Published in final edited form as:

Early Child Res Q. 2016 ; 36: 49–63. doi:10.1016/j.ecresq.2015.11.006.

Cross-Language Associations in the Development of Preschoolers' Receptive and Expressive Vocabulary

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Abstract

The increasing population of dual language learners (DLLs) entering preschool classrooms highlights a continued need for research on the development of dual language acquisition, and specifically vocabulary skills, in this age group. This study describes young DLL children's ($N = 177$) vocabulary development in both English and Spanish simultaneously, and how vocabulary skills in each language relate to one another, during a contextual shift that places greater emphasis on the acquisition of academic English language skills. Findings demonstrated that DLL preschoolers made gains in vocabulary in both languages with more change evidenced in receptive, in comparison to expressive, vocabulary as well as in English in comparison to Spanish. When examining whether children's vocabulary scores in one language at the beginning of preschool interact with their vocabulary scores in the other language to predict vocabulary growth, no significant associations were found for receptive vocabulary. In contrast, the interaction between initial English and Spanish expressive vocabulary scores was negatively related to growth in English expressive vocabulary. This cross-language association suggests that children who have low expressive vocabulary skills in *both* languages tend to grow faster in their English expressive vocabulary. The study extends previous work on dual language development by examining growth in expressive and receptive vocabulary in both English and Spanish. It also provides suggestions for future work to inform a more comprehensive understanding of DLL children's development in both languages.

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Keywords

dual language learner; vocabulary development; preschool; cross-language association

Demographic changes in the United States in recent years have resulted in a growing population of students who are exposed to a language other than English at home (Aud et al., 2011; National Clearinghouse for English Language Acquisition and Language Instruction Educational Programs (NCELA), 2006). This linguistic diversity is evident among young children in the increased number of dual language learners (DLLs) enrolled in early childhood programs nationwide (Hernandez, Denton, & Macartney, 2007). For example, reports on student enrollment in the nation's federally funded Head Start program calculate that about 30% of enrolled children are DLLs, with 85% of those coming from families who speak Spanish as their primary language (Office of Head Start, 2007).

As a consequence of this growing population of DLLs in the U.S., many young children experience a shift in their language context, specifically the vocabulary to which they are exposed, as they transition from the home into a school-based setting. For many DLLs, this shift represents their first official foray into formal education and experiences with the English language. Many go from a home setting where the primary language is typically not English into a school setting whose goal tends to be the promotion and support of English language development, both in terms of comprehension and production (Pacini-Ketchabaw & Armstrong de Almeida, 2006). Although the primary goal of a majority of educational programs is English language acquisition, there is great diversity in how this goal is achieved: programs for DLLs range from reliance on the first language to requiring use of English only (López & Tapanes, 2011; Thomas & Collier, 2002). Even in immersion contexts where children's academic, or school-based, exposure is in their home language, many children likely experience various sources of English language exposure from siblings and peers to the media, libraries, or schools. In sum, the early language experiences of young children entering formal school settings are diverse and nuanced, making this transition from the home to preschool a salient time period to examine language development in DLL children.

Despite the growing population of DLLs entering the nation's schools and a growing understanding of the receptive and expressive vocabulary development of school-age DLLs (Genesee, Lindholm-Leary, Saunders, & Christian, 2005; Gutiérrez, Zepeda, & Castro, 2010; Hernandez, Denton, & Macartney, 2008), the course of dual language development in young children exposed to multiple languages during the transition to school is not well understood (McCardle & Hoff, 2006)—particularly the interactions between the two languages. For instance, there is less, and sometimes conflicting, evidence about the association between oral language skills in children's first and second languages (Melby-Lervag & Lervag, 2011). Given the importance of vocabulary skills for children's school readiness and later academic success (Biemiller, 2003), as well as the complexity of acquiring two languages, we were interested in examining young children's vocabulary development in both English and Spanish simultaneously, during a contextual transition that places greater emphasis on the acquisition of academic English language skills. Therefore,

the goal of this study was to examine the development of vocabulary skills in both English and Spanish and how they relate to one another among young, DLL preschoolers during a period when vocabulary is a rapidly developing and critical skill.

Interactive Contexts and Processes in Dual Language Acquisition

This study was motivated by developmental and linguistic theories that highlight the importance of understanding children's language development within specific contexts and as an important tool for communication across multiple contexts. Evidence suggests that variation in both home (Farkas & Beron, 2004; Hart & Risley, 2003; Place & Hoff, 2011) and school (Barnett, Yarosz, Thomas, Jung, & Blanco, 2007; Schechter & Bye, 2007) contexts plays an integral role in the nature and course of language development. This change in context expands the microsystem-level interactions that most children experience—interactions typically take place between child and parents or child and siblings—to include classroom-level interactions with peers and teachers (Bronfenbrenner, 1986; 1994). Moreover, as Vygotsky would argue, language serves as one of the primary tools through which meaning making occurs in the context of social interactions, and language is particularly important for children as they transform and internalize elementary processes toward higher-order, abstract conceptualizations (Lantolf & Thorne, 2007). Given the rapid growth in vocabulary taking place for children ranging between two and four years of age (Farkas & Beron, 2004), and the changing microsystem-level context that may place an increasing emphasis on the acquisition of academic English, the present study seeks to examine how the vocabulary of DLLs grows during this important developmental period.

In addition to ecological and sociocultural perspectives, this study is motivated by competitive models of language development, such as the Unified Competition Model (UCM) (MacWhinney, 2005, 2011). These models highlight the coactive and interactive processes by which two languages may influence one another over time (Jarvis & Pavlenko, 2008). For example, research documents the interactive nature of learning two languages: skills in one language may interact with developing skills in the other language—in positive or negative (through interference) ways (Melby-Lervag & Lervag, 2011). Thus, for DLL children, it is important to examine language development in both the home and second language.

Development of Vocabulary Skills

Importance of early vocabulary

Decades of research on monolingual children demonstrate the critical role young children's vocabulary skills play in many areas of development, including reading comprehension and overall school success into the elementary grades (Biemiller, 2003; Cunningham & Stanovich, 1997; NICHD Early Child Care Research Network [ECCRN], 2005; Snow, Burns, & Griffin, 1998; Storch & Whitehurst, 2002;). This work demonstrates that early vocabulary skills lay a foundation for learning how to read and write (Dickinson & Snow, 1987; Lonigan, 2003; Storch & Whitehurst, 2002; Whitehurst & Lonigan, 1998). Similar relationships have been found for DLLs, confirming a link between early vocabulary skills in both English and Spanish and later reading abilities (Davidson, Hammer, & Lawrence,

2011; Hammer, Lawrence, & Miccio, 2007; Rinaldi & Pérez, 2008; Swanson, Saez, & Gerber, 2006).

Growth of vocabulary skills

Vocabulary skills—both receptive and expressive—are developing throughout childhood, particularly during the preschool years (Farkas & Beron, 2004). These skills follow a developmental sequence whereby receptive vocabulary skills appear to develop before expressive vocabulary skills (Benedict, 1979). Studies of monolingual children from low- and middle-income families demonstrate that vocabulary growth consistently follows a linear trend (Snow, Porsche, Tabors, & Harris, 2007) with some acceleration in growth around age two (Huttenlocher, Haight, Bryk, Selter, & Lyons, 1991; Pan, Rowe, Singer, & Snow, 2005). Research on the vocabulary development of DLLs coincides with the results from monolingual populations. Regardless of whether receptive or expressive vocabulary is examined, several studies on DLLs have demonstrated positive growth in English and Spanish vocabulary over two years of Head Start (Hammer, Lawrence, & Miccio, 2008; Hammer, Scarpino, & Davidson, 2011), in Kindergarten (Uchikoshi, 2006), and from first to third grade (Swanson et al., 2006). There is also evidence of acceleration in the growth rates of English receptive vocabulary in preschool (Hammer et al., 2008). Similar to research on monolingual children, DLLs' growth in language skills during preschool (in both languages) has been shown to be positively related to the development of reading skills later on in kindergarten and in first grade (Davidson et al., 2011; Hammer et al., 2007; Pérez & Rinaldi, 2006; Rinaldi & Pérez, 2008).

Despite the positive growth that DLLs demonstrate, their vocabulary scores on standardized tests in each language are typically lower (one to two standard deviations) than national norms of monolingual peers as early as preschool (Mancilla-Martinez & Lesaux, 2010; Nakamoto, Lindsey, & Manis, 2007; Uccelli & Pérez, 2007). Yet, DLLs' vocabulary is distributed across the two languages making the combined size of their English *and* Spanish vocabulary bank similar to their monolingual peers in preschool (Hammer et al., 2008; Pérez, Tabors, & López, 2007; Zill et al., 2003). These results have been found in studies of children from homes of middle- (Bialystok, Barac, Blaye, & Poulin-Dubois, 2010) and lower-socioeconomic status (Hammer et al., 2008; Tabors, Pérez, & López, 2003). Although differences in English language abilities between monolingual English speakers and DLL preschoolers tend to persist into later grades (Lesaux, 2006; Mancilla-Martinez & Lesaux, 2011), there is evidence that DLLs catch up to the typical range for monolingual children after several years (Hammer et al., 2011).

Notwithstanding these studies on young children, there is a relative dearth of research on both English *and* Spanish receptive and expressive vocabulary of young DLL children. The studies that have examined both languages and both types of vocabulary do so in early elementary school or focus on a special population, such as children at risk for reading disability (Swanson et al., 2006). Or, they tend to examine the association between vocabulary development and other English language and literacy outcomes. For example, the work of Hammer and colleagues (2007, 2008) examines the relations between children's English and Spanish receptive vocabulary abilities in preschool and their emergent literacy

and reading skills in English and Spanish in Kindergarten. Others have examined associations between children's receptive vocabulary skills and their letter-word identification, reading comprehension (Davidson et al., 2011) and word reading skills (Páez & Rinaldi, 2006; Rinaldi & Páez, 2008) across both languages. The present study extends this work by examining how English and Spanish language vocabulary development are associated in early childhood for children who may receive varied degrees of support for each language.

Predictors of vocabulary skills

Several studies have examined child and home factors that are associated with children's vocabulary skills. Findings suggest that amount of exposure to each language (Quiroz, Snow, & Zhao, 2010; Thordardottir, 2011), children's usage of language, maternal education, socioeconomic status (Bohman, Bedore, Peña, Mendez-Perez, & Gillam, 2010), timing of language exposure (simultaneous vs. sequential learners; Hammer et al., 2008), home literacy environment (Gonzalez & Uhing, 2008), and whether the parents are native speakers (Place & Hoff, 2011) are associated with children's language development, and particularly vocabulary skills.

Aspects of the classroom context are also related to vocabulary skills. For example, the total number of words produced by the teacher is associated with vocabulary growth (Bowers & Vasilyeva, 2011). Having a teacher that speaks your language is thought to be important to avoid a cultural mismatch in conversational patterns and expectations, which may lead poorer academic achievement (August & Hakuta, 1997). In bilingual classrooms, greater language proficiency in English shifts from being associated with peer interactions in English to being related to teacher interactions in English as the percent of Spanish-speaking preschoolers in the classroom increases (Chesterfield, Hayes-Latimer, Chesterfield, & Chavez, 1983). Finally, language of instruction has been shown to be related to growth in reading comprehension in that same language from second to fifth grade (Proctor, August, Carlo, & Barr, 2010).

Cross-language Associations

Early exposure to two languages is associated with cognitive, psychosocial, and academic benefits in preschool (Espinosa, 2007; Rodríguez, Díaz, Duran, & Espinosa, 1995; Winsler, Diaz, Espinosa, & Rodriguez, 1999), upper elementary school (Golash-Boza, 2005; Portes & Hao, 2002, 2004), and high school (Collier & Thomas, 2004). Given the benefits of bilingualism, one driving question in research is how DLLs develop, and become fluent in, two languages. Models of language acquisition (Jarvis & Pavlenko, 2008), particularly the Unified Competition Model (UCM) (MacWhinney, 2011), underscore the possibility that languages are co-activated, in a dynamic process, through which both languages serve to interact with and influence each other. This suggests that languages operate and develop within a common processing system (Cummins, 1979, 1991). And structural similarities (or differences) between the two languages (Kohnert & Bates, 2002; Odlin, 1989) may help or hinder language acquisition and vocabulary retrieval in each language. For example, language acquisition may be easier—and therefore more positively related to one another—when two languages are more structurally similar (e.g., in phonological, lexical, or

syntactical ways) or share many cognates, as in the case of English and Spanish (Connor, 1996; Dickinson, McCabe, Clark-Chiarelli, & Wolf, 2004). By studying children's English and Spanish vocabulary across three time points, the study contributes to our understanding of vocabulary development in DLLs by examining associations that may be present across languages.

A meta-analysis by Melby-Lervag and Lervag (2011, p. 128), focusing on children age 6 to 10, suggests that there is a “small but reliable, overall correlation” between oral language skills in the home language and a second language. Much of the research on such cross-language associations has examined a cross-linguistic process via the transfer of skills between the home and second languages at the metalinguistic level of analysis (e.g., phonology) (Cárdenas-Hagan, Carlson, & Pollard-Durodola, 2007; Dickinson et al., 2004; Durguno lu et al., 1993; Durguno lu & Öney, 1999; López, 2012; López & Greenfield, 2004). For example, López and Greenfield (2004) examined the relationship between oral language and phonological awareness skills among Spanish-speaking DLLs in Head Start, finding that phonological awareness in English was related to phonological awareness in Spanish as well as to English and Spanish oral language proficiency. Fewer studies have specifically examined transfer of oral language skills (Carlisle & Beeman, 2001; Melby-Lervag & Lervag, 2011; Ordóñez, Carlo, Snow, & McLaughlin, 2002), leaving a gap in the literature. Although the current study does not directly test the processes underlying any cross-linguistic transfer in vocabulary development, it can contribute to our understanding of cross-language associations by examining correlations among developing vocabulary skills across two languages.

Study Aim

The aim of this study was to examine the development of vocabulary skills in both English and Spanish, and their association with one another, during the transition to school. This was done using a sample of DLL preschoolers from lower- to middle-income families as they move through the first year of preschool into the beginning of the second year of preschool. To examine the synergistic nature of simultaneously learning two languages, this study was guided by two research questions:

- 1) Do children's vocabulary scores at the beginning of preschool in one language predict vocabulary growth in the other language?
- 2) Do children's vocabulary scores at the beginning of preschool in one language interact with their vocabulary scores at the beginning of preschool in the other language to predict vocabulary growth?

Given the complexity of acquiring vocabulary—and by doing so in more than one language—both receptive and expressive vocabulary skills were considered. Receptive and expressive vocabulary follow a developmental sequence with receptive abilities tending to develop earlier, making it unclear whether cross-language associations would be found in one domain but not the other, or in both domains but at different time points. Therefore, this study sought to investigate both domains of vocabulary separately when examining how

preschoolers' vocabulary skills in one language may be associated with vocabulary skills in a second language.

Method

Participants

Data for this study were collected as part of a two-year study in the greater Los Angeles metropolitan region that examined predictors of classroom engagement in typically developing preschoolers, representing diverse linguistic and socioeconomic groups in this area. The study followed preschool children across three time points with initial data collection occurring in the fall of preschool (Time 1 [T1]), followed by a second data collection in the spring (Time 2 [T2]) and a third during fall of the subsequent academic year (Time 3 [T3]). Parent consent was obtained for children in 101 classrooms with participating teachers. Children were excluded from selection if their parents indicated they had an existing active Individualized Education Plan at T1 (5% of consented children). Four children (two girls and two boys) were randomly selected, when possible, from the pool of consented children in each classroom. The full sample included 381 children (192 girls and 189 boys, $M = 46.78$, $SD = 6.68$ age in months as of September 1st at the beginning of T1), 341 in T1 and 40 additional children were recruited in T2 (all children were tracked into T3).

Analytic Sample

This analysis uses a subset of children who were identified by their parents or teachers as speaking Spanish and were administered both English and Spanish versions of the vocabulary direct assessments. Thus, the final analytic sample for the current study included 177 children (96 girls and 81 boys, $M = 47.53$, $SD = 6.33$ age in months as of September 1st, which is the beginning of T1 academic year) in 75 classrooms. All children in the analytic sample were reportedly in a preschool classroom at T3. Information on prior schooling or day care experiences to which children may have been exposed was not gathered in this study. The majority of the children were Hispanic (94%), with less than 1% white; six percent were categorized by parents into some other racial or ethnic category. Forty-five percent of children had parents who reported that English was one of the languages spoken in the home. On average, maternal education was 11.59 years ($SD = 2.43$). The average income-to-needs ratio (computed by taking the family income, exclusive of federal aid, and dividing this by the federal poverty threshold for that family) was 1.02 ($SD = .88$) with 57% percent of parents reporting a family income that fell below the poverty line (ratios lower than 1.0) and an additional 25% of parents reporting an income that resulted in an income-to-needs ratio between 1.0 and 2.0.

Of the 75 classrooms in the analytic sample, 19 preschool classrooms were Head Start with the remaining being a mix of state and privately funded centers. All of the preschool classrooms met for half days only, mostly in the morning. On average, classrooms had 19 children enrolled at the start of the school year ($SD = 4$), with approximately 49% boys. All lead teachers were female; 76% were Hispanic, 8% were White, and 15% reported other ethnicities. Although language of instruction was not assessed, teachers reported on which

languages either they or their assistant teacher spoke in the classroom: a majority of the classrooms reported speaking Spanish in addition to some other language (76% Spanish and English; 2% Spanish, English and Other; 2% Spanish and other). Only 16% of the teachers reported only English was spoken in their classroom. See Table 1 for additional demographic information on the children, teachers, and classrooms in this sample.

Procedures

Recruitment—During school recruitment, permission was first secured from center directors or principals, followed by invitations to teachers. After consenting, teachers completed personal/ classroom demographic surveys, and assisted with the parental consent process. Teachers received a small stipend of \$25 for each completed survey. All parents or guardians of children in each participating classroom were given an informed consent form and short family demographic survey. The only exclusion criteria utilized was if the parent identified the child as having an established Individualized Educational Plan (IEP) at the time of recruitment into the study.

Training—All data collectors were English-Spanish bilingual and completed an intensive training on administration of the direct child assessments followed by an additional day of supervised live practice. They also attended a 2-day training session on an observation measure focused on children's classroom engagement (see *Individualized Classroom Assessment Scoring System* described below) and were required to code and pass five reliability clips independently before observing live in the field.

Child assessment protocol—Children were brought to a quiet, private area and administered an assessment battery lasting approximately 40 minutes at each time point. Data collectors also observed selected children in a series of alternating 15-minute cycles (10 minutes of observation and 5 minutes of coding) throughout one morning at T1 (fall of preschool).

Measures

Control variables—Analyses controlled for a range of child, family, teacher, and classroom context characteristics, which are described below.

Child demographics: Consenting parents completed a survey when they entered the study that provided information about their child's date of birth, gender, race/ethnicity, and Individualized Educational Plan (IEP) status, as well as maternal education, family income, and what languages were spoken in the home (English, Spanish, or other).

Teacher and classroom demographics: Teachers were asked to complete questionnaires designed to provide information about teachers' professional experience (e.g., education level, years teaching) and their classroom composition (e.g., gender, ethnicity, and language).

Classroom context: Three sets of variables were created as covariates representing the classroom context to which children were exposed. First, family demographics received

from all consented children (selected and non-selected) at entry into the study were used to create classroom-level variables representing the percentage of children in the classroom whose parents reported that Spanish was spoken in the home and the percentage of children in the classroom whose parents reported that English was spoken in the home. Second, two variables representing whether the child's language matched with the lead or assistant teacher in the classroom (1 = language match, 0 = no language match), as well as whether the child's race/ethnicity matched their teacher (1 = race/ethnicity matched, 0 = race/ethnicity did not match), were created.

Third, as a measure of child communication in the classroom, children's quality and frequency of communication with teachers and peers in the classroom was assessed using the *Individualized Classroom Assessment Scoring System* (inCLASS; Downer, Booren, Lima, Luckner, & Pianta, 2010). The inCLASS is an observational assessment of children's classroom engagement in interactions with teachers, peers, and tasks, comprised of 10 dimensions. The dimensions are: positive engagement with teacher, teacher communication, teacher conflict, peer sociability, peer assertiveness, peer communication, peer conflict, engagement with tasks, self-reliance, and behavior control. Each dimension is rated on a seven-point scale with higher ratings indicating higher quality and/or more frequent engagement within that dimension.

Only two inCLASS dimensions related to communication observed at T1 are of interest in the present study, as covariates when calculating the intercept and slope in the growth models. Communication with teachers measures the degree to which the child initiates communication, sustains conversations, and uses speech for varied purposes in communicating with the teacher(s). Similarly, communication with peers measures the degree to which the child initiates communication, sustains conversations, and uses speech for varied purposes in communicating with the other children in the classroom. These dimensions are rated on a seven-point scale guided by descriptors of low (ratings 1-2), medium (3-5), and high quality (6-7) engagement, with higher ratings indicating higher quality and more frequent communication. Scores take into account any communication that child exhibits but does not account for the language being used during the exchange. Children were observed an average of four 10-minute cycles across a single morning. Scores for each cycle were averaged across each dimension. Inter-rater reliability was calculated across 10% of all cycles during live observations as two data collectors independently observed and rated the same children. Inter-rater reliability (agreement within one point) was .96 for communication with teachers and .97 for communication with peers. Intraclass correlation (ICC) was .80 for communication with teachers and .86 for communication with peers.

Outcome variables

English and Spanish receptive vocabulary skills: Children's receptive vocabulary skills in English were assessed with the *Peabody Picture Vocabulary Test-3rd edition* (PPVT-III; Dunn & Dunn, 1997). Children's receptive vocabulary in Spanish was similarly measured by the Spanish version of the PPVT (Test de Vocabulario en Imagenes Peabody [TVIP]; Dunn, Padilla, Lugo, & Dunn, 1986). In this assessment, the child is shown a card with four

pictures, hears a word that corresponds to one of the pictures, and is asked to point to the corresponding picture. Both the PPVT-III and TVIP demonstrate acceptable reliability and validity (Chow & McBride-Chang, 2003; Dunn and Dunn; 1997; Dunn et al., 1986). Split half and test-retest reliability for the PPVT-III is reported to be 0.83-0.97 and 0.77-0.90, respectively. The median internal consistency coefficient for the TVIP is 0.93. The child's raw scores were used in the current analysis to examine absolute growth across time and not growth relative to the norm. To promote easier comparisons across the outcomes, receptive vocabulary scores at each of the three time points were converted to z scores using the mean and standard deviation from the outcome at T1.

English and Spanish expressive vocabulary skills: Children's expressive vocabulary skills were assessed in English with the Picture Vocabulary subtest of the Woodcock-Johnson III Tests of Achievement (Woodcock, McGrew, & Mather, 2001) and in Spanish with the Bateria III Woodcock- Muñoz; Vocabulario sobre dibujos subtest (Muñoz-Sandoval, Woodcock, McGrew, & Mather, 2005). These subtests are widely used, individually administered assessments and demonstrate high internal reliability and acceptable validity (Schrack, McGrew, & Woodcock, 2001; Schrank et al., 2005). The Picture Vocabulary subtest measures aspects of word knowledge by asking children to name objects depicted in a series of pictures. Raw scores were converted into W-scores, which are IRT-scaled to allow for growth modeling and, thus, can capture absolute growth rather than growth relative to the norm. To promote easier comparisons across the outcomes, expressive vocabulary scores at each of the three time points were converted to z scores using the mean and standard deviation from the outcome at T1.

Data Analytic Plan

To examine the development of vocabulary skills in both English and Spanish, and their relation to one another, we first conducted latent growth curve (LGC) modeling using *Mplus* Version 6.11 (Muthén & Muthén, 1998-2010). LGC models included a host of child, family, and classroom covariates to help control for the varied language contexts to which children are exposed. LGC modeling considers change over time as an underlying latent process, using a structural equation modeling (SEM) approach to estimate the parameters of the growth model. There are two levels of analysis: at Level 1, the unit of analysis is the repeated observations within a child, and at Level 2, the units are children. In this analysis, a trajectory of change is established for each child, and the growth parameters of the trajectory (intercept, slope) may vary across children and are treated as latent variables.

A Bayesian estimator with noninformative priors was used in the LGC model estimation. Bayesian estimation has many advantages over full information maximum likelihood (FIML) estimation because it has relaxed distributional assumptions and is robust to small sample sizes and non-normal data (Kruschke, 2010; Muthén, 2010). Trace plots showed appropriate mixing and autocorrelations were low (Lynch, 2007). Model fit was examined using a posterior predictive p value (PPP), which compares the sample data to the data that the model parameters create (Gelman, Meng, & Stern, 1996). A non-significant, or high, p value suggests good model fit, and a PPP around .50 represents excellent fit (Muthén & Asparouhov, 2011).

Multilevel nature of the data—In this study, multiple measurement occasions are nested within children, who are nested within classrooms. Our design effects ranged from 1.22 (English expressive vocabulary at T2) to 1.55 (Spanish expressive vocabulary at T3). Design effects less than 2 suggest that children within the same classroom do not look more similar to one another than children in different classrooms, and thus accounting for this nesting was not warranted (cf., Muthén, 1991, 1994; Muthén & Satorra, 1989, 1995).

Missing data—As expected in longitudinal studies, there were missing data due largely to child attrition (leaving the preschool program) and multiple absences. Thirty-three percent of study children were missing vocabulary outcomes at T1, 28% at T2, and 39% at T3. Some children were also missing information on other study variables: child age (11%), maternal education (3%), English in the home (34%), child language match with teacher (4%), child race/ethnicity match with teacher (22%), and children's observed communication with teachers (9.5%) and with peers (9.5%).

Missing data were handled using Bayesian estimation. Similar to full information maximum likelihood (FIML), the Bayesian estimator uses all available data to estimate parameters (Asparouhov & Muthén, 2010; Little & Rubin, 1987). Missing data were determined to be missing at random (MAR) by examining bivariate correlations and finding missingness positively related to some of the variables in the models: child sex and age. The inclusion of these variables in analyses, thus, helps to reduce bias in estimates and improve power (Enders, 2010).

Analytic steps

Modeling growth in vocabulary: To investigate growth in children's vocabulary, two latent growth factors corresponding to initial level (intercept) and rate of change (slope) were defined in a structural equation model. Measurements of the outcome at the three different time points (T1, T2, and T3) were used as multiple indicators of the two latent growth factors. The latent factor representing the slope was defined by fixing the loadings of its indicators to follow a linear progression across the three time points and to reflect the amount of time elapsed between the different measurement occasions (i.e., T1 = 0, T2 = .4 [four months later], and T3 = 1 [6 months later]). Error variances in the outcomes across time were freely estimated.

First, an unconditional latent growth curve (LGC) model was estimated for each of the four outcomes. Once significant variability in the latent growth factors was established, conditional LGC models were estimated. Covariates, to control for the varied language contexts to which sample children were exposed, included child and family characteristics (child age, boy, maternal education, and home English exposure) and aspects of the classroom context (child language match with teacher, child race/ethnicity match with teacher, percent Spanish-speaking children in the classroom, percent English-speaking children in the classroom, and observational ratings of children's communication with teachers and peers).

Examining cross-language associations: Once the final conditional LGC model was established for each outcome, the estimated intercepts and slopes for each individual child in

the sample were outputted and saved to be used in subsequent analyses. Using Bayesian estimation, plausible values for the latent variables (intercept and slope) were obtained from the LGC models using multiple imputation (Asparouhov & Muthén, 2010), which resulted in 10 data sets where missing values were imputed. These values were used for subsequent model estimation by averaging over the data sets, and the standard errors were computed using the Rubin formula (1987).

Next, two regression models were estimated using maximum likelihood estimation: one for receptive vocabulary and another for expressive vocabulary. In these models, initial vocabulary scores in one language were examined as predictors of rates of change (slope estimates) in vocabulary scores in the other language. Additionally, the interaction between initial scores in English and initial scores in Spanish was examined as a predictor of rates of change in vocabulary scores in both languages.

Results

Descriptives

Descriptive statistics for child, family, and teacher characteristics, classroom context variables, and the four outcomes can be found in Tables 1 and 2. Bivariate correlations among the language variables over time can be found in Table 3 (correlations between the language variables and the control variables are available upon request). Standard scores on the outcomes are also reported in Table 2 to compare the scores utilized in the LGC models to national norms. On both standardized measures of vocabulary across the two languages, the scores were below national norms for monolingual speakers at all three time points.

Modeling Growth in Vocabulary

Across all language outcomes, unconditional models demonstrated significant variance in initial levels and rates of change. Children made significant gains in vocabulary scores across the three time points, with slope estimates of 0.99, 0.84, 0.66, and 0.31 of a standard deviation in English receptive, Spanish receptive, English expressive, and Spanish expressive vocabulary scores, respectively. These unconditional models fit the data well as evidenced by non-significant posterior predictive p (PPP) values (see Table 4).

Conditional models, which added controls for home and classroom contexts, fit the data well as evidenced by non-significant posterior predictive p (PPP) values (see Tables 5 and 6 for Conditional LGC results for receptive vocabulary and expressive vocabulary, respectively). Slope estimates remained similar to those found in the unconditional models, demonstrating that children made significant gains in vocabulary scores over time. Only two covariates (child age and home English exposure) were found to be consistent, significant predictors of the intercepts; none of the covariates consistently predicted the slopes. Child age was found to be positively associated with the intercept in all models, demonstrating that older preschoolers tended to have higher vocabulary scores in both English and Spanish at the beginning of preschool. Home English Exposure (whether the parents reported that English was a language spoken in the home) was a significant and positive predictor of both English

receptive and expressive vocabulary skills at the beginning of the year, but was a negative predictor of Spanish expressive vocabulary skills at the beginning of the year.

Examining Cross-Language Associations

As described earlier, individual children's intercept and slope estimates saved from the final LGC models were used in subsequent regression analyses to examine the relations between (1) children's beginning-of-year vocabulary scores in one language and vocabulary growth in the other language; and (2) the interaction between children's beginning-of-year vocabulary scores in English and in Spanish and vocabulary growth in both languages. Two models were estimated: one for receptive vocabulary and another for expressive vocabulary (see Figures 1a and 1b respectively).

Predicting vocabulary growth across languages—For the first research question, we sought to examine whether children's vocabulary scores at the beginning of preschool in one language predicted vocabulary growth in the other language. For receptive vocabulary, there was a significant, positive correlation between initial receptive vocabulary scores in English and Spanish. At the beginning of preschool, children with higher English receptive scores also tended to have higher Spanish receptive vocabulary scores ($r = .20, p = .02$). Children's initial receptive vocabulary scores, however, were not related to change in the same language or in the other language.

In contrast to the pattern identified above for receptive vocabulary, children's initial expressive vocabulary scores in English and in Spanish were not correlated with one another. Initial expressive vocabulary scores in English were also unrelated to growth in Spanish. However, initial scores in Spanish were significantly related, but negatively, to growth in English: children with lower Spanish expressive vocabulary skills at the beginning of preschool showed more growth in English expressive vocabulary, $b = -.07, SE = .03, p = .013$.

Cross-language association predicting vocabulary growth—For the second research question, we examined whether children's beginning-of-year vocabulary scores in one language interacted with their beginning-of-year vocabulary scores in the other language when predicting vocabulary growth. For receptive vocabulary, the interaction between English and Spanish initial scores was not related to vocabulary growth in English or in Spanish. For expressive vocabulary, the interaction between English and Spanish initial scores was significantly related to vocabulary growth in English ($b = -.09, SE = .03, p = .012$) but not Spanish. This suggests that children who have low expressive vocabulary skills in *both* languages tend to grow the fastest in their English expressive vocabulary (See Figure 2 for a graphical representation of the interaction effect). Significant variance remained in the rates of change for both languages in receptive vocabulary and expressive vocabulary.

Discussion

The aim of the present study was to describe the interactive nature of English and Spanish vocabulary development in young DLL children during preschool—a salient time period in which vocabulary is rapidly developing and children are entering a school context that

presumably focuses on English language acquisition. Because DLL children are interacting with and learning two languages, it is important not only to assess both languages but also to examine how they might relate to one another. In order to achieve this goal, we modeled growth in each of these language outcomes, controlling for select preschool contextual factors as well as child and family factors typically related to vocabulary growth. This allowed us to obtain growth estimates that could be utilized to examine correlations between English and Spanish vocabulary skills. Our findings suggest that there may be differences between receptive and expressive vocabulary in terms of whether cross-language associations are found when predicting vocabulary growth.

Examining Growth in Children's Vocabulary Skills

Consistent with previous research on the vocabulary skills in a single language of young DLL preschoolers, children in the present study began their first year of preschool with average vocabulary scores lower than the national norms of their monolingual peers and did not catch up by the end of the study (i.e., fall of their second year of preschool) to their monolingual peers (Mancilla-Martinez & Lesaux, 2010; Nakamoto et al., 2007). Children's vocabulary skills remained about a standard deviation below the national average for monolingual speakers on English and Spanish receptive vocabulary and English expressive vocabulary, and two standard deviations below on Spanish expressive vocabulary. These findings are unsurprising given vocabulary was assessed in a single language, and thus these scores are not likely to be fully representative of DLLs' total vocabulary bank or total conceptual vocabulary (Hammer et al., 2014).

Although children started (and ended) considerably lower than the national averages for monolinguals, there was substantial growth in children's vocabulary skills across the study period. Consistent with previous research in dual language populations (Hammer et al., 2008, 2011; Uchikoshi, 2006), preschoolers in the current sample showed positive change across the study in receptive and expressive vocabulary in both languages. On average, children's raw scores increased by approximately one standard deviation in English receptive vocabulary, 3/4 of a standard deviation in Spanish receptive vocabulary, 2/3 of a standard deviation in English expressive vocabulary, and 1/3 of a standard deviation in Spanish expressive vocabulary. While growth was observed on all four outcomes, there were differences in how much change children exhibited during the study, with more change evidenced in receptive, in comparison to expressive, vocabulary as well as in English, in comparison to Spanish, scores. These findings are aligned with other studies of bilingual children that have found differences in receptive and expressive abilities whereby children's standard scores on receptive assessments tend to be higher than their standard scores on expressive assessments in one or both of their languages (Gibson, Oller, Jarmulowicz, & Ethington, 2012; Ribot & Hoff, 2014).

Worth discussing are the differences in growth in Spanish, as compared to English, observed in the present sample. Slower growth rates in Spanish vocabulary may be related to the language(s) spoken at home and at school. Growth modeling results showed that children with exposure to English in the home began the school year with higher scores in English receptive and expressive vocabulary but lower in Spanish expressive vocabulary, in

comparison to children without exposure to English in the home. Home English exposure, however, was unrelated to growth in either language. Further, whether children's language matched one of their teachers was also unrelated to vocabulary growth. Although these findings suggest that which language is being spoken (or has the possibility to be spoken at home) is not related to growth, it may be that the *quality* of home language exposure and the language of classroom instruction are related to growth; however, neither is testable in the present sample due to data limitations.

All children came from homes where Spanish was reportedly spoken when the child entered the study. Thus, the average child in this sample was likely continuously exposed to conversations in Spanish while at home throughout the study. The quality of this exposure could explain the growth in Spanish receptive vocabulary that was almost as fast as the growth in English receptive vocabulary. Similarly, the exposure to, and likely participation in, conversations in Spanish could explain the growth—albeit small—in Spanish expressive vocabulary. The slower growth in Spanish expressive vocabulary, however, may be linked to the kinds of opportunities children had to practice speaking in each language. Although untestable in the current study, this finding makes it seem as if acquisition of vocabulary in English may come at a cost of Spanish vocabulary acquisition. This is consistent with prior research showing that DLL children who enter formal education are less likely to use their home language for all of their learning and social interactions, with tendencies to speak in English (Oller & Eilers, 2002) and code-switch from Spanish to English (and not the other way around) (Ribot & Hoff, 2014). Thus, Spanish language skills may regress (Hammer et al., 2008; Proctor et al., 2010), plateau (Kan & Kohnert, 2005), or develop more slowly (Tabors et al., 2003).

While we did not find evidence in the current study to support *loss* of Spanish abilities, we did find that preschoolers maintained lower levels of Spanish vocabulary and grew more slowly in Spanish than in English vocabulary, most especially in the domain of expressive vocabulary. Use of the English language and/or lack of support in the Spanish language across both home and school contexts may result in fewer opportunities to practice Spanish language skills and may explain children's low scores and slower growth in Spanish expressive vocabulary. This is only speculation, though, as we do not know the amount or quality of Spanish that was spoken in the classroom or the home, which offers a natural next step in better understanding vocabulary development in this population of young children. Additionally, as children transition to formal preschool contexts, they are likely being exposed to academic English at greater levels—academic English refers to concepts and ideas relevant for school success (Cummins, 2008)—over the two-year span, and this exposure may relate to the growth rates evident in English receptive and expressive vocabulary. These findings may suggest a trend toward English becoming the stronger language, especially in terms of expressive abilities, as children transition into a center-based school setting. Providing an environment rich in language in *both* English and Spanish may better capitalize on children's existing vocabulary skills and promote bilingualism more effectively.

Examining Cross-Language Associations

Predicting vocabulary growth across languages—We first examined whether children's vocabulary scores at the beginning of preschool in one language predicted vocabulary growth in the other language. The pattern of findings showed no significant relations between initial scores in either language predicting growth in receptive vocabulary. For expressive vocabulary, children's initial skills were found to be negatively predictive of vocabulary growth in the same language. Although not an examination of cross-language associations, the findings suggest that children who begin the preschool year lower in vocabulary skills, in either English or Spanish, tend to show more vocabulary growth in that language in general. This may be because there was more “room to grow” developmentally in comparison to their higher-scoring peers.

Additionally, children's initial skills in Spanish were negatively related to growth in expressive vocabulary skills in English. This suggests that children who begin the preschool year with lower expressive vocabulary skills in Spanish tend to show more growth in English expressive vocabulary. This finding is qualified by a significant interaction between initial scores in English and Spanish, which is discussed in the next section.

A positive association was also found between children's initial English and initial Spanish receptive vocabulary abilities. In other words, children who have high scores in receptive vocabulary in one language typically demonstrated high receptive vocabulary scores in the other language at the start of the study, even after accounting for child, family, and classroom context factors. The positive relation between initial receptive vocabulary skills in English and Spanish suggests a common language processing system for receptive vocabulary where abilities in one language are positively related to abilities in another language (Cummins, 1991). It is possible that the more words you understand in one language, the more easily you are able to learn and use that vocabulary to understand words in another language, especially when there are linguistic similarities between words (Kupisch, 2007; Marchman, Fernald, & Hurtado, 2010). This positive cross-language association for receptive vocabulary seen here may also be due to the fact that a sizeable number of English and Spanish words are cognates (Dressler, Carlo, Snow, August, & White, 2011; Lubliner & Heibert, 2011). This finding has positive implications for certain classrooms, as it suggests that a proportion of DLL students arrive at preschool with a strong foundation upon which early language and literacy skills may be built. Yet, the finding also calls attention to the group of students who may begin preschool with limited receptive vocabulary skills in both languages, and who may require additional, targeted language services.

Adding to the complexity of the findings is the lack of a correlation in English and Spanish expressive vocabulary skills at the start of the study. This finding is understandable given that the development of receptive vocabulary is expected to occur prior to the development of expressive vocabulary. In fact, the different patterns highlight the need for longitudinal tracking of both receptive and expressive vocabulary for extended periods during this important transition.

Cross-language interaction predicting vocabulary growth—We also examined whether children's vocabulary scores at the beginning of preschool in one language interact with their vocabulary scores at the beginning of preschool in the other language to predict vocabulary growth. Again, there were no significant relations when examining receptive vocabulary; however, the interaction between initial English and Spanish expressive vocabulary scores was negatively related to growth in English expressive vocabulary. The interaction suggests that children who have low expressive vocabulary skills in *both* languages tend to grow the fastest in their English expressive vocabulary. In contrast, for children with higher English expressive vocabulary scores at the onset of the study, the level of Spanish expressive vocabulary was not significantly related to how much they grew in English expressive vocabulary.

Lower expressive scores in both languages could be indicative of two non-overlapping bases of conceptual knowledge, and such a distributed base of conceptual knowledge may be what predicts greater growth in expressive abilities in English over time. This explanation, however, does not fully account for why children scoring at lower levels (one standard deviation below the mean) would demonstrate greater growth than those scoring at higher levels, given both groups of children are acquiring two languages simultaneously. It may be that children with lower expressive scores in both languages simply have more room to grow. It could also be the case that preschool may be more effective for children who are more at risk. Recent work reanalyzing the Head Start Impact Study (HSIS) finds that Head Start produces a “compensatory” pattern of effects whereby it increases cognitive outcomes the most for children with the lowest initial skills (Bloom & Weiland, 2015). This was particularly true for DLLs and Spanish-speaking children, suggesting that preschool may be making up for limited prior English language skills.

Contextual factors may also be at play, with children needing the most support receiving the most help. For example, children's vocabulary abilities—in any language—are related to the language input and supports they receive, including how responsive, complex, positive, and frequent the input is (McCabe et al., 2013). It may be that children who come into the preschool context with low language abilities in general may be exposed to linguistic interactions within the classroom environment that intentionally provide instruction and model conversational and academic language in English. A shift in exposure to more intentional language-supportive interactions that are meaning-focused, as well as opportunities for dramatic play with peers that preschool classrooms typically afford, may be related to greater growth in English expressive abilities for children with lower vocabulary skills (Connor, Morrison, & Slominski, 2006). This same shift, though, may not be associated with growth in Spanish expressive abilities because the focus of the input is on *English* language acquisition.

It is important to note that variability in the language(s) to which children are exposed should be considered when examining DLL children's vocabulary abilities in this shifting context from home to school. The DLL children in this sample were likely receiving a mix of input in English and Spanish across the home and school contexts during the preschool period. An enriched linguistic environment in preschool may begin to level the playing field for children who enter the classroom with fewer skills, affording them the opportunity to

begin to catch up with their age mates. However, a preschool environment may be more likely to level the playing field when it actively finds ways to provide supports for both the first and the second language across the school and the home contexts (McCabe et al., 2013).

Overall, limited cross-language associations were found. This may be because there are threshold levels of linguistic competence, which DLL children must attain, in order to allow the potentially beneficial aspects of becoming bilingual to influence cognitive growth and promote accelerated growth in language (Cummins, 1991). Cross-linguistic work on phonological awareness, for example, has found that evidence for positive transfer when Spanish-speaking children are proficient in and have obtained phonological skills in their first language (Durgunoglu, 1998; López & Greenfield, 2004; Quiroga, Lemos-Britton, Mostafapour, Abbott, & Berniger, 2002). If a certain amount of language proficiency must be in place before positive associations between oral language skills can be seen, it is possible that the “threshold hypothesis” may account for the negative cross-language correlation found for expressive vocabulary. The relatively limited language abilities of children within the current sample, as evidenced by vocabulary scores substantially below national norms for monolingual speakers in both English and Spanish across all time points, may be below that critical threshold, inhibiting a positive cross-language correlation.

Language proficiency could also explain the findings: studies have shown positive cross-language associations to flow from a dominant language to a weaker language (Yip & Matthews, 2000). In the present study, children with low scores in both English and Spanish expressive vocabulary are not highly proficient in either language, thus limiting the possibility of cross-language supports. Future work in samples with a greater range in vocabulary scores should consider a threshold analysis and level of language proficiency to test these hypotheses.

Limitations and Future Directions

The current study adds to the research on DLL children's vocabulary development in both English and Spanish, but there are several limitations that should be noted. Although the present study included a range of child, family, and classroom context characteristics as controls in the analysis, some important aspects of the linguistic environmental contexts to which children are exposed were unavailable. This includes, but is not limited to, the quality of the home language context (Roberts, Jurgens, & Burchinal, 2005); the quality of the school language context; the amount of exposure to and use of each language by the child in both contexts; and the ways in which the home and classroom environments provide and elicit different languages from children, almost all of which have been shown to be related to vocabulary acquisition (Hammer et al., 2014). For example, while we were able to control for the child's communication with teachers and peers using the inCLASS, this measure is unable to account for the language of communication, limiting its functionality in this study. Of note, we found that differences in inCLASS scores across the three time points were small in magnitude and suggested a consistent pattern of limited child communication that remained fairly low over. Future work that accounts for child initiation and sustainment of communication in more nuanced ways is critical as it may capture the opportunities

available to the child to use vocabulary in one or both languages to make their needs, emotions, and opinions known. Given the little or no English exposure—or linguistic isolation—experienced by many DLLs (Cannon, Jacknowitz, & Karoly, 2012), it is important to consider this contextual factor.

Relatedly, we know that the DLL children in this sample are Spanish speakers, but we were unable to account for their degree of bilingualism, dialect, cultural background, immigration status, nativity status (generation), or family's country of origin, all of which have been shown to be related to educational outcomes (De Feyter & Winsler, 2009; Leventhal, Xue, & Brooks-Gunn, 2006). Future research is necessary to better understand the context in which DLL children are developing and how contextual factors relate to language development, particularly the unique contributions of, and potential interactions between, the linguistic environment experienced at both home and school.

The generalizability of this study is somewhat limited by the measures collected. Receptive vocabulary and expressive vocabulary were each assessed in this study using a single, standardized measure for each language that is normed on monolingual speakers. There is a great need in the field for the development of measures that are standardized on DLL populations and, therefore, can capture DLL children's development in more appropriate and nuanced ways (Hammer et al., 2014). Moreover, the use of conceptual scoring to account for total vocabulary distribution across both languages has been used in number of studies (Pearson, Fernandez, & Oller, 1993) and should be considered in future work examining vocabulary development in DLLs.

This study examined children's vocabulary skills and did not include other language-related outcomes. A fuller understanding of young DLL children's development in both English and Spanish would require comprehensive assessment of children's language skills in both languages. Finally, due to the longitudinal nature of the present study we were able to examine growth in vocabulary skills in both English and Spanish for DLLs. Research of this nature has the potential to help both researchers and educators to better understand the complex task of simultaneously learning two languages and adapt educational settings to meet the needs of DLL children. Although longitudinal, the data were limited to three time points restricting our ability to examine more complex growth trajectories. Some studies that assess DLL children over longer periods of time suggest acceleration in language growth during the preschool period (Jackson-Maldonado, Thal, Marchman, Bates, & Gutierrez-Clellen, 1993; Hammer et al., 2008). Further, Hammer and colleagues (2007) have found that growth in language (and not performance levels at one point in time) is related to later skills. Longitudinal research that examines how growth in one language (or the interaction between the slope estimates in each language) is related to later skills in the other language would add to the literature on cross-language associations.

Conclusion

The growing population of dual language learners in America's classrooms has established the need for a better understanding of the course of dual language development in young children exposed to multiple languages. The present study was designed to examine young

children's development of receptive and expressive vocabulary skills in both English and Spanish and how vocabulary skills in one language may be associated with vocabulary skills in a second language. Such work can have important implications for designing and evaluating interventions for DLLs. For example, developmentally focused curricula that are aligned with Common Core and promote overall child development in addition to bilingualism in DLLs need to be created and rigorously evaluated. Such curricula should take into account the interactive nature of dual language development and the influence that the home and school contexts can have on development in order to meet the needs of the increasing DLL populations using early child education services. Further, effective implementation of such curricula requires systematic and high-quality training and coaching of teachers (Hamre, 2014). To be truly effective, early childhood teachers need to be aware of and continually responsive to the individual learning needs of their DLLs, most particularly those who are entering their classroom with lower language abilities, so that they can leverage the vocabulary growth this study did find across the preschool period.

Research, such as the current study, that examines the interactive nature of dual language development of young DLL children during the transition to a school context that places greater emphasis on the acquisition of academic English language skills is critical. Such work can help ascertain how to best support preschool children's dual language acquisition. Future research examining cross-language associations across wider age ranges, over a greater period of time, and with more sophisticated measures of children's skills—while also examining the roles the larger home and classroom contexts can play—will begin to provide a clearer picture of dual language acquisition in young children and provide guidance to early childhood educators in designing programs that effectively support the dual language learner.

Acknowledgments

This study was supported by two grants to the University of Virginia: one from the National Institute of Child Health and Human Development and the Interagency Consortium on Measurement of School Readiness (R01 HD051498) and by the Institute of Education Sciences, U.S. Department of Education (R305A060021) funding of the National Center for Research on Early Childhood Education (NCRECE). The opinions expressed are those of the authors and do not represent views of the funding agencies. The authors wish to thank Jason Downer for his feedback on earlier drafts of this manuscript. We extend our gratitude to the teachers, parents, and children who invited us into their classrooms.

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Highlights

- Examined how DLL's vocabulary skills in English and Spanish relate to one another
- Preschoolers made greater gains in receptive vocabulary skills and in English
- No cross-language associations found for receptive vocabulary
- Negative cross-language association found for expressive vocabulary

a) Receptive Vocabulary Results

b) Expressive Vocabulary Results

Figure 1.

Regression results examining cross-language associations. All estimates, except for correlations, are unstandardized.

Figure 2.

Graphical representation of the interaction effect predicting growth in English expressive vocabulary. Low and high scores are one standard deviation below and above the mean, respectively.

Table 1

Sample Descriptives

	<i>N</i>	<i>M</i>	<i>SD</i>	<i>Min</i>	<i>Max</i>
Child & Family Characteristics					
Age (in months)	157	47.53	6.33	33	56
Boy	177	0.46	0.50	0	1
Hispanic	175	0.94	0.24	0	1
White	175	0.01	0.08	0	1
Other ethnicity	175	0.06	0.23	0	1
Maternal education (in years)	172	11.59	2.43	8	18
Home English exposure ¹	117	0.45	0.50	0	1
Child language match with teacher ²	170	0.84	0.37	0	1
Child race/ethnicity match with teacher ³	138	0.83	0.37	0	1
Teacher Characteristics					
Age (in years)	58	40.10	10.49	23	65
Education (in years)	59	14.68	1.40	13	17
Experience teaching preschool (in years)	58	8.57	5.90	0	37
Hispanic	59	0.76	0.43	0	1
White	59	0.08	0.28	0	1
Other	59	0.15	0.36	0	1
Classroom Context					
% Classroom English speaking ⁴	177	48.40	27.79	0	100
% Classroom Spanish speaking ⁴	177	87.03	18.29	0	100
Communication with teachers ⁵	160	1.88	0.64	1	3.80
Communication with peers ⁵	160	1.79	0.68	1	4.67

Note. A subset of classrooms (16) were taught by the same teachers (morning and afternoon sessions) resulting in fewer teachers ($N=59$) than the total number of classrooms ($N=75$).

¹Parent reported English was spoken in the home.

²Child's language matched with the lead or assistant teacher in the classroom.

³Child's race/ethnicity matched the lead teacher's race/ethnicity.

⁴Percentage of consented children in the classroom whose parents reported English (Spanish) was spoken at home.

⁵inCLASS scores are on a 7-point scale with higher ratings indicating higher quality and more frequent communication (1-2 = low, 3-5 = mid, 6-7 = high).

Table 2

Descriptive Statistics for Outcome Variables

	<i>N</i>	<i>M</i>	<i>SD</i>	Min	Max	<i>N</i>	<i>M</i>	<i>SD</i>	Min	Max
English										
Receptive Vocabulary	Raw Scores					Standard Scores				
T1	118	28.61	18.26	3	83	118	74.73	17.35	40	118
T2	127	35.54	19.09	4	88	127	78.46	17.24	40	118
T3	108	47.94	20.90	0	99	107	83.84	15.53	45	120
Expressive Vocabulary	W Scores					Standard Scores				
T1	118	433.71	26.47	384	505	118	80.20	20.65	33	145
T2	127	442.44	20.57	384	484	127	84.12	16.16	41	118
T3	108	451.68	18.65	397	494	108	87.03	14.85	40	126
Spanish										
Receptive Vocabulary	Raw Scores					Standard Scores				
T1	117	14.96	10.87	0	48	115	84.91	14.61	40	128
T2	125	18.22	10.77	0	43	123	85.46	13.52	56	116
T3	107	24.05	13.28	1	50	102	85.70	15.65	55	113
Expressive Vocabulary	W Scores					Standard Scores				
T1	120	416.22	23.01	368	472	115	67.73	16.41	28	106
T2	126	419.72	21.72	368	481	123	66.40	16.56	25	120
T3	108	425.55	24.64	368	472	106	66.34	19.11	24	109

Note. T1 = Fall of Year 1; T2 = Spring of Year 1; T3 = Fall of Year 2

Table 3

Correlations among English and Spanish Receptive and Expressive Vocabulary Scores

	1	2	3	4	5	6	7	8	9	10	11
1. Eng Receptive 1	--										
2. Eng Receptive 2	.85***										
3. Eng Receptive 3	.89***	.88***									
4. Sp Receptive 1	.34***	.30**	--								
5. Sp Receptive 2	.19*	.27**	.18	.74***	--						
6. Sp Receptive 3	.18	.23	.21*	.72***	.81***	--					
7. Eng Expressive 1	.73***	.79***	.79***	.17	.13	.05	--				
8. Eng Expressive 2	.74***	.78***	.71***	.13	.05	.04	.86***	--			
9. Eng Expressive 3	.75***	.77***	.71***	.02	-.02	-.07	.87***	.81***	--		
10. Sp Expressive 1	-.19*	-.20*	-.27*	.44***	.59***	.58***	-.26*	-.31**	-.37**	--	
11. Sp Expressive 2	-.16	-.14	-.21	.44***	.55***	.47***	-.23*	-.19*	-.26*	.87***	--
12. Sp Expressive 3	-.30*	-.21	-.15	.28*	.50***	.56***	-.31*	-.28*	-.30**	.87***	.83***

Note. Receptive vocabulary scores are raw scores, and expressive vocabulary scores are W scores. Eng = English; Sp = Spanish; 1 = Fall of Year 1; 2 = Spring of Year 1; 3 = Fall of Year 2.

Table 4

Latent Growth Curve Modeling Unconditional Results for English and Spanish Receptive and Expressive Vocabulary

	English				Spanish			
	Point Estimate	SD	95% CI		Point Estimate	SD	95% CI	
			LL	UL			LL	UL
Receptive Vocabulary								
Intercept	0.02	.08	−0.14	0.18	−0.04	.09	−0.21	0.13
Intercept variance	0.93	.13	0.71	1.21	0.73	.13	0.52	1.02
Slope	0.99	.07	0.86	1.12	0.84	.10	0.64	1.04
Slope variance	0.13	.09	0.02	0.35	0.34	.22	0.05	0.86
PPP value	0.56	--	−13.51	10.46	0.53	--	−11.33	9.66
Expressive Vocabulary								
Intercept	0.05	.08	−0.11	0.21	0.03	.07	−0.12	0.16
Intercept variance	0.84	.13	0.64	1.12	0.73	.10	0.56	0.96
Slope	0.66	.07	0.53	0.81	0.31	.06	0.20	0.43
Slope variance	0.17	.08	0.07	0.36	0.07	.06	0.01	0.24
PPP value	0.26	--	−8.38	16.85	0.48	--	−12.67	11.81

Note. Bolded estimates have credibility intervals (which are similar to confidence intervals) that do not include zero. Outcomes were converted to *z* scores using the mean and standard deviation from T1.

CI = credibility interval; UL = upper level estimate of the credibility interval; LL = lower level estimate of the credibility interval; PPP = posterior predictive *p* value

Table 5

Latent Growth Curve Modeling Conditional Results for English and Spanish Receptive Vocabulary

	English				Spanish			
	Point Estimate	SD	95% CI		Point Estimate	SD	95% CI	
			LL	UL			LL	UL
Intercept	0.03	.09	−0.13	0.21	−0.02	.09	−0.19	0.16
Age	0.08	.01	0.06	0.10	0.05	.01	0.03	0.08
Maternal Education	0.03	.03	−0.03	0.09	−0.00	.04	−0.07	0.07
Boy	0.14	.14	−0.13	0.40	−0.05	.17	−0.38	0.29
Home English Exposure	0.80	.18	0.45	1.14	−0.14	.22	−0.56	0.29
Teacher Communication	0.11	.10	−0.09	0.30	0.15	.12	−0.09	0.39
Peer Communication	−0.03	.12	−0.26	0.20	−0.11	.14	−0.39	0.16
Lang Match with Teacher	−0.23	.21	−0.66	0.17	−0.35	.25	−0.83	0.14
Race Match with Teacher	0.05	.23	−0.42	0.49	0.20	.29	−0.36	0.78
% Classroom Spanish	−0.01	.01	−0.02	0.00	−0.01	.01	−0.02	0.00
% Classroom English	0.00	.00	−0.01	0.01	−0.01	.01	−0.02	−0.00
Intercept variance	0.47	.09	0.32	0.66	0.55	.11	0.36	0.80
Slope	0.96	.07	0.82	1.10	0.81	.11	0.59	1.02
Age	0.01	.01	−0.01	0.03	0.00	.02	−0.03	0.04
Maternal Education	0.01	.03	−0.05	0.07	−0.06	.05	−0.15	0.03
Boy	0.09	.15	−0.20	0.40	−0.18	.22	−0.61	0.27
Home English Exposure	0.09	.17	−0.26	0.42	−0.09	.28	−0.63	0.45
Teacher Communication	−0.15	.12	−0.39	0.07	0.01	.18	−0.34	0.36
Peer Communication	0.04	.12	−0.19	0.27	0.30	.18	−0.05	0.65
Lang Match with Teacher	−0.25	.21	−0.67	0.14	−0.02	.30	−0.61	0.60
Race Match with Teacher	0.07	.23	−0.40	0.51	−0.12	.37	−0.82	0.60
% Classroom Spanish	0.01	.01	−0.00	0.02	0.01	.01	−0.01	0.02
% Classroom English	0.00	.00	−0.01	0.01	0.01	.01	−0.01	0.02
Slope variance	0.14	.09	0.01	0.35	0.36	.22	0.07	0.88
PPP value	0.31	--	−26.96	52.53	0.29	--	−32.40	51.26

Note. Bolded numbers have confidence intervals that do not include zero (i.e., are significant). Outcomes were converted to *z* scores using the mean and standard deviation from T1.

CI = credibility interval; UL = upper level estimate of the credibility interval; LL = lower level estimate of the credibility interval; % = percent children in classroom that speak that language; PPP = posterior predictive *p* value

Table 6

Latent Growth Curve Modeling Conditional Results for English and Spanish Expressive Vocabulary

	English				Spanish			
	Point Estimate	SD	95% CI		Point Estimate	SD	95% CI	
			LL	UL			LL	UL
Intercept	0.06	.09	−0.12	0.23	0.03	.08	−0.12	0.18
Age	0.05	.01	0.02	0.07	0.03	.01	0.01	0.05
Maternal Education	0.02	.03	−0.05	0.09	−0.03	.03	−0.09	0.03
Boy	0.23	.16	−0.07	0.53	−0.26	.14	−0.53	0.01
Home English Exposure	0.79	.20	0.39	1.18	−0.58	.19	−0.93	−0.19
Teacher Communication	−0.04	.12	−0.27	0.19	−0.03	.10	−0.23	0.17
Peer Communication	0.09	.14	−0.18	0.37	0.00	.12	−0.24	0.23
Lang Match with Teacher	−0.18	.24	−0.64	0.28	0.09	.20	−0.31	0.49
Race Match with Teacher	0.09	.26	−0.43	0.60	0.19	.22	−0.25	0.62
% Classroom Spanish	−0.00	.01	−0.02	0.01	−0.00	.01	−0.01	0.01
% Classroom English	0.00	.00	−0.01	0.01	−0.01	.00	−0.01	0.00
Intercept variance	0.62	.11	0.45	0.85	0.54	.08	0.40	0.73
Slope	0.63	.08	0.48	0.78	0.30	.07	0.16	0.43
Age	−0.02	.01	−0.04	0.01	−0.01	.01	−0.03	0.01
Maternal Education	0.00	.03	−0.06	0.06	0.01	.03	−0.05	0.07
Boy	−0.09	.15	−0.38	0.19	0.00	.14	−0.28	0.26
Home English Exposure	−0.13	.18	−0.49	0.21	0.27	.17	−0.07	0.62
Teacher Communication	0.21	.12	−0.04	0.45	0.23	.11	0.01	0.45
Peer Communication	−0.26	.13	−0.51	−0.02	−0.06	.11	−0.29	0.16
Lang Match with Teacher	−0.12	.21	−0.53	0.28	−0.17	.19	−0.53	0.20
Race Match with Teacher	−0.06	.24	−0.53	0.42	−0.20	.22	−0.64	0.23
% Classroom Spanish	−0.00	.01	−0.01	0.01	−0.00	.01	−0.01	0.01
% Classroom English	0.00	.00	−0.01	0.01	−0.00	.00	−0.01	0.00
Slope variance	0.21	.09	0.08	0.44	0.08	.07	0.00	0.26
PPP value	0.21	--	−23.84	58.95	0.34	--	−28.35	52.86

Note. Bolded numbers have confidence intervals that do not include zero (i.e., are significant). Outcomes were converted to *z* scores using the mean and standard deviation from T1.

CI = credibility interval; UL = upper level estimate of the credibility interval; LL = lower level estimate of the credibility interval; % = percent children in classroom that speak that language; PPP = posterior predictive *p* value