EF and EC and their unique associations with children's academic abilities have led investigators to call for models of self-regulation that consider both constructs as complementary to achievement (Liew, 2012; Zhou, Chen, & Main, 2012). This approach is critical to better understand the role of self-regulation in children's academic success. The present study tested a self-regulation model that examined the unique and interactive associations of EF and EC with low-income Spanish-speaking children's English and Spanish vocabulary and letter-word skills in preschool.

Children's EF and Academic Skills

Prior research suggests that EFs are key correlates of children's language (primarily vocabulary) and academic skills, with children who exhibit high EF abilities performing better than those who exhibit low EF abilities (Best, Miller, & Naglieri, 2011; Nesbitt, Farran, & Fuhs, 2015; Welsh, Nix, Blair, Bierman, & Nelson, 2010). This is because the ability to control one's attention, inhibit irrelevant thoughts, and retain and manipulate information in working memory is believed to underlie learning across multiple academic domains. Studies conducted with preschoolers from diverse ethnic, linguistic, and socioeconomic backgrounds suggest that EF abilities (measured by attention shifting, inhibitory control, and working memory tasks) associate positively with gains in vocabulary and letter-word skills throughout children's time in preschool (Fuhs, Nesbitt, Farran, & Dong, 2014; Weiland, Barata, & Yoshikawa, 2014).

Note that children from bilingual homes, including those from low-income backgrounds, generally exhibit EF advantages early in their development compared to children from monolingual homes (Abreu, Cruz-Santos, Tourinho, Martin, & Bialystok, 2012; Bialystok, Barac, Blaye, & Poulin-Dubois, 2010; Bialystok & Martin, 2004). The EF advantage is believed to stem from bilingual children having to constantly manage and attend to multiple languages—in particular, selectively attending to one language while temporarily inhibiting the other according to environmental demands. Thus, individual differences in preschoolers' EF abilities may stem in part from the language environment at home. The constant usage of attention and inhibitory control mechanisms during early childhood might enhance the early development of EF abilities (Bialystok, 2007). Such EF advantages may be evident in bilingual children by 2 years of age (Poulin-Dubois, Blaye, Coutya, & Bialystok, 2011). This is important because early advances in EF abilities might enhance bilingual children's later learning in preschool. The EF advantage is particularly evident on tasks that require children to manage conflictive attentional demands, inhibit dominant responses, and ignore misleading information. For example, Carlson and Meltzoff (2008) administered nine different EF tasks to three groups of kindergarten children: English-speaking monolinguals, English speakers attending a Spanish or Japanese immersion program, and Spanish–English bilinguals exposed to both languages from birth. In general, the children who were bilingual from birth performed better on the EF tasks than both the monolinguals and those attending immersion programs. Thus, it may be that because of their relatively advanced EF abilities, the positive linkages between EF abilities and Spanish and English and academic skills is stronger for Spanish-speaking preschoolers who are exposed to both languages at home than for those who are exposed to only Spanish.

Children's EC and Academic Skills

As with EF abilities, there is evidence that EC abilities contribute to children's learning of language and academic skills (Allan & Lonigan, 2011; Blair & Razza, 2007; Chen et al., 2015; Valiente et al., 2011; Zhou, Main, & Wang, 2010). For example, both impulsivity and attentional control problems have been negatively linked with children's language, letter-word, and math skills at 54 months of age (National Institute of Child Health and Human Development Early Child Care Research Network, 2003). Conversely, McClelland et al. (2007) found that children who exhibited greater growth in behavioral regulation capabilities throughout 1 year of preschool (measured primarily by the ability to inhibit dominant behavioral responses in favor of subdominant ones) exhibited greater gains in vocabulary and letter-word skills throughout preschool than those who exhibited less growth in behavioral regulation capabilities.

Building on this work, recent research raises the possibility that EC abilities support the learning of English among Spanish-speaking children. Winsler et al. (2014) found that high levels of self-control (a construct that overlaps considerably with EC, measured by teachers' ratings of children's ability to exhibit emotions, communicate, and behave in socially appropriate manners) enhanced Spanish-speaking preschoolers' likelihood of becoming orally proficient in English a year later, by

the end of kindergarten. In addition, Bohlmann et al. (2015) examined the bidirectional linkages between Spanish-speaking preschoolers' behavior regulation (measured by attention focusing, inhibitory control, and compliance tasks) and expressive vocabulary skills in English across three waves of data collection: the fall and spring of preschool and the subsequent fall academic semester when the children were in either their second year of preschool or kindergarten. After controlling for children's prior Spanish vocabulary knowledge, they found that behavior regulation abilities associated positively with gains in English vocabulary knowledge. Thus, EC abilities may be an important correlate of Spanish-speaking children's English vocabulary and letter-word skills in preschool.

EC abilities may enhance academic performance by fostering behaviors and emotions that support learning. Children with high EC levels are likely to engage in classroom content, participate in classrooms discussions, and persist in challenging learning tasks to a greater extent than those with low EC levels (Iyer, Kochenderfer-Ladd, Eisenberg, & Thompson, 2010; Valiente, Lemery-Chalfant, Swanson, & Reiser, 2008; Zhou et al., 2007). Children with high EC levels also seem to enjoy school more and believe that they can succeed academically more so than children with low EC levels (Liew, McTigue, Barrois, & Hughes, 2008; Silva et al., 2011; Valiente, Lemery-Chalfant, & Castro, 2007). EC abilities also associate positively with social competence, maximizing children's ability to form positive relationships with classroom teachers and peers (Fabes et al., 1999; Silva et al., 2011; Valiente et al., 2008; Zhou et al., 2007). Positive experiences with teachers and peers are important correlates of preschoolers' academic performance, including that of ELL preschoolers (Birch & Ladd, 1997; Palermo, Hanish, Martin, Fabes, & Reiser, 2007). A recent study suggested that engaging in positive interactions with peers and in learning behaviors, such as participating in classroom discussions and focusing one's attention during learning activities, enhances Spanish-speaking preschoolers' later English vocabulary and letter-word skills (Palermo & Mikulski, 2014).

By fostering mechanisms that support learning, such as classroom engagement and social competence, EC abilities may play a key role in fostering Spanish-speaking preschoolers' learning of English, particularly for those who receive limited English support at home and thus have fewer resources in that language to build on when they enter preschool (Branum-Martin, Mehta, Carlson, Francis, & Goldenberg, 2014; Hammer et al., 2007). This is because Spanish-speaking children who are exposed to English at home are likely to enter preschool with some English knowledge to build on (Hammer et al., 2007), whereas those who are exposed to only Spanish at home may rely more on their EC abilities and related mechanisms to begin learning English in early educational settings. Consequently, the strength of the positive association between Spanish-speaking preschoolers' EC abilities and English skills may vary by parents' use of Spanish and English at home, with the association being stronger for those whose parents speak exclusively Spanish than for those whose parents speak both languages.

The Present Study

The present study examined the variability in Spanish-speaking children's Spanish and English vocabulary and letter-word knowledge after 1 year of preschool and the extent to which EF and EC abilities were associated with their vocabulary and letter-word knowledge in both languages. Three research questions guided this study:

(1) What is the variability in Spanish-speaking children's vocabulary and letter-word knowledge in Spanish and English after 1 year of preschool, and to what extent does that variability associate with key child- and family-level factors, such as parents' education levels and children's nonverbal cognitive ability?
(2) What are the associations between EF and EC abilities and Spanish-speaking preschoolers' English vocabulary and letter-word skills?
(3) Do the associations between EF and EC abilities and Spanish-speaking preschoolers' English vocabulary and letter-word skills vary by parents' English and Spanish use?

We used cluster analysis to address the first research question and classify Spanish-speaking children based on their vocabulary and letter-word skills in Spanish and English at the end of preschool. Consistent with the work of Gonzalez et al. (2015), who used latent class analysis to classify preschoolers based on their Spanish and English vocabulary and preliteracy skills (e.g., Spanish letter naming and phonological awareness), and the work of Leung and Uchikoshi (2012), who used cluster analysis to classify children in first grade based on their Cantonese and English vocabulary skills, we expected to find considerable variability in preschoolers' dual language skills. Specifically, we expected some preschoolers to exhibit comparable levels of Spanish and English skills, some to exhibit greater Spanish than English skills, and others to exhibit greater English than Spanish skills.

To address the second and third research questions, we used logistic regression analysis to examine the extent to which EF and EC abilities were associated with children's bilingual classification, with a particular emphasis on their English skills, and whether those associations varied by parents' language use at home. It was expected that EF abilities would associate positively with children's English vocabulary and letter-word skills, with the association being stronger for the children whose parents used Spanish and English than for those whose parents used only Spanish (Fuhs et al., 2014; Poulin-Dubois et al., 2011). On a related note, it was expected that EC abilities would associate positively with children's English vocabulary and letter-word skills, with the association being stronger for the children whose parents used only Spanish than for those whose parents used Spanish and English (Bohlmann et al., 2015; Branum-Martin et al., 2014). Finally, it is possible that EF and EC abilities interact to predict Spanish-speaking preschoolers' English vocabulary and letter-word skills. Given the lack of research in this area from which to formulate hypotheses, we examined this possibility in an exploratory manner.

Methods

Participants

The participants were Spanish-speaking children drawn from 10 Head Start preschool classrooms in a southwestern U.S. metropolitan area. Two cohorts of five classrooms were recruited. Each cohort represented a year of data collection. All classrooms operated for 3.5 hr a day, 5 days a week. Classroom sizes ranged from 15 to 20 students. The proportion of Spanish-speaking students per classroom ranged from 70% to 100%. At least one teacher per classroom (the lead teacher and/or aide) spoke Spanish fluently. In the fall, the teachers reported conducting activities in English on a daily basis. They reported conducting activities in Spanish approximately 1–2 times per week. Mean-level comparisons revealed that children's Spanish and English vocabulary and letter-word skills at the end of preschool did not vary between the classrooms with one or two teachers who were fluent in Spanish.

Parental consent was obtained from 143 children (out of 161; permission rate = 89%). Children with missing data on any of the English and Spanish assessments (described next) were excluded from the present study (n = 26). These children were mainly those who left or enrolled in a participating classroom mid-year, were frequently absent, or lived in non-Spanish-speaking households. The final study sample consisted of 117 Spanish-speaking children. If children attended a participating classroom for 2 years, only their first year of data was used (n = 9). According to parents (mostly mothers), the children were mainly Mexican American (95%). The remainder were of Central/South American (2%) or unknown (3%) descent. Most of the children had been born in the United States (91%). They ranged in age from 43 to 60 months (M = 52.74, SD = 4.50) at the start of preschool. More than half were boys (57%). The majority lived in two-parent households (70%), with most mothers (84%) and fathers (88%) born outside of the United States. Parents reported living in the United States an average of 13 years (SD = 6.39 years, range = 2–33 years). Also, 41% of the parents reported

that they had not completed high school, 27% had completed high school, 22% had spent some time in college, and 10% had completed a college degree. The vast majority of parents reported earning less than $30,000 annually (86%). The remainder earned $30,000–$40,000 (7%), $40,000–$50,000 (3%), or more than $50,000 (4%). Finally, 40% of the parents reported speaking only Spanish at home, 51% used more Spanish than English, and 9% used more English than Spanish.

Procedures

Bilingual research assistants (three females, one male) assessed children's EF abilities in the fall (October–November) and spring (March–May) semesters. They also assessed children's nonverbal cognitive ability in the fall and their English and Spanish skills in the spring. To control for order effects, the language of the first assessment was randomly chosen for each child. To minimize practice effects across the English and Spanish versions, at least 2 weeks were allowed to pass between administrations. Lead teachers completed questionnaires on children's EC abilities in the fall and spring. Demographic data were gathered from parents (mostly mothers) during the fall.

Measures

EF

The Day-Night Stroop task was used to measure children's EF inhibitory control and working memory abilities. In this task, children are presented with 16 cards with one of two images: a nighttime or daytime sky (Gerstadt, Hong, & Diamond, 1994). The children are instructed to say "night" or *"noche"* when presented with the daytime image and "day" or *"día"* when presented with the nighttime image. Thus, the task measures primarily inhibitory control capabilities by requiring children to suppress a dominant response associated with a perceptual image in favor of a subdominant response while ignoring the conflicting image. The task also measures children's ability to maintain task instructions in working memory across the 16 trials in order to respond correctly. The children were allowed to respond in either language. We used the sum of correct responses in our analyses. Kuder–Richardson formula 20 reliability coefficients for the present sample were .94 for the fall and .96 for the spring.

EC

To measure children's EC, lead teachers completed the Inhibitory Control, Attention Focusing, and Attention Shifting Subscales from an adapted version of the Children's Behavior Questionnaire (Rothbart, Ahadi, Hershey, & Fisher, 2001). These subscales are frequently used to assess children's EC abilities (e.g., Eisenberg et al., 2005; Valiente et al., 2011). The inhibitory control subscale (αs = .86 for the fall and .78 for the spring) included 10 items gauging children's ability to follow instructions and suppress inappropriate behaviors when instructed to do so (e.g., "Can wait before entering into new activities if s/he is asked to"). The attention focusing subscale (αs = .74 for the fall and .69 for the spring) included nine items gauging children's ability to control their attention and stay on task (e.g., "When drawing or coloring in a book s/he shows strong concentration"). The attention shifting subscale (αs = .86 for the fall and .66 for the spring) included four items gauging children's ability to switch between tasks when instructed (e.g., "Can easily quit working on a project if asked"). Teachers' responses ranged from *extremely false* (1) to *extremely true* (5). The three subscales were positively correlated in the fall and spring: fall, $rs(114) \geq .50$, $p < .001$; spring, $rs(114) \geq .47$, $p < .001$. Together they tap children's ability to regulate their behavior according to environmental demands. Thus, consistent with prior studies, the three subscales were averaged in each semester to create fall and spring EC scores for each child.

Vocabulary Skills

Children's receptive vocabulary skills in English and Spanish were assessed using the Peabody Picture Vocabulary Test–IV (Dunn & Dunn, 2007; α = .97) and its Spanish version, the Test de Vocabulario en Imágenes Peabody (Dunn, Lugo, Padilla, & Dunn, 1986; α = .93). Both measures gauge receptive vocabulary by presenting children with four images and asking them to point to a specific one in the relevant language. We used children's raw scores in our analyses to gauge children's actual abilities, not those relative to the assessment norming samples. To gauge children's expressive vocabulary, we used the Picture Vocabulary subscale of the Woodcock–Johnson III Tests of Achievement (Woodcock, McGrew, & Mather, 2000; α = .81) and its Spanish version, the Batería III (Woodcock, Muñoz-Sandoval, McGrew, & Mather, 2004; α = .89). Both versions measure expressive vocabulary by having an examiner point to the image of an object and asking children to name it in the relevant language. We used the *W* scores provided by the test developers in our analyses, which are Rasch model mathematical transformations of the raw scores designed to gauge children's actual performance, not their performance relative to the monolingual norms (Woodcock et al., 2000).

Letter-Word Skills

To assess children's English and Spanish letter-word skills, we used the Letter-Word Identification subscale of the Woodcock–Johnson III Tests of Achievement (α = .94; Woodcock et al., 2000) and the Batería III (α = .95; Woodcock et al., 2004). Both versions gauge children's ability to recognize letters, name them, and decode words in each language. As with expressive vocabulary skills, we used the *W* scores in our analyses.

Nonverbal Cognitive Ability

Children's nonverbal cognitive ability was measured using the Naglieri Nonverbal Ability Test, which uses matrix items of shapes and geometric designs interrelated via spatial and logical organization to gauge nonverbal cognitive abilities in a culturally neutral manner because it can be administered in English or Spanish (Naglieri, 2003). It is a reliable (α = .89) and valid measure that correlates ($r > .50$) with tests of intelligence, such as the Wechsler Intelligence Scale for Children–Fourth Edition (Naglieri, 2003; Naglieri, Booth, & Winsler, 2004). Given that it was normed for use starting in kindergarten, we used raw scores in our analyses to control for individual differences in preschoolers' nonverbal cognitive ability.

Demographics

In the fall of preschool, parents completed single-item measures of family income levels, their education levels, language use at home, and their own and their children's birthplaces. The responses for family income ranged from *less than $30,000 annually* (1) to *more than $50,000 annually* (4). Education levels ranged from *less than high school* (1) to *having a college degree* (4). Regarding language use, their response choices were "only Spanish," "more Spanish than English," or "more English than Spanish." Finally, parents reported whether children's mothers, fathers, and the children themselves had been born in the United States or not.

Results

We examined the variability in Spanish-speaking children based on their Spanish and English vocabulary and letter-word skills in preschool and the extent to which EF and EC abilities associated with their varying levels of knowledge across both languages. First, cluster analysis was used to classify children based on their Spanish and English skills. Second, we described children's bilingual profiles and their connections with several family- and child-level factors, such as nonverbal cognitive ability and parents' language use. Third, we used repeated measures analysis to examine children's EF and EC abilities in preschool and to test whether patterns of change or stability varied

across the bilingual profiles. Finally, logistic regression was used to examine the relations among EF and EC abilities and children's bilingual classification.

Bilingual Profiles of Spanish-Speaking Preschoolers

To classify children based on their Spanish and English skills in the spring of preschool, we used cluster analysis. Six variables were included in the cluster analysis: receptive and expressive vocabulary and letter-word skills in English and Spanish. Consistent with cluster analysis guidelines, a two-step approach was implemented (Henry, Tolan, & Gorman-Smith, 2005). First, we used hierarchical cluster analysis with the cosine index of similarity and average linkage to identify a cluster solution. Second, we used *k*-means cluster analysis, a nonhierarchical clustering method, to test whether the hierarchical cluster solution was replicable. All of the variables used in the cluster analysis were standardized ($M = 0$, $SD = 1$) to equate their scales and limit bias toward larger variances (Henry et al., 2005).

Based on several stopping criteria, including examination of the dendrogram, cluster sizes, and solution replicability, we selected a three-cluster solution as the best characterization of the data. Crosstab analysis revealed high agreement between the hierarchical and *k*-means cluster solutions, with 88% of the children placed in the same cluster, $\chi^2(4, N = 117) = 154.36$, $p < .001$. To describe the cluster profiles, we examined whether the means of the clustering variables were different from zero (the mean) within each cluster. Means were considered high if they were significantly ($p < .05$) greater than zero, low if significantly less than zero, and average if not significantly different from zero. As shown in Figure 1, the first cluster (i.e., high-balanced bilinguals) exhibited high English and Spanish vocabulary and letter-word skills ($n = 49$). The second cluster (i.e., English dominant) exhibited average to high English vocabulary and letter-word skills and low to average Spanish vocabulary and letter-word skills ($n = 29$). The third cluster (i.e., Spanish dominant) exhibited low English vocabulary and letter-word skills, average to high Spanish vocabulary skills, and low Spanish letter-word skills ($n = 39$).

In addition, we conducted an analysis of variance to identify differences and similarities between the clusters with respect to their Spanish and English vocabulary and letter-word skills. Cluster group was the between-subjects factor and the clustering variables were the outcomes. The results revealed several differences (see Table 1). Specifically, least significant difference mean comparisons revealed that the high-balanced bilingual and English-dominant clusters exhibited greater English expressive vocabulary and letter-word skills than the Spanish-dominant cluster. In addition, the high-balanced bilingual and Spanish-dominant clusters exhibited greater Spanish expressive

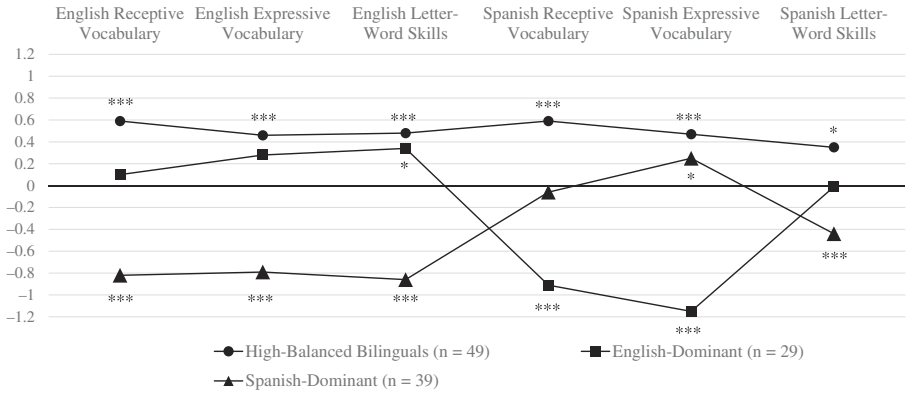

Figure 1. Hierarchical three-cluster solution of Spanish-speaking preschoolers' vocabulary and letter-word skills in English and Spanish. All variables are standardized ($M = 0$, $SD = 1$). Asterisks denote cluster patterns that are significantly different from the mean of zero.
*$p < .05$. ***$p < .001$.

Table 1. Analyses of Variance and Unstandardized Means (*SD*) for Children's English and Spanish Skills Based on the Hierarchical Three-Cluster Solution (N = 117).

	Cluster Membership						
Variable	High-Balanced Bilinguals (n = 49)		English Dominant (n = 29)		Spanish Dominant (n = 39)		F
English receptive vocabulary	50.20[a]	(17.38)	40.58[b]	(20.07)	22.15[c]	(8.36)	34.57***
English expressive vocabulary	446.10[a]	(16.57)	442.34[a]	(18.11)	419.21[b]	(18.81)	27.30***
English letter-word skills	337.49[a]	(19.35)	334.45[a]	(18.02)	308.44[b]	(12.90)	34.87***
Spanish receptive vocabulary	28.41[a]	(12.55)	8.45[b]	(5.29)	19.64[c]	(10.83)	32.51***
Spanish expressive vocabulary	441.16[a]	(16.21)	405.21[b]	(16.83)	436.38[a]	(16.55)	46.88***
Spanish letter-word skills	325.49[a]	(21.67)	318.45[a,b]	(16.24)	310.13[b]	(13.91)	7.83**

Note. The degrees of freedom were (2, 114) in all analyses. Different superscripts across the rows denote significant (p < .05) mean differences among the clusters with least significant difference adjustment.
**p < .01. ***p < .001.

vocabulary skills than the English-dominant cluster. Finally, the high-balanced bilingual cluster exhibited greater Spanish letter-word skills than the Spanish-dominant cluster. Taken together, the clusters varied on their English and Spanish receptive and expressive vocabulary and letter-word skills, and the replication of the three-cluster solution via *k*-means clustering provided further validity to the profiles.

Family- and Child-Level Differences

We conducted a series of analyses of variance and crosstab analyses to identify family- and child-level differences and similarities across the three clusters. Children's age and gender did not vary by cluster. However, their nonverbal cognitive ability did, $F(2, 112) = 7.16$, $p < .001$. The children in the high-balanced bilingual (M = 9.35, SD = 3.86) and English-dominant (M = 9.20, SD = 4.41) clusters exhibited greater nonverbal cognitive ability in the fall of preschool than the children in the Spanish-dominant cluster (M = 6.23, SD = 4.09).

Family income levels also differed between the clusters, $F(2, 90) = 3.72$, $p = .028$. Least significant difference mean comparisons revealed that the families of the children in the high-balanced (M = 2.36, SD = 1.43, range = 1–6) and English-dominant (M = 2.52, SD = 1.27) clusters reported higher annual incomes than the families of the children in the Spanish-dominant cluster (M = 1.68, SD = 0.72). Parents' language use at home also varied, $\chi^2(4, N = 117) = 34.83$, $p < .001$. The majority (74%) of the children in the Spanish-dominant cluster lived with parents who used only Spanish, whereas the majorities of the children in the English-dominant (76%) and high-balanced bilingual (57%) clusters lived with parents who used more Spanish than English. It is notable that 33% of the children in the high-balanced bilingual cluster lived with parents who reported using only Spanish; that is, although their parents used Spanish exclusively, by the spring of preschool these children exhibited high abilities in both languages. Some of the children in the high-balanced bilingual (10%) and English-dominant (17%) clusters lived with parents who used more English than Spanish. Also, mothers' birthplace (United States vs. foreign born) was marginally associated with children's cluster profiles, $\chi^2(2, N = 93) = 5.48$, $p = .065$. That is, 81%, 74%, and 97% of the children in the high-balanced bilingual, English-dominant, and Spanish-dominant clusters, respectively, had mothers who had been born outside of the United States. Finally, fathers' and children's birthplace did not vary by cluster, nor did parents' education levels.

Spanish-Speaking Preschoolers' EF and EC Abilities

At the bivariate level, preschoolers' EF abilities correlated positively across the fall and spring, $r(115) = .31$, $p < .001$. This was also the case for their EC abilities, $r(115) = .63$, $p < .001$.

However, EF and EC abilities were uncorrelated within and across semesters. Next we used mixed-model repeated measures analysis to examine children's EF and EC abilities throughout preschool. Separate repeated measures models were tested for EF and EC abilities. Time (fall and spring) was the within-subjects factor. Cluster group and parents' language use were the between-subjects factors. We also included two interaction terms (i.e., Time × Cluster Group and Time × Parents' Language Use) to examine whether any patterns of change or stability in EF and EC abilities varied among the clusters or by parents' use of one or two languages at home. Thus, parents' language use was recoded to include two groups of children: those whose parents used only Spanish (n = 47) and those whose parents used Spanish and English. The latter group was created by combining the children whose parents used more Spanish than English (n = 60) and those whose parents used more English than Spanish (n = 10).

The results revealed that time had an effect on EF abilities (β = 2.83, SE = 1.32, p = .032). All of the children gained EF abilities across the fall (M = 4.17, SD = 4.83) and spring (M = 8.18, SD = 5.92). The nonsignificant cluster group effect suggested that EF abilities did not differ by cluster. However, the Time × Cluster Group effect was significant (β = 3.63, SE = 1.81, p = .045). This suggested that the children in the high-balanced bilingual cluster exhibited greater gains in EF ability (fall, M = 4.24, SD = 5.49; spring, M = 9.86, SD = 6.04) than the English-dominant (fall, M = 2.96, SD = 3.14; spring, M = 5.96, SD = 6.01) and Spanish-dominant (fall, M = 4.75, SD = 4.93; spring, M = 7.33, SD = 5.57) clusters. Finally, the effects of parents' language use and Time × Parents' Language Use were nonsignificant, suggesting that children's EF abilities and their gains in those abilities did not vary by parents' use of one or two languages at home.

With respect to EC abilities, the cluster group effect was significant (β = 0.50, SE = 0.17, p = .003). On average, the children in the high-balanced bilingual cluster exhibited greater EC abilities (fall, M = 3.77, SD = 0.70; spring, M = 3.79, SD = 0.59) than the children in the English-dominant (fall, M = 3.31, SD = 0.90; spring, M = 3.38, SD = 0.72) and Spanish-dominant (fall, M = 3.37, SD = 0.74; spring, M = 3.45, SD = 0.71) clusters. However, the effect of time was nonsignificant, suggesting that children's EC abilities remained stable. Similarly, the Time × Cluster Group and Time × Parents' Language Use effects were both nonsignificant, as was the effect of parents' language use.

EF and EC Abilities and Spanish-Speaking Preschoolers' Bilingual Classification

To examine the contributions of EF and EC abilities to children's bilingual classification (i.e., high-balanced bilingual, English dominant, or Spanish dominant), we used multinomial logistic regression. Because we were interested in children's English knowledge, the Spanish-dominant cluster served as the reference category. Two models were tested. Consistent with logistic regression analysis guidelines, in the first model, all of the covariate, independent, and interaction variables were entered simultaneously (Osborne, 2015). In the second model, we excluded the variables that did not contribute to children's classification. Prior to the analysis, all of the continuous variables were standardized (M = 0, SD = 1). The recoded variable of parents' language use was included in the models to account for English exposure at home, with the children from Spanish-only homes serving as the reference category. In addition, because children gained EF abilities throughout preschool (as described previously), we included the fall and spring EF variables in the model to assess whether children's EF gains contributed to their bilingual classification. To control for children's nonverbal cognitive ability and family income levels, we included those variables in the models as well. We did not include parents' education levels or the birthplaces of mothers, fathers, and children because those variables did not vary by cluster. To assess model fit, we examined whether the set of variables included in the model reliably distinguished among children's bilingual classification better than a baseline (i.e., intercept-only) model and whether each of those variables contributed uniquely.

The results of the first model revealed that the set of predictor variables reliably distinguished among the high-balanced bilingual, English-dominant, and Spanish-dominant preschoolers better than the baseline model (baseline −2LL = 251.89, final −2LL = 178.70), $\chi^2(20, N = 117) = 73.79$,

Table 2. Multinomial Logistic Regression Examining the Contributions of EF and EC Abilities to Children's Bilingual Profile Classification.

	High-Balanced Bilinguals (n = 49)				English Dominant (n = 29)			
Model	*B*	*SE*	OR	95% CI	*B*	*SE*	OR	95% CI
Model 1								
Family income levels	0.43	0.49	1.54	[0.56, 4.19]	0.52	0.47	1.69	[0.65, 4.35]
Parents' language use	2.22**	0.72	9.25	[2.23, 38.29]	3.34***	0.93	28.29	[4.51, 177.46]
Nonverbal cognitive ability	0.65*	0.32	1.92	[1.02, 3.62]	0.60	0.37	1.82	[0.88, 3.77]
EC (f)	0.14	0.43	1.15	[0.49, 2.72]	−0.24	0.42	0.78	[0.34, 1.80]
EF (f)	0.07	0.44	1.08	[0.45, 2.57]	−0.08	0.47	0.92	[0.36, 2.31]
EF (s)	0.30	0.45	1.35	[0.56, 3.27]	−0.25	0.46	0.77	[0.31, 1.92]
EC (f) × EF (f)	−0.64†	0.37	0.52	[0.25, 1.08]	−0.30	0.39	0.74	[0.33, 1.61]
EC (f) × Parents' Language Use	1.61*	0.78	5.01	[1.06, 23.55]	0.32	0.98	1.37	[0.19, 9.56]
EF (f) × Parents' Language Use	−0.12	0.60	0.88	[0.27, 2.88]	−0.31	1.02	0.73	[0.09, 5.47]
EF (s) × Parents' Language Use	−0.41	0.67	0.66	[0.17, 2.49]	0.30	1.10	1.35	[0.15, 11.90]
Model 2								
Parents' language use	2.21***	0.61	9.19	[2.74, 30.73]	3.45***	0.84	31.66	[6.10, 164.30]
Nonverbal cognitive ability	0.63*	0.28	1.88	[1.08, 3.30]	0.59†	0.33	1.80	[0.93, 3.50]
EC (f)	0.06	0.39	1.07	[0.49, 2.30]	−0.26	0.39	0.76	[0.35, 1.65]
EC (f) × Parents' Language Use	1.52*	0.68	4.61	[1.21, 17.53]	0.31	0.87	1.37	[0.24, 7.63]

Note. The Spanish-dominant cluster served as the reference category (n = 39). Parents' language use was coded as Spanish and English (0) or Spanish only (1), with the Spanish-only group being the reference category. EF = executive function; EC = effortful control; OR = odds ratio; CI = confidence interval; f = fall; s = spring.
†p < .10. *p < .05. **p < .01. ***p < .001.

p < .001. However, not all of the variables contributed to the classification of children. As shown in Table 2, parents' language use and children's nonverbal cognitive ability distinguished among the clusters of children, as did the EC × Parents' Language Use interaction. No other variables appeared to associate with children's bilingual classification. Thus, they were excluded and the model was retested. The EC variable remained in the model in order to continue testing the interaction of EC × Parents' Language Use.

The results of the second model revealed that parents' language use was associated with children's classification as English dominant versus Spanish dominant (see Table 2). The odds ratio indicated that the children whose parents spoke Spanish and English at home, compared to those whose parents spoke only Spanish, were 31.66 times more likely to be classified as English dominant than Spanish dominant. In addition, nonverbal cognitive ability was positively associated with children being classified as high-balanced bilinguals versus Spanish dominant. The odds ratio indicated that for every 1-unit increase in nonverbal cognitive ability, children were 1.88 times more likely to be classified as high-balanced bilinguals than Spanish dominant. Parents' language use also contributed to children being classified as high-balanced bilinguals versus Spanish dominant, but this contribution was subsumed by a significant EC × Parents' Language Use interaction. As shown in Figure 2, for every 1-unit increase in fall EC abilities, the probability of being classified as high-balanced bilinguals during the spring versus Spanish dominant increased by a multiplicative factor (i.e., odds ratio) of 4.61, but this was only the case for the children whose parents spoke exclusively Spanish. For those whose parents spoke Spanish and English, the contribution of EC was nonsignificant. Thus, the extent to which EC abilities associated with Spanish-speaking preschoolers' later classification as high-balanced bilinguals versus Spanish dominant varied by parents' language use at home.

Discussion

In the present study, we examined the extent to which EF and EC abilities associated with low-income Spanish-speaking children's English and Spanish skills and investigated the heterogeneity in children's dual language vocabulary and letter-word knowledge after 1 year of preschool. Using

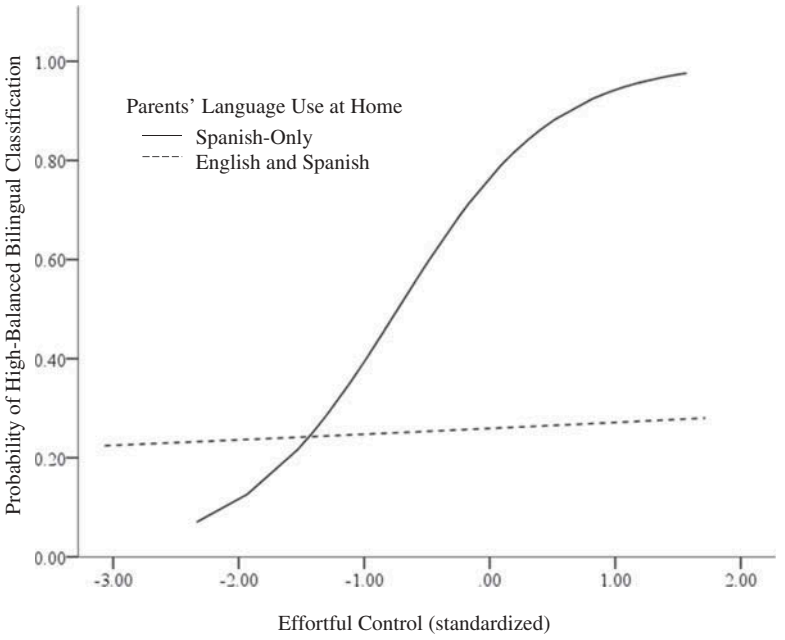

Figure 2. The probability of Spanish-speaking preschoolers being classified as high-balanced bilinguals versus Spanish dominant based on their fall effortful control levels and by parents' language use at home.

cluster analysis, we found three distinct groups of Spanish-speaking preschoolers. One group exhibited high levels of Spanish and English vocabulary and letter-word skills. The remaining two groups exhibited either more English than Spanish skills or more Spanish than English skills. We also found that all of the children gained EF abilities (primarily inhibitory control) throughout the preschool year, with the children who exhibited high levels of Spanish and English vocabulary and letter-word skills (i.e., the high-balanced bilinguals) achieving the most EF gains relative to the children who exhibited predominantly English or Spanish skills. In addition, EC abilities differed among the three groups, with the high-balanced bilingual children exhibiting greater EC abilities than the Spanish- and English-dominant children. Finally, EC abilities appeared to enhance children's later likelihood of being classified as high-balanced bilinguals versus Spanish dominant. However, this was only the case for the children whose parents spoke exclusively Spanish at home. Thus, EC abilities may be particularly important for these children's early building of English knowledge.

EF and EC Abilities and Spanish-Speaking Preschoolers' English and Spanish Skills

The findings of this study are consistent with the literature noting the stability of EC abilities in preschool and the critical role that they play in children's early learning (Blair & Razza, 2007; Chen et al., 2015; Valiente et al., 2011; Zhou et al., 2010). Our findings extend this literature by suggesting that EC abilities may facilitate Spanish-speaking preschoolers' learning of English vocabulary and letter-word skills and thereby enhance their dual language knowledge, particularly for children whose parents speak exclusively Spanish at home. For the Spanish-speaking preschoolers whose parents spoke both Spanish and English, the contribution of EC appeared to be nonsignificant. For these children, parents' English use seemed to play a key role in enhancing their English vocabulary and letter-word knowledge. Indeed, the amount of English parents use at home plays a critical role in shaping Spanish-speaking preschoolers' English skills (Palermo et al., 2014).

The differential links between Spanish-speaking children's EC abilities and their Spanish and English skills by parents' language use at home may have important implications for advancing these children's dual language skills. For instance, other studies have suggested that warm and supportive mother–child interactions, including those that occur in low-income immigrant families, enhance children's EC and behavioral regulation abilities (Eisenberg et al., 2005; Mistry, Biesanz, Chien, Howes, & Benner, 2008; Spinrad et al., 2007). Alongside the present findings, this may suggest that mothers who speak exclusively Spanish can enhance children's learning of English vocabulary and letter-word skills in preschool by engaging in warm and supportive interactions with them at home. There is also evidence that intervention programs, such as the Chicago School Readiness Project, which trains teachers to effectively manage dysregulated behavior in preschool, can enhance children's vocabulary and letter-word skills by improving their attention and impulse control (Raver et al., 2011). Such intervention programs may also enhance the English and Spanish vocabulary and letter-word skills of Spanish-speaking preschoolers whose parents provide limited exposure to English at home. For Spanish-speaking preschoolers whose parents speak Spanish and English at home, engaging in rich conversations and literacy experiences with parents in both languages, such as book reading, is likely to play a critical role in fostering their dual language vocabulary and literacy knowledge (Patterson, 2002; Reese, Sparks, & Leyva, 2010).

Regarding EF abilities, we expected that Spanish-speaking children would exhibit EF gains in preschool and that EF abilities would enhance children's English vocabulary and letter-word skills (Fuhs et al., 2014; Weiland et al., 2014). We also expected that this association would be stronger for the Spanish-speaking preschoolers whose parents spoke Spanish and English at home. This was based on the idea that children from bilingual homes may exhibit early EF advantages relative to children from monolingual homes and that these EF advantages may facilitate later academic learning (Bialystok, 2007; Poulin-Dubois et al., 2011).

Our findings are consistent with the literature in suggesting that Spanish-speaking children gain EF abilities (primarily inhibitory control) throughout 1 year of preschool. However, children's EF abilities at the start or end of preschool did not associate with their English vocabulary and letter-word knowledge. Furthermore, these associations did not vary by parents' use of one or two languages at home. One possibility for the lack of findings is that EC abilities play a more critical role than EF abilities in the early stages of acquiring English as a second language by facilitating Spanish-speaking children's ability to regulate their attention and behavior according to teachers' instructions. Indeed, EC abilities, such as following instructions and controlling behavioral impulses, have been highlighted by kindergarten teachers as critical to children's school readiness (Lin, Lawrence, & Gorrell, 2003). Perhaps EF abilities begin to enhance Spanish-speaking children's English skills once these children acquire enough proficiency in the language to self-direct their own engagement during classroom learning activities conducted in English. Finally, the association between EF abilities and children's English skills may not have varied by parents' language use because the vast majority of the children in this study had been born in the United States. Thus, all of them may have been developing bilingually to varying degrees. Even the children whose parents spoke exclusively Spanish at home likely received some exposure to English from other relatives or community members prior to entering preschool. This may have diminished our ability to detect whether the association between children's EF abilities and English skills varied by parents' use of one or two languages.

Heterogeneity in Spanish-Speaking Preschoolers' English and Spanish Skills

Our cluster analysis findings are consistent with prior work highlighting the variability that exists in ELL children's bilingual skills (Leung & Uchikoshi, 2012; Tabors, Páez, & López, 2003). This variability is known to stem from the interplay of multiple child and environmental factors, such as linguistic and literacy experiences at home and children's first language abilities upon starting to learn English (Paradis, Genesee, & Crago, 2010). Despite the known variability, most studies have

examined children's Spanish and English skills using a variable-centered approach, which considers dual language abilities as independent and does not fully capture the organization of those abilities within individuals (Hart, Atkins, Fegley, Robins, & Tracy, 2003). Consequently, Spanish-speaking children are generally studied as a homogeneous group with comparable English and Spanish skills. This is a critical gap in the literature that makes it difficult to identify the Spanish-speaking children who are most and least at risk for struggling academically. By identifying preschoolers who exhibited comparable Spanish and English skills, greater English than Spanish skills, and greater Spanish than English skills, our findings add to the literature and can inform program policies designed to enhance Spanish-speaking children's school readiness.

Limitations and Directions for Future Research

Several limitations of this study are noteworthy. First, we used single measures to gauge children's EF and EC abilities. The EF task in particular measured primarily inhibitory control capabilities, which is an important component of EF but not a complete representation of those abilities. On a related note, the EC and EF measures were gathered from two different sources: teacher report versus a child task. This may explain the differential outcomes for EC and EF abilities. For example, it is possible that the lack of EC gains can be explained by a diminished sensitivity of teacher reports to detect changes in children's EC abilities during 1 year of preschool. Future research should use multiple measures from varying sources to examine the changes and relations among the different components of EF and EC and how the interaction among them associates with Spanish-speaking preschoolers' English and Spanish skills. Second, we did not measure classroom quality or the relative use of English and Spanish by teachers during instructional times. Thus, we were unable to examine the extent to which classroom quality or the amounts of time that teachers spent instructing students in English or Spanish contributed to children's English and Spanish abilities. Future research should address these limitations. Third, our study sample was composed of Spanish-speaking children enrolled in Head Start preschool classrooms with mostly Spanish-speaking students. Thus, the extent to which our findings can be generalized to Spanish-speaking children attending other preschool programs or ELL children whose first language is not Spanish may be limited. Future research should examine the extent to which EF and EC abilities associate with the English skills of Spanish-speaking children who attend other preschool programs and of ELL children whose first language is not Spanish.

As the number of Spanish-speaking children in U.S. schools grows, it is increasingly critical to understand the factors associated with their academic readiness for school in general and their English skills in particular to maximize their ability to enter school ready to learn (Halle et al., 2012). The present study built on previous research by (a) examining the extent to which EF and EC abilities were associated with Spanish-speaking preschoolers' English and Spanish vocabulary and letter-word skills and (b) describing the variability in children's dual language skills after 1 year in preschool. The different associations of EF and EC abilities with Spanish-speaking preschoolers' English skills suggest that EC, including the abilities to voluntarily regulate attention and behavior based on classroom demands, may play a more critical role in fostering these children's early learning of English skills and thereby benefiting their dual language knowledge, particularly for those whose parents provide limited support for English at home. Nevertheless, more research is necessary to identify the factors that maximize Spanish-speaking children's academic readiness prior to entering kindergarten.

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