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A cross-linguistic and bilingual evaluation of the interdependence between lexical and grammatical domains

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Abstract

The purpose of this study was to examine within and across language relationships between lexical and grammatical domains by focusing on measures of lexical diversity and grammatical complexity in Spanish and English. One hundred and ninety-six preschool and school-aged Latino children with different levels of English and Spanish proficiencies and different language abilities produced narratives in Spanish, English, or both. Analyses revealed strong associations between lexical (number of different words and number of different verbs) and grammatical measures (mean length of utterances in words and use of ditransitive predicates), supporting the domain interdependence hypothesis within a language. Cross-linguistic comparisons indicate a greater diversity of verbs and ditransitive predicates in Spanish compared to English for this population. In the language samples of children who produced narratives in the two languages, there was no relationship between the two domains across languages. The lack of cross-language correlations may be related to other variables influencing lexical and semantic development in bilingual learners. Methodological issues to be considered in future studies with bilingual speakers are discussed.

Numerous investigations in child language suggest a strong association between lexical and grammatical abilities in the early stages of language (e.g. Bates & Goodman, 1997, 1999; Dale, Dionne, Eley, & Plomin, 2000; Dionne, Dale, Boivin, & Plomin, 2003; Marchman & Bates, 1994). The strong association between lexicon and grammar is thought to indicate continuity, interdependence and "inseparability" of these two language domains (Bates & Goodman, 1997). Moreover, hypotheses such as the Lexical Bootstrapping Hypothesis, the Continuity Hypothesis, and the Critical Mass Hypothesis propose that the acquisition of lexical knowledge is prior and a prerequisite for the development of grammar (see Bartsch, 2006; Marchman & Thal, 2005) for a review). Across different languages, children do not begin to combine words until their vocabularies reach several hundred words (see Bates and Goodman, 1999). Children typically master a critical mass of words before producing a variety of syntactic constructions; for example, the size of verb vocabulary strongly predicted the number of verb overregularization errors in young English-speaking children (Marchman & Bates, 1994). The interdependence between the lexicon and the grammar supports the assumption of a single or domain-general mechanism behind language development (Marchman & Thal, 2005; Tomasello, 2003). These domain interdependence hypotheses clash against other theoretical frameworks, such as the declarative/procedural model or dual-system theory of language acquisition (Pinker & Ullman, 2002; Ullman, 2001; Ullman, Izvorski, Love, Yee, Swinney, &

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Hickok, 2005). In these frameworks, the lexicon and the grammar constitute two separate language subsystems organized in distinct cognitive and neural modules. The lexicon is learned as part of declarative memory, in rote or associative memory, and is subserved by domain specific cognitive components. In contrast, the grammar (or the rules or constraints that combine lexical forms into phrases and sentences) depends on procedural memory which is subserved by different cognitive components (Ullman, 2001; Ullman, 2004). Support for these ideas comes from studies of children's use of regular and irregular morphology in English, Spanish, and German. They found that children tend to overapply "rules"; for example, children may use the English regular past tense morpheme "–ed" with irregular verbs. In contrast, overgeneralization of irregular language forms to regular forms (e.g., vowel stem changes observed in English irregular past tense or Spanish irregular verbs used with regular verbs) is rare, suggesting that irregular verbs are stored in declarative memory and that the rules for regular verbs are part of procedural memory (Clahsen, 2007; Clahsen, Aveledo, & Roca, 2002; Ullman, 2001).

Empirical support for the interdependence of the lexicon and the grammar is based on studies of young children with typical and atypical development, as well as of children who speak typologically different languages. For example, researchers examined the relationship between English vocabulary size and grammatical skills (measured by length of utterance, use of functional words, and mean number of words of the 3 longest utterances) using the MacArthur Communicative Development Inventory [CDI] (Fenson, Dale, Reznick, Thal, Bates, Hartung, Pethick, & Reilly, 1993). Parental reports from more than 1800 monolingual English-speaking children between 8 and 30 months of age were examined and a strong relationship between vocabulary size and use of selected regular and irregular bound morphemes (e.g., plural –s) (r= .85, p< 001) was found (Fenson, Dale, Reznick, Bates, Thal, & Pethick, 1994). Similar findings were observed in special populations of English-speaking young children, such as early and late talkers and children with Down syndrome, Williams syndrome and focal brain lesions (Bates, Thal, Trauner, Fenson, Aram, Eisele, & Nass, 1997; McGregor, Sheng, & Smith, 2005; Moyle, Ellis Weismer, Evans, & Lindstrom, 2007; Singer-Harris, Bellugi, Bates, Rossen, & Jones, 1997).

The link between lexical and grammatical development has also been found in monolingual speakers of other languages such as Italian, Hebrew, Icelandic, and Spanish (Caselli, Bates, Casadio, Fenson, Fenson, Sanderl, & Weir, 1995; Caselli, Casadio, & Bates, 1999; Devescovi, Caselli, Marchione, Pasqualetti, Reilly, & Bates, 2005; Jackson-Maldonado, Thal, Marchman, Bates, & et al., 1993; Maital, Dromi, Sagi, & Bornstein, 2000; Thordardottir, Weismer, & Evans, 2002). However, limited research is available for children exposed to more than one language, in particular Latino children who are learning both Spanish and English languages. These children constitute an increasing percentage of the children in the U.S. with great variability in proficiency and use of the languages (United States Census Bureau, 2000). The linguistic performance of these children may reveal relationships between lexical and grammatical domains within languages as well as cross-language interactions. In fact, several researchers have noted that bilingual children provide an excellent opportunity to measure associations between lexical and grammatical domains within and across languages while holding other child-related factors constant (Marchman, Martínez-Sussmann, & Dale, 2004; Pearson, Fernandez, Lewedeg, & Oller, 1997).

In particular, the language performance of bilingual children allows us to examine whether grammatical attainment in one language is associated to lexical abilities within the same language and/or across languages. During development, the grammar emerges gradually. Children who speak either English or Spanish have been shown to initially use morphosyntactical forms with constrained lexical items and to later generalize grammatical rules to other words (Gathercole, Sebastian, & Soto, 2002; Tomasello, 2000; Tomasello, 2001). Within this framework, the role of experience with a variety of lexical items is fundamental for the development of the grammar (Bates & Goodman, 1999; Tomasello, 2003). Under this perspective, grammatical attainment in a given language is expected to be more strongly associated to lexical knowledge in that specific language, than to vocabulary level in the other language. This prediction is also consistent with a perspective that underscores the role of general cognitive abilities, such as perceptual and structural bootstrapping (i.e, cognitive processes that are not domain specific), on language development (Marchman & Bates, 1994; Plunkett & Marchman, 1993). Perceptual and structural bootstrapping refers to the child's cognitive abilities to discover perceptual cues and pattern distributions in the language input, which in turn facilitate the child's learning of the language(s) (Naigles, 1990; Naigles & Hoff-Ginsberg, 1998; Shi, Werker, & Morgan, 1999; Werker & Yeung, 2005). Because these abilities support the learning of both the lexicon and the grammar, one may expect associations between these two language domains. However, a child who is exposed to two languages must also be able to detect different cues and distributions of phonemes, words and word order, for example, for each language. The impact of these cross-linguistic differences in cues and distributions may vary depending on the amount and quality of exposure to the two languages. Thus, the strength of the association between lexical and grammatical domains may be affected by the degree of similarity/difference between the morphosyntactic characteristics of the two languages as well as sociolinguistic factors affecting the acquisition of the two languages in bilingual children. Bilingual children may also be able to extract abstract concepts about word combinations from one language and apply them to the other (Conboy & Thal, 2006). Yet, additional factors such as typological similarities and differences across the two languages, the context of language(s) exposure, the social status of the languages, language dominance and age of acquisition may also affect the extent to which attainments in one language relate to attainments in the other, and as a result, the associations between lexical and grammatical domains may not be apparent across the two languages.

A study of Spanish-English bilingual toddlers living in the U.S. looked at the relationship between vocabulary and grammar variables within Spanish and English and across languages using parental report (Marchman *et al.*, 2004). One or both parents completed the MacArthur CDI (Fenson et al., 1993) and its Spanish equivalent (Inventario del Desarrollo de Habilidades Comunicativas: Palabras y Enunciados [IDHC]) (Jackson-Maldonado, Thal, Marchman, Newton, Fenson, & Conboy, 2003) based on their ability to read and write in that language and their familiarity with their child's language use. Significant correlations between vocabulary size and grammatical complexity (use of selected bound and unbound morphemes) were found within each language (English $r = .74$; Spanish $r = .79$). However, cross-language multiple correlation coefficients were weak and non-significant (English vocabulary and Spanish grammatical complexity $R = .28$; Spanish vocabulary and English grammatical complexity $R = .18$) (Marchman, Martínez-Sussmann, & Dale, 2004). Spontaneous English and Spanish language samples of a subset of these children (n = 22) revealed similar findings. Strong and significant within-language correlations were found between lexical (number of different words or NDW) and grammatical measures (mean length of utterance in words or MLUw) (Spanish $r = .89$; English $r = .71$). In contrast, cross-language multiple correlation coefficients between vocabulary and grammar were weaker (Spanish NDW and English MLU $R = .55$, $p < .05$; English NDW and Spanish MLU $R = .34$, n.s.) (Marchman, Martínez-Sussmann, & Dale, 2004).

In another study, 64 bilingual toddlers from Spanish-English background in the U.S. were followed up from 19 to 31 months of age (Conboy & Thal, 2006). Overall, there was no significant difference in vocabulary across languages. English and Spanish vocabularies were moderately correlated ($r = .43$, $p < .0001$). Vocabulary was classified into social terms, nouns, predicates, and closed class words. Verbs were included in the predicate category along adjectives, quantifiers and adverbs, and predicates were correlated across languages ($r = .34$,

$p < .01$). Longitudinal growth curve analyses were used to analyze growth in the grammatical measures (e.g., sentence complexity score and MLU of the 3 longest utterances) as a function of age and vocabulary size. Changes in these measures were related to age and to changes in same-language vocabulary size but not to changes in vocabulary size in the other language. For example, the slope of English MLU growth was predicted by English vocabulary change ($t(29) = 3.60$, $p < .001$) and the slope of Spanish MLU growth was predicted by Spanish vocabulary change ($t(29) = 5.38$, $p < .0001$). In contrast, neither Spanish vocabulary change was significantly related to English MLU growth ($t(28) = 0.36$, $p > .50$) nor English vocabulary change to Spanish MLU growth ($t(28) = -1.67$, $p > .10$) (Conboy & Thal, 2006). The only exception to this trend was that the number of English words at the end of the study positively predicted Spanish MLU at the same time, above and beyond the effect of Spanish vocabulary at that age. This effect was only found in the English vocabulary to Spanish grammar direction and not in the opposite direction (Spanish lexicon to English grammar) (Conboy & Thal, 2006). The authors proposed that differences in word order cue reliability favoring English over Spanish may explain the positive effect of English vocabulary on Spanish MLU. However, the characteristics of their data (which did not distinguish correct versus incorrect utterances) did not allow for a conclusive interpretation.

The reviewed studies support the interdependence of the lexicon and the grammar in a given language. However, within young bilinguals, lexical attainments in one language do not appear to be related to grammatical attainments in the other. The available research examining this question with bilingual learners is difficult to evaluate due to differences in the methodological procedures used (e.g., cross-sectional versus longitudinal designs; spontaneous language samples versus parent report). In addition, these studies focused on simultaneous bilingual toddlers and their findings cannot be generalized to older bilingual children and/or to children whose exposure to a second language began at a later age, such as preschool. Clearly, research is needed to examine these questions directly.

What is the relationship between the lexicon and the grammar in older bilingual children?

Research examining the interdependence of the lexicon and the grammar in older bilingual children, in particular children who are learning English as a second language, is also limited and inconclusive, because of the measures used across studies. Most of the available studies are based on measures derived from standardized tests. This is problematic because the majority of these tests have limited validity and comparability across English and Spanish (Gutiérrez-Clellen & Simon-Cereijido, 2007; Peña, Iglesias, & Lidz, 2001). Moreover, many of these measures can result in culturally based performance differences (Peña & Quinn, 1997; Quinn, Goldstein, & Peña, 1996). For example, a large study of 704 Spanish-English bilingual children attending kindergarten, 2nd grade and 5th grade in Miami, Florida used the Test de Vocabulario en Imágenes [TVIP] (Dunn, Padilla, Lugo, & Dunn, 1986) which is a translation of the English Peabody Picture Vocabulary Test [PPVT] (Dunn & Dunn, 1981) (Cobo-Lewis, Eilers, Pearson, & Umbel, 2002). They also administered subtests of the Woodcock-Muñoz Language Battery (Woodcock & Muñoz-Sandoval, 1995), which is not normed with bilingual children in the U.S., but rather with monolingual populations from Spanish-speaking countries. This study found high correlations between reading and writing subtests across languages but no significant correlation between oral measures in English and Spanish. Principal components analysis of unresidualized standard scores showed that Spanish and English measures of literacy (e.g., Word Attack, Letter-Word, Passage Comprehension, Proofing and Dictation) loaded highly on Factor 1 (Factor 1 loadings range from .61 to .82); that is, literacy measures were interdependent across English and Spanish. In contrast, English oral language measures (e.g., Picture Vocabulary, Verbal Analogies, Oral Vocabulary and PPVT) loaded highly on Factor 2 while Spanish oral language measures loaded on Factor 3. Thus, oral language measures were related within language and not across languages. Spanish proficiency was not associated to English proficiency or vice versa (Cobo-Lewis *et al.*, 2002).

Similar results were found in a study of 92 Spanish-speaking English language learners ages 6 to 8 (Gottardo, 2002). Vocabulary, measured by the PPVT and the TVIP, was correlated to an experimental measure of grammar targeting plurals, noun-verb agreement, verb tense and adjectives in English and Spanish, within language (PPVT and English grammar: $r = .67$, $p = .001$; TVIP and Spanish grammar: $r = .47$, $p = .001$) but not across the languages (PPVT and Spanish grammar: $r = .22$, *n.s.*; TVIP and English grammar: $r = .01$, *n.s.*) (Gottardo, 2002).

In contrast, a longitudinal study of 49 Spanish-speaking preschoolers learning English found that Spanish language abilities at Time 1 or prior to intervention significantly predicted English morphosyntax at Time 2 or 9 months after intervention (Castilla & Restrepo, 2004). In this study, elicited measures of Spanish morphosyntax (e.g., the Cloze Task and Sentence Repetition Task of the Spanish Morphosyntax Test of the Bilingual English Spanish Assessment (BESA) (Peña, Gutiérrez-Clellen, Iglesias, Goldstein, & Bedore, n.d.)) and of Spanish semantics (e.g., Semantics Test of the BESA (Peña *et al.*, n.d.)) predicted later performance in elicited English morphosyntax tasks (e.g., Cloze Task and Sentence Repetition Task of the English Morphosyntax Test of the BESA (Peña *et al.*, n.d.)). Significant correlations among different domain variables within and across languages were found. For example, English Morphosyntax Cloze Task scores were significantly correlated with the Spanish Cloze Task ($r = .74$, $p < .001$), with the Spanish Sentence Repetition Task ($r = .69$, $p < .001$), and with the Spanish Semantic Test ($r = .50$, $p < .001$). In addition, the English Sentence Repetition Task was significantly correlated with the Spanish Cloze Task ($r = .45$, $p < .001$), Spanish Sentence Repetition Task ($r = .69$, $p < .001$), and Spanish Semantics Test ($r = .59$, $p < .001$) (Castilla & Restrepo, 2004). Of note, correlations within the same domain (e.g., the morphosyntax tasks) tended to be stronger than across domain (e.g., morphosyntax and semantics). It is also important to note that this study did not use a direct vocabulary measure in these analyses. Although performance on the Semantics Test required specific vocabulary knowledge, the task involved processes such as categorization and semantic associations. Once again, the contradictory findings of these studies may be related to methodological differences in design (e.g., cross-sectional versus longitudinal studies) and in the language measures selected (e.g., standardized versus experimental measures, lexical diversity versus vocabulary knowledge measures). The current study investigates cross-domain and cross-linguistic interactions using spontaneous measures of lexical diversity and grammatical complexity. The following section addresses the advantages of this approach.

In addition, available research with bilingual children has focused on children with typical language development. These studies have not included bilingual children with different language abilities, such as children with language delays. This is a question of interest since previous research suggests differences across lexical and syntactic abilities, depending on the languages investigated. For example, utterance length from spontaneous language samples and receptive vocabulary, measured by the raw scores of the PPVT-R (Dunn & Dunn, 1981), were not significantly correlated ($r = .08$) for English-speaking preschoolers with specific language impairment (SLI), in contrast to the significant correlations reported for the younger language-matched control group with typical language (Rice, Redmond, & Hoffman, 2006). Based on this evidence and on persistent morphological deficits in English-speaking children with SLI, grammatical growth has been posited to be dissociated from lexical growth for this population (for a review, see (Rice, 2003)). However, studies of late talkers and children with SLI who speak other languages, such as German, Italian, Icelandic, and Spanish, have found lower frequencies of morphological deficits than their English peers (Leonard & Bortolini, 1998; Lindner & Johnston, 1992; Simon-Cereijido & Gutierrez-Clellen, 2007; Thordardottir *et al.*,

2002) and thus, associations between the lexicon and the grammar for children with limited language ability may vary across languages.

Use of spontaneous measures of lexical diversity and grammatical complexity

An alternative approach to examine cross-language relationships for oral language measures in older children is to assess their spontaneous language samples. One advantage is that this methodology does not rely on tests developed for monolingual speakers as it is the case with current standardized measures. Additionally, in order to study bilingual children in the two languages, it is important to use measures that are comparable across the languages. Narratives can help measure lexical diversity and grammatical complexity in both languages. During narration, children need to use sentences of different length and complexity as well as an appropriate and relevant lexicon. Then, these utterances can be analyzed to obtain estimates of lexical and grammatical complexity in every language. Narratives allow us to study cross-linguistic differences across the languages of monolingual speakers (e.g., in samples produced by English-only and Spanish-only speakers) and within bilingual speakers (e.g., in English and Spanish samples produced by the same bilingual speakers).

The best methodology to study lexical diversity in Spanish is not established yet. In contrast to English, Spanish is highly inflected for verbs, articles, and adjectives and thus rules for counting word roots differ from one language to the other. Lexical diversity measures such as type-token ratio or the measure of lexical diversity D (a purportedly stable measure that is independent of sample size (Malvern & Richards, 2002)) may prove to be comparable across the two languages; however, there is no evidence to support its use with Spanish and English samples from bilingual individuals at this time. Alternatively, the number of different words (NDW) used in the children's narratives can be directly compared across the two languages. Studies in English demonstrate that the NDW significantly correlates with age (Miller, 1987). The NDW has been shown to discriminate between children with typical versus impaired language development as well (Klee, 1992; Watkins, Kelly, Harbers, & Hollis, 1995). Since the NDW is dependent on sample size, it is important to calculate the NDW in a set number of utterances. A computerized language sample software, such as the Systematic Analysis of Language Transcripts or SALT (Miller & Iglesias, 2006), allows us to calculate the NDW in the first 50 utterances of the sample. For this study, the NDW in the first 50 utterances of both English and Spanish samples was calculated using the conventions of the bilingual (English-Spanish) version of the SALT program.

To assess grammatical complexity, SALT provides two measures of mean length of utterance (MLU), one measured in morphemes (MLUm) and one in words (MLUw). MLU is considered a general measure of syntactic complexity and correlates significantly with age in English (Miller, 1987; Miller & Chapman, 1981) and Spanish (Echeverría, 1979; Gutiérrez-Clellen & Hoffstetter, 1994). Based on previously published research guidelines for bilingual children (Gutiérrez-Clellen, Restrepo, Bedore, Peña, & Anderson, 2000), MLUw is deemed to be the most reliable measure in both English and Spanish for this population.

In addition, linguistic complexity can be estimated by examining the use of verbs with complex argument structure. In a previous study, use of ditransitive predicates and MLUw assisted in the identification of language impairment (LI) in Spanish-speaking children. A semantic-syntactic complexity model using MLUw, theme argument use, and proportion of ditransitive verbs classified children with LI as well as a model focused on morphological accuracy (Simon-Cereijido & Gutierrez-Clellen, 2007). English-speaking children with LI also exhibit limited use of verbs with three arguments in spontaneous language (Thordardottir & Weismer, 2002) and complex argument structure may pose greater grammatical challenges to children with specific language impairment (SLI) in terms of argument and auxiliary omissions (Grela & Leonard, 2000). Use of ditransitive predicates may be a meaningful measure for both English and Spanish. Bilingual children may apply what they know about transitivity in one language to the other language. For example, second language learners do not have parsing difficulties in the second language comprehension when the verb argument structures in the two languages match (Dussias & Cramer, 2006; Juffs, 1998; Zyzik, 2006).

Verb argument structure use may be related to the child's overall lexicon or to the child's verb lexicon diversity. Within constructivist models and domain interdependence hypotheses (Bates & Goodman, 1999; Tomasello, 2003), experience with a variety of lexical items is critical for the development of verb argument structure. As verb vocabulary grows, argument structure is predicted to become more complex. The number of different verbs may be an important measure of lexical diversity which may relate to the number of ditransitive predicates in the two languages.

The purpose of this study was to examine within and across language relationships between lexical and grammatical domains by focusing on measures of lexical diversity and grammatical complexity in Spanish and English in preschool and school-aged Latino children with different language abilities. We hypothesized that if there is interdependence between the lexical and grammatical domains, (1) strong correlations will be observed between these two domains in English and in Spanish; and (2) correlations between domains within each language will be stronger than correlations between domains across languages.

Method

Participants

Since the goal was to examine the lexical and grammatical performance of children with different levels of proficiency, the sample included both children with typical language development (TLD) and children with language delays. There were one hundred and ninety-six Latino children with different levels of English and Spanish proficiencies and different language abilities (126 children with typical language development (TLD) and 70 children with language delay), The mean age of the full sample was 67 months or 5;7 years (SD = 11.45 months, range: 47 to 85 months). The children were sampled from schools in districts serving predominantly low-income families in the Southwest region of the United States. School lunch program status was used as a metric for income level. Each school independently determined lunch program qualification status, which was determined by family income and the number of occupants in the household. Sixty-nine % of the children were eligible for reduced or free lunch and 37% of the children's mothers had less than 12 years of schooling. The majority of the children were of Mexican-American descent.

The children with language delay were identified based on (1) evidence of parent concern and/or teacher concern; (2) clinical judgment based on observations of trained bilingual speech-language pathologists (e.g., reported evidence of limited responsiveness in conversational samples, modifiability, etc); and (3) below cutoff scores on the Spanish Morphosyntax Test (S-MST) and/or the English Morphosyntax Tests (E-MST) of the Bilingual English Spanish Assessment (BESA) (Peña *et al.*, n.d.) as determined by previous research with these measures (Gutiérrez-Clellen, Restrepo, & Simon-Cereijido, 2006). For children who completed the two morphosyntax tests, the best score was selected to measure language proficiency. The children with TLD met criteria based on the same measures as the children with language delay. The children with TLD had higher BESA Morphosyntax scores (*Mean* = .78, *SD* = .16) than the children with language delay (*Mean* = .47, *SD* = .20). Both groups were recruited from the same classrooms and schools. None of the children had hearing impairments, mental retardation, emotional disturbance, motor difficulties, or neurological deficits, according to parent report and school records.

Procedures for establishing English and Spanish exposure and use—English and Spanish exposure and use were determined using parent and teacher reports based on previous research with these measures (Gutiérrez-Clellen & Kreiter, 2003). Parents were asked to rate the spoken English and Spanish proficiency and use of their child using a 5-point rating scale for each measure (0 representing no use or proficiency and 4 representing use all the time and native-like proficiency). They also reported the number of hours the child interacted with each member of the household and the language spoken during those interactions. The children's teachers were also given a questionnaire to rate the participants' use and proficiency of English and Spanish using the same 5-point scale. In addition, they provided an estimate of the percentage of time that the child was exposed to English and Spanish as a measure of language exposure at school. Table 1 describes the English and Spanish exposure, proficiency, and use of the children based on the questionnaire data.

Testing procedures

Each participant produced at least one narrative language sample in Spanish, English, or both, depending on the child's language ability or willingness to speak the target language. Some children were reluctant to speak Spanish, and some did not have sufficient English proficiency to complete the task in that language. From the pool of 196 children, 136 (69.4%) produced Spanish narratives and 104 (53.1%) produced English narratives. A similar number of children with language delay produced narratives in each language (39 in Spanish and 40 in English). Twenty-two percent (44/196) of the participants produced narratives in the two languages. In this subset of children, there were 35 children with TLD and 9 with language delay.

Narrative samples were elicited with wordless frog stories and transcribed using the Systematic Analysis of Language Transcripts – English and Spanish (SALT-RV9) computer program (Miller & Iglesias, 2006). For Spanish, children were asked to tell the stories "Frog on his own" (Mayer, 1973) and "Frog goes to dinner" (Mayer, 1974). For English, narratives were elicited using "Frog, where are you?" (Mayer, 1969) and "One frog too many" (Mayer, 1975). All the samples were collected in the schools. Trained and supervised bilingual research assistants, both graduate and undergraduate students, collected the language samples. Each language was tested on a different day. The order of elicitation for each child varied depending on the examiner and the child's availability. The samples were obtained using a story retell and a spontaneous narration format. For the retelling task, evaluators read the script corresponding to the story and the language of elicitation. There was one sentence per picture on average. Specific prompts for encouragement such as "anything else?", "what else?" were provided to ensure uniformity. For the spontaneous narration, children were allowed to look at the pictures of the book first, and then encouraged to tell the story to the evaluator. The two languages were tested using the same procedures.

Analysis procedures

The narrative samples were recorded for later transcription and transcribed by trained bilingual research assistants at the university laboratory using the conventions of SALT for English and Spanish samples (Miller & Iglesias, 2006). The samples were segmented in T-units (Hunt, 1965). A T-unit is a single main clause and any dependent constituents. In English, concatenatives (wanna, gonna) were not expanded. In Spanish, word roots were assigned using the root identification command of the bilingual version of SALT. Only spontaneous utterances were included and Spanish-English mixed utterances and utterances with unintelligible words were excluded from the analysis. Children's narratives were 58 utterances in length on average with a standard deviation of 20 utterances.

The analysis was based on two measures of lexical diversity (number of different words and number of different verbs) and two measures of grammatical complexity (mean length of utterance in words and use of ditransitive predicates). The number of different words (NDW) and the mean length of utterance in words (MLUw) were generated by the SALT program. The number of different verbs (NDV) was obtained as follows. First, a list of verbs was extracted using the SALT Explore command. Then, the number of different verbs used by each individual was calculated manually. Neither the copula verbs “be”, “ser”, “estar”, the auxiliaries, or the English modals were included in the total count of different verbs. English verbs used as nouns were also excluded. In Spanish infinitival phrases such as “va a X” (“is going to X”), the auxiliary “go” was not counted (coded as auxir) and the X was counted as a verb. Verbs were counted when used as main verbs and when used as modifiers. This is frequent in Spanish, e.g.,”va corriendo/*(he) goes running”.

The number of ditransitive predicates (DITR) was calculated by counting the number of predicates that had a direct and an indirect object (e.g., “he gave him a present”, “le dio un regalo”). These utterances were coded by hand and a count of the number of ditransitive predicates in each sample was generated by SALT.]

About one-half of the transcripts were independently transcribed by a second transcriber to achieve at least 90% item-by-item agreement for transcription accuracy, segmentation, and coding.

As noted, the English and Spanish measures were derived from different stories. In order to directly compare the measures across languages, the individual measures (NDW, NDV, MLUw, and DITR in each language) were normalized using the following equation: $(x_i/max_x) \times 100$ (e.g., individual scores were divided by the maximum observed score and multiplied by 100) prior to the statistical analyses. In the full sample, the English and Spanish normalized scores were compared by inspecting means and calculating effect sizes (Cohen, 1988).

Pearson correlations were used to explore relationships between language domains (i.e., between NDW and MLUw, NDW and DITR, NDV and MLUw, and NDV and DITR) within languages. Due to the reduced sample size of the subset of children who produced narratives in both languages, across language correlations were conducted only between the more traditional measures of NDW and MLUw.

Results

Table 2 presents the means and standard deviations of the lexical and grammatical measures based on the raw data in each language for all participating children (i.e., children with typical language and children with language delay). Examination of the raw and normalized data shows similarities and differences across languages. Overall, the means for the normalized MLUw and NDV appeared to be similar across languages (English MLUw = 67.05 (14.16) and NDV = 56.13 (17.56); Spanish MLUw = 65.44 (13.16) and NDV = 56.10 (16.64)). Effect sizes for these measures were small (MLUw d = .25; NDV d = .08). MLUw raw scores across languages were comparable (see Table 2). Even though the normalized scores of verb diversity were comparable across languages, it was noted that the Spanish count of different verbs was somewhat larger than the English count (See Table 2). Overall lexical diversity (NDW) and use of ditransitive predicates was higher in Spanish. The means of the normalized scores of NDW were 71.97 (15.01) for Spanish and 62.40 (14.16) for English. The effect size for this lexical measure across languages was large (d = .75). In addition, based on the normalized data, the mean number of ditransitive predicates for Spanish was also higher (*Mean*= 37.25, *SD*=23.76) than the English mean (*Mean* = 21.87, *SD*=25.28). The effect size for number of ditransitive predicates across languages was moderate (d = .44). The mean of the raw count of ditransitive predicates in Spanish was noticeably higher than the English count (See Table 2). The reported effect sizes are based on the normalized data.

Table 3 describes the means and standard deviations of the measures' raw scores for the subset of bilingual children who provided samples in the two languages. Mean scores parallel the full sample results on Table 3.

Table 4 lists the correlations between lexical and grammatical measures within each language. In both English and Spanish, there were strong and significant correlations between NDW and MLUw (in English, .$r = .64$, $p < .001$ and in Spanish, $r = .71$, $p < .001$). The NDV also correlated significantly with MLUw in both languages (in English, $r = .44$, $p < .001$; in Spanish, $r = .52$, $p < .000$). Both NDW and NDV were more strongly correlated with the use of ditransitive predicates in Spanish (NDW and DITR: $r = .58$, $p < .001$; NDV and DITR: $r = .56$, $p < .001$) than in English (NDW and DITR: $r = .30$, $p < .01$; NDV and DITR: $r = .33$, $p < .001$).

Similar trends were observed in the small subset of children with language delays (39 children with Spanish language samples and 40 with English language samples). The means and standard deviations of the lexical and grammatical measures for this subgroup and for the children with typical language development are included in Table 5. Children with language delays had lower means than the typical group for NDW, NDV, MLUw and use of ditransitive predicates in Spanish. In English, the atypical group had lower means than the typical group for all the measures with the exception of verb diversity. In addition, NDW was also significantly correlated with MLUw in Spanish ($r = .68$, $p < .001$) and in English ($r = .59$, $p < .001$).

Cross- language correlations across domains for the subset of bilingual children were not significant for any of the measures (Spanish NDW and English MLUw: $r = .18$, *n.s.*; English NDW and Spanish MLUw: $r = .15$, *n.s.*). Of the 44 children who provided narratives in the two languages, 32 participants had greater Spanish proficiency (relative to English proficiency). For these Spanish-dominant bilinguals, the within-language correlation across domains (Spanish NDW and MLUw: $r = .65$, $p < .001$) was comparable to the correlation found for the children who were able to produce a narrative in Spanish but not in English (Spanish NDW and MLUw: $r = .76$, $p < .001$). However, there were no significant correlations between their Spanish NDW and their English MLUw ($r = .27$, *n.s.*) or between their English NDW and their Spanish MLUw ($r = .27$, *n.s.*).

Discussion

The purpose of this study was to examine relationships between lexical diversity and grammatical complexity in Spanish and English in preschool and school-aged children with different language abilities. Similarly to previous research findings reported for young bilingual children, lexical diversity and grammatical complexity were correlated within English and Spanish languages. These results provide support for the domain interdependence hypothesis.

There were stronger associations between lexical and grammatical measures in the Spanish samples than in English. This was more noticeable for use of ditransitive predicates. It is possible that this disparity is related to differences in the number of ditransitive predicates obtained in each language. The number of ditransitive predicates used in Spanish was greater than in English. This difference was observed for the children with TLD (Spanish mean = 4.97 (2.83); English mean = 1.05 (1.03)) and for the children with language delay (Spanish mean = 3.23 (2.55); English mean = .60 (.93)). The Spanish samples of the 44 children with narratives in the two languages had more ditransitive predicates (mean = 4.32) than the English samples (mean = 1.00) as well.

This difference may also be related to characteristics of the two languages. There are certain constructions in Spanish that require use of direct object and indirect objects such as inalienable possession constructions (le corté el pelo/I cut his hair) that are not ditransitive in English. In particular, there were 9 Spanish verbs used in ditransitive contexts among the 30 most frequently used verbs in the Spanish narratives. They are “agarrar/grab, decir/say, dar/give, llevar/bring, tomar/take, poner/put, picar/sting, sacar/take, tirar/throw”. Three of these verbs (i.e., grab, put, sting) are not used in ditransitive contexts in English. For example, the Spanish sentences “le agarró la pata a la rana”, “le puso una velita al pastel”, and “la abeja le picó la lengua” have a direct and an indirect object. The English translations only include a direct object: “[he] grabbed the frog’s leg”, “[he] put a little candle on the cake”, and “the bee stung his tongue”. Future studies examining the use of ditransitives in specific contexts amenable to parallel English/Spanish constructions (e.g., events expressed with verbs of communication and object exchanges such as “to tell/contar” and “to give/dar”) will be needed to examine these cross-linguistic differences further.

There were also differences in the number of different verb types used in the Spanish and English samples. The Spanish samples showed greater verb diversity than the English samples. For example, in the Spanish narratives there were 209 different verb types and 22 of those verbs were used by more than 60 children (see Table 6). In contrast, the English samples had a count of 156 different verb types but only 8 of those verbs were used by more than 60 children. Once again, typological differences between the two languages may help explain these findings. Spanish is a manner verb language (Slobin & Bocaz, 1988;Talmy, 1991) and does not use verb particles to indicate path. Thus, when Spanish speakers mark path and manner, they rely on the use of two different lexical verbs (sube corriendo/(he) goes up running). In contrast, English is considered to be a path verb (Slobin, 1996;Talmy, 1991). In order to communicate path and manner, English speakers use one lexical verb in conjunction with a verb particle (he runs up). Our methodology to calculate NDV did not account for verb particle combinations and this could explain the smaller number of verb types in English.

However, the lower number of English verbs is surprising in comparison to previous cross-linguistic research conducted by Slobin (1996). In fact, the frog story used by Slobin and colleagues is one of our English elicitation stories. In Slobin’s studies, monolingual English speaking children used a greater number of verb types (n = 47) than monolingual Spanish speaking children, who used 27 types of verbs. In fact, if English verbs were combined with the verb particles (e.g., counting “fall down” and “fall in” as two different types of verbs), the number of verb types in Slobin’s studies increased to 123. This research suggested that English speakers use a larger variety of verbs than Spanish speakers. In contrast, in our samples, the opposite was found. Latino children produced a smaller variety of English verbs than of Spanish verbs. Limited English proficiency cannot fully account for the reduced English verb diversity. Among the 104 children who produced English narratives, only 31% (32/104) had greater proficiency in Spanish than in English. Therefore, the majority or 69% of the children was dominant in English. The English verb diversity rates found in the present study may be related to the sociolinguistic characteristics of the participants. In contrast to Slobin’s middle class sample, the participants of the present study had a greater representation of children from lower socio-educational background. This is a variable repeatedly associated to low vocabulary (Hart & Risley, 1995; Jewkes, 2005; Qi, Kaiser, Milan, & Hancock, 2006; Restrepo, Schwanenflugel, Blake, Neuharth-Pritchett, Cramer, & Ruston, 2006). In addition, educational research has repeatedly shown that Latino children from low socio-economic status (SES) backgrounds in the U.S. tend to start school with language skills, including vocabulary, below age expectations (St. Pierre, Ricciuti, Tao, Creps, Kumagawa, & Ross, 2001; St. Pierre, Ricciuti, Tao, Creps, Swartz, Lee, Parsad, & Rimdzius, 2003; Zill, Resnick, Kim, O'Donnell, Sorongon, McKey, Pai-Sarmant, Clark, O'Brien, & D'Elio, 2003; Zill, Resnick, McKey, Clark, Pai-Sarmant, Connell, Vaden-Kiernan, O'Brien, & D'Elio, 2001). Limited access to quality day care and preschools and insufficient professional training of the educational staff caring for this population also impact the development of lexical skills in these children (Herzenberg, Price, & Bradley, 2005; National Task Force on Early Childhood Education for Hispanics, 2007). Thus, these differences should be interpreted with caution, in particular for second language learners in the U.S. who may systematically represent a particular socioeducational level (Werker & Byers-Heinlein, 2008).

The children with language delay exhibited similar lexical-grammatical associations as their peers with typical language development within the same language. However, the strength of the correlations between semantic and grammatical domains appeared to vary depending on the languages that were being compared. These patterns were observed in the full sample and the subset of children with language delay. The correlations between Spanish NDW and Spanish MLUw were stronger than the corresponding English correlations for the full sample (Spanish $r = .71$, English $r = .64$) and for the subset of children with language delays (Spanish $r = .68$, English $r = .59$). These cross-linguistic differences in the strength of the association (Spanish $r = .89$, English $r = .71$) were also found in the spontaneous language of bilingual toddlers by Marchman, Martínez-Sussmann, and Dale (2004). It is unclear whether this is related to differences in the characteristics of the Spanish and English samples and/or to language elicitation differences across studies. In contrast, Gottardo (2002) reported stronger lexical-grammatical associations in English ($r = .67$) than in Spanish ($r = .47$) when using elicited tasks of vocabulary and grammar. In contrast to Rice, Redmond and Hoffman (2006), our study revealed a significant positive correlation between English MLUw and lexical skills in the children with limited language ability. Participants' demographic disparities (e.g., participants' ethnicity, parental education, socioeconomic status) and methodological differences (e.g., spontaneous vocabulary vs. standardized vocabulary measures) may partly explain the different results. This underscores the need to carefully explore the effects of socioeconomic, educational, and sociolinguistic factors, in addition to methodological considerations, in studies of children with language delays.

In addition, we examined cross-language relationships in the language of the 44 bilingual children who provided narrative samples in each language. As observed in previous studies with bilingual children in the U.S., there were no significant correlations between Spanish and English measures. In order to ascertain the possible influence of dominance in this subset of bilingual children, we also examined the cross-language lexical-grammatical correlations in the 34 children who were Spanish dominant because of their greater Spanish than English proficiency. In contrast to Conboy & Thal (2006), the correlations in both directions (Spanish lexicon to English grammar and English lexicon to Spanish grammar) were not significant. However, the lack of evidence of a lexical-grammatical relationship across the two languages does not constitute evidence that the two languages are learned independently. In fact, Spanish and English lexical and grammatical domains may be associated by other measures which were not controlled in the present study both within and across languages.

There are several limitations of the current study affecting our ability to fully explore cross-language associations between lexical and grammatical measures. First, the sample size of children with narratives in both languages precluded multivariate analyses exploring the effect of factors such as relative language exposure and proficiency on lexical and grammatical attainments in the languages. Second, the cross-sectional design of the current study does not allow for a direct evaluation of the interactions between these domains as children acquire a second language. Crosslinguistic associations in second language learners were found in longitudinal studies (e.g., Castilla & Restrepo (2004)) rather than in cross-sectional studies (e.g., Gottardo, 2002). Research using longitudinal methods is needed to examine these associations in a direct manner.

Language learning may also be more evident when change over time, rather than static proficiency, is measured. That is, rates of growth, instead of static scores or gains in scores, should be considered. For example, children who exhibit a fast rate of growth in Spanish vocabulary (regardless of the absolute starting and ending lexical level) may also exhibit accelerated growth in English grammar, in contrast to children whose rate of growth is slow. Of note, a longitudinal study of bilingual Spanish- and English-speaking preschoolers has shown that rates of growth in one language predict later performance on the other language (Hammer, Lawrence, & Miccio, 2007). In particular, growth in Spanish receptive language abilities during preschool predicted early Spanish and English reading abilities in kindergarten. The same prediction was observed for growth in English receptive language (Hammer *et al.*, 2007). It is also possible that certain grammatical constructions may be relatively easier or more difficult based on the typological overlap between the two languages, and that the level of complexity of grammatical measures may moderate the strength of lexical and grammatical associations at different points in development. In addition, differences in proficiency may affect language learning across domains differently as children learn a second language. For example, lexical abilities in the first language may mediate the acquisition of grammatical skills in a second language only during the initial stages of second language learning, but not after children are capable of speaking the two languages fluently, such as with the bilingual participants in the present study. Future longitudinal studies will be needed to address these questions.

Future research should also use both spontaneous and elicited tasks. The specific lexical and grammatical measures should be carefully considered in terms of what they intend to measure and in terms of equivalency across the pair of languages of interest. Lexical abilities may be determined based on vocabulary size, vocabulary use, lexical diversity, or semantic knowledge. Grammatical knowledge may be operationalized by measures as diverse as length and complexity of utterances or use of a specific grammatical inflection or constructions (e.g., use of irregular verbs or use of ditransitive predicates). Once a given measure is selected, the measure should be comparable across English and Spanish. Furthermore, research is critically needed focusing on children learning a second language at a later age. As it was discussed earlier, sequential bilinguals may initially rely more on their first language when learning a second language. Age of acquisition and the context of language(s) exposure are also important variables to consider in future studies.

In conclusion, strong associations between lexical and grammatical measures reported in previous research were also observed in this sample of children with various levels of English and Spanish exposure and ability. The findings of the study support the domain interdependence hypothesis within a language.

From a clinical perspective, the lack of cross language correlations within bilingual speakers underscores the importance of looking at each of the two languages of the bilingual child, in particular for measures of oral language. As previous studies have suggested (Cobo-Lewis et al., 2002; Marchman et al., 2004), proficiency in one language is not necessarily associated with concurrent proficiency in the other language. Importantly, bilingual children demonstrate different levels of abilities in each language, and thus examination of each language is fundamental in order to gauge their linguistic knowledge and ability.

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Table 1

Mean and standard deviation (*SD*) of measures of Spanish and English exposure, use and proficiency for all participants (n = 196)

Language Ability	***Mean***	***SD***
Proportion of Spanish exposure at home	63.85	30.31
Proportion of English exposure at home	36.15	30.31
Parents' rating of use of Spanish	3.38	1.10
Parents' rating of use of English	2.73	1.30
Parents' rating of proficiency of Spanish	3.39	1.10
Parents' rating of proficiency of English	2.56	1.34
Teachers' rating of use of Spanish	2.57	1.47
Teachers' rating of use of English	2.43	1.18
Teachers' rating of proficiency of Spanish	2.88	1.42
Teachers' rating of proficiency of English	2.38	1.23
Proportion of Spanish exposure at school	43.03	32.40
Proportion of English exposure at school	51.84	33.10

Table 2

Mean, standard deviation (*SD*) and range of Number of Different Words, Number of Different Verbs, Mean Length of Utterance in Words (MLUw), and Number of Ditransitive Predicates based on the raw scores for the full sample (n = 196)

	Mean	SD	Range
English (n = 104)			
Number of Different Words	78.00	17.70	28–125
Number of Different Verbs	20.77	6.49	7–37
MLUw	5.96	1.09	2.65–8.89
Number of ditransitives	0.88	1.01	0–4
Spanish (n = 136)			
Number of Different Words	76.29	15.91	29–106
Number of Different Verbs	26.92	7.98	7–48
MLUw	5.63	1.13	2.42–8.60
Number of ditransitives	4.47	2.85	0–12

Table 3

Mean and standard deviation (*SD*) of Number of Different Words, Number of Different Verbs, Mean Length of Utterance in Words (MLUw), and Number of Ditransitive Predicates based on the raw scores of the children who provided narratives in both English and Spanish (n = 44)

	Mean	***SD***	**Range**
English			
Number of Different Words	74.68	16.18	32–99
Number of Different Verbs	19.32	6.27	7–34
MLUw	6.13	.75	4.67–7.94
Number of ditransitives	1.00	.99	0–3
Spanish			
Number of Different Words	73.91	18.07	31–104
Number of Different Verbs	24.36	8.84	7–43
MLUw	5.74	1.06	3.00–9.00
Number of ditransitives	4.32	3.03	0–11

Table 4

Within language correlations between lexical measures (Number of Different Words (NDW) and Number of Different Verbs (NDV)) and grammatical measures (Mean Length of Utterance in Words (MLUw) and Use of Ditransitive Predicates) for the full sample.

English (n = 104)	MLUw	Use of ditransitives
NDW	.64**	.30*
NDV	.44**	.33**
Spanish (n = 136)	MLUw	Use of ditransitives
NDW	.71**	.58**
NDV	.52**	.56**

*Note: p < .01,

**p < .001

Table 5

Mean and standard deviation (*SD*) of Number of Different Words, Number of Different Verbs, Mean Length of Utterance in Words (MLUw), and Number of Ditransitive Predicates based on the raw scores of the full sample by language ability

Language Ability	Language Delays		Typical Language	
	Mean	**SD**	**Mean**	**SD**
English	n = 40		n = 64	
Number of Different Words	73.80	14.90	80.63	18.89
Number of Different Verbs	20.20	6.25	21.13	6.67
MLUw	5.53	1.15	6.23	.98
Number of ditransitives	.60	.93	1.05	1.03
Spanish	n = 39		n = 97	
Number of Different Words	68.13	15.37	79.58	14.98
Number of Different Verbs	23.15	6.78	28.44	7.96
MLUw	5.20	1.15	5.80	1.08
Number of ditransitives	3.23	2.55	4.97	2.83

Table 6

English and Spanish verbs used by more than 60 children in the full sample

English verb	Number of children	Spanish verb	Number of children
Jump	100	Ir	136
Look	90	Agarrar	124
Go	98	Caer	117
Get	93	Asustar	115
Fall	87	Decir	113
Come	74	Comer	111
Say	70	Meter	111
Cry	64	Ver	104
		Dar	103
		Llorar	103
		Querer	90
		Brincar	89
		Llevar	83
		Enojar	79
		Picar	76
		Tener	76
		Tomar	75
		Correr	67
		Jugar	67
		Mirar	67
		Caminar	66
		Salir	62