The language-specific nature of grammatical development: evidence from bilingual language learners

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Abstract

The fact that early lexical and grammatical acquisition are strongly correlated has been cited as evidence against the view that the language faculty is composed of dissociable and autonomous modules (Bates & Goodman, 1997). However, previous studies have not yet eliminated the possibility that lexical–grammar associations may be attributable to language-general individual differences (e.g. children who are good at learning words are good at learning grammar). Parent report assessments of toddlers who are simultaneously learning English and Spanish (n = 113) allow an examination of the specificity of lexical–grammar relationships while holding child factors constant. Within-language vocabulary–grammar associations were stronger than cross-language relationships, even after controlling for age, proportion of language exposure, general language skill and reporter bias. Similar patterns were found based on naturalistic language samples (n = 22), ruling out a methodological artifact. These results are consistent with the view that grammar learning is specifically tied to lexical progress in a given language and provide further support for strong lexical–grammatical continuity early in acquisition.

Introduction

For most children, the development of language is characterized by both periods of steady progress and rapid bursts of new abilities. After the appearance of first words around 12 to 14 months of age, single words dominate production as vocabularies increase in size at a relatively slow pace over the next months. Well before the second birthday, on average, the rate of word learning typically undergoes a marked increase (the vocabulary ‘burst’) and simple word combinations (e.g. ‘mommy sock’) begin to appear. These telegraphic combinations characterize productive language use over the next few months, followed by another burst in children’s use of the morphology and syntax of their native language. Although the specifics of this developmental trajectory vary somewhat from child to child and language to language, the temporal character of early language learning has been cited as evidence for the view that the lexicon and grammar are distinct domains, with grammatical acquisition being relatively autonomous, or modularized, from the earlier task of word learning (Pinker, 1999).

Recent theorizing, however, has moved away from traditional modular interpretations toward a view in which lexical-semantics and grammar share crucial properties and resources (e.g. Bates & Goodman, 1997). The move to unite grammar and the lexicon can be seen in linguistics within frameworks like Lexical-Functionalist Grammar (e.g. Bresnan, 1982). An increased integration of lexical and grammatical structures is evident even within generative grammar, the school that originally proposed a modular distinction between grammar and the lexicon (Chomsky, 1995). A lexicalist approach is also compatible with connectionist approaches to developmental psycholinguistics (e.g. Elman, Bates, Johnson, Karmiloff-Smith, Parisi & Plunkett, 1996).

Strong empirical support for a lexicalist view comes from the finding that lexical and grammatical development are highly associated during the early phases of language learning (e.g. Bates, Bretherton & Snyder,
and grammatical development in the reverse direction. That is, grammatical analysis is a driving force behind word learning. Here, the process of analyzing sentences into their constituent grammatical parts can be seen to facilitate the further acquisition of lexical-semantic knowledge (Anisfeld, Rosenberg, Hoberman & Gasparini, 1998; Gleitman, 1990; Naigles, 1990).

In short, associations between lexical and grammatical development play a central role in theories of the structure of the language faculty and the mechanisms guiding the transition from first words to productive use of grammar. Before evaluating these specific proposals, however, more general explanations must be eliminated. Namely, it is possible that lexical and grammatical associations are entirely indirect, reflecting the mutual influence of mechanisms or representational requirements that operate outside the lexical and grammatical systems per se. For example, lexical–grammar associations may simply reflect a strong correlation between general cognitive skill and each of the individual tasks of learning words and learning grammar. Analogously, lexical–grammar associations could be attributable to the impact of a common set of environmental influences. It is well known that the quality and quantity of talk that children hear has a substantial impact on vocabulary learning (e.g. Hart & Risley, 1995; Huttenlocher, Haight, Bryk; Seltzer & Lyons, 1991). It is feasible to propose that features of the language-learning environment (e.g. amount of talk) that enhance children’s learning of words might also enhance the mechanisms guiding the acquisition of grammar.

To explore these possibilities, Dale et al. (2000) used behavioral genetic techniques to analyze the contribution of genetic and environmental factors on the development of lexical, grammatical and non-verbal cognitive skills in 1008 monozygotic and 1890 dizygotic 2-year-old twins. Non-verbal cognitive skills were only weakly associated, either phenotypically or genetically, with lexical and grammatical progress (see also Price, Eley, Dale, Stevenson, Saudino & Plomin, 2000). This finding suggests that verbal and non-verbal development are relatively independent in this age range. In addition, although there were substantial shared environmental contributions to both lexical and grammatical development and to the correlation between them, there was a strong genetic correlation of .61 (a measure of overlap in genetic effect) for the relationship between lexical and grammatical skills. Taken together, these findings indicate that there is a substantive genetic contribution to the correlation between lexical and grammatical growth, and that these individual differences are not reducible to general cognitive skill nor to the role of common environmental factors.
However, previous studies have yet to rule out the possibility that general verbal proficiency guides development in both domains (a type of language learning ‘g’). In spite of the behavioral genetic evidence that verbal and non-verbal skills are dissociable during this period, tight relationships within language (i.e. between lexical and grammatical skill) could nevertheless be attributable to general individual differences in language learning skill across children. That is, it may simply be the case that children who learn words early are also those children who are good at learning grammar; children who are less proficient in learning words are also those children who are less proficient in learning grammar. If lexical–grammatical associations could be accounted for by this type of general explanation, then it would not be necessary to posit the type of specific cross-domain continuities in mechanistic or representational factors that have been the topic of recent theorizing.

For children learning just one lexicon and one grammar, i.e. monolingual children, it is difficult to distinguish the influence of general language learning ability from that of specific lexical–grammatical links as explanations for the correlation between the two. Children who are learning two languages offer an intriguing opportunity to ‘hold the child factor constant’ (Pearson, Fernández, Lewedeg & Oller, 1997, p. 43) while exploring the relationship between different levels of lexical accomplishments and grammatical outcomes in each language.

In this study, we examine language-specific and language-general predictors of lexical and grammatical development in toddlers who are simultaneously learning both Spanish and English. These children have the potential to become ‘simultaneous bilinguals’ (i.e. to master the lexical and grammatical systems of both languages) and many do so by the time they enter school (McLaughlin, 1984). As with their monolingual peers, there is substantial individual variation in language outcomes in this population and different levels of accomplishments are frequently observed in the two languages early in acquisition (Pearson, Fernández & Oller, 1993; Pearson & Fernández, 1994). A child’s achieved level of language must be, to some degree, a function of the age of the child, as well as features of the language learning environment (e.g. how much and what kind of talk does the child experience? how much English versus Spanish does he/she hear on a daily basis?) (Hart & Risley, 1995; Gathercole, 2002). At the same time, general language learning characteristics of the child that are relatively independent of quantity or quality of experience (e.g. different levels of efficiency or effectiveness in abstracting linguistic information from the relevant input) could also contribute to the variation that is observed. Another possibility, however, is that lexical and grammatical learning are associated in a largely language-specific fashion, only moderately affected by general factors that mediate acquisition in both domains.

We first examine the general influence of age and degree of exposure to English and Spanish on lexical and grammatical outcomes in each language. Next, we examine the relationships between lexical and grammatical accomplishments both within and across languages. If general language learning skill accounts for the close lexical–grammar associations that have been observed in monolingual children, one would expect substantive within-domain, cross-language associations in children learning two languages, over and above what is attributable to age and degree of exposure. That is, children should tend to have more similar across-language lexical and grammatical accomplishments than one would predict from their developmental level and relative English vs. Spanish input. In addition, progress in grammar in a given language should be closely tied to language-neutral indices of language learning skill (e.g. lexical and grammatical progress in the other language, or total number of words produced regardless of the language used). On the other hand, if grammatical accomplishments are strongly associated with lexical level in the same language (cross-domain, within-language) and only weakly related to lexical and grammatical level in the other language, over and above these general factors, individual differences in grammar would appear to be related to specific features of the task of vocabulary learning in that language. These results would suggest that lexical and grammatical development are connected at the level of learning mechanism or content in ways that have significant implications for views of the structure of the language faculty (e.g. grammatical accomplishments emerge as a consequence of specific lexical accomplishments). Finally, we conduct additional analyses to rule out the contribution of reporter bias and compare the results from parent report to those based on naturalistic language samples.

Method

Participants

Participants were 113 (57 females and 56 males) toddlers (M = 23.5 months, range = 17–30) living in a major metropolitan area of the US. All participants had been regularly exposed to both English and Spanish, typically from birth, and were reported to produce at least a few words in each language. Children with major birth complications, extended hospitalizations, diagnosed developmental disabilities and/or hearing loss were excluded.
The families were primarily Hispanic (77%), and most mothers (78%) and fathers (65%) were native Spanish speakers. However, 45.7% of the families reported that the preferred ‘home language’ was a mixture of both English and Spanish. On average, both mothers ($M = 13.1$ years) and fathers ($M = 12.6$ years) reported some college education (range = 6–18 years). Most children were living with both biological or adoptive parents ($n = 104$, 89.7%), and 24% ($n = 28$) of the families had additional adults living in the home (e.g. grandparents, aunts, uncles, etc.). Approximately 58% of the children were receiving some type of non-parental child care, in their own home ($n = 23$), in another home ($n = 24$), or at a day care center ($n = 19$).

Procedure

Language environment interview

One or both parents participated in a Bilingual Background Interview administered by a trained bilingual research assistant (RA) in the language that was most comfortable for the parent. Each person in regular contact with the child was identified. The interviewer probed how much time the child spent with each individual per week, as well as the language(s) they spoke to the child. Summing across all individuals in the child’s daily life, the total number of hours of exposure to each language was computed (excluding TV), and converted to a proportion score in order to compare across children with different daily schedules. The overall mean proportion of English to Spanish exposure was 41.3%:58.7%, reflecting the fact that, as a group, these children were receiving slightly more Spanish- than English-language input. At the same time, there was a broad range of language learning environments, spanning from 6% English (94% Spanish) to 90% English (10% Spanish). Approximately 61% of the participants ($n = 69$) were exposed to a greater proportion of Spanish- than English-language input. There was a tendency for older children (≥24 months, $n = 66$) to have less exposure to English than younger children (<24 months, $n = 47$), $t(111) = 2.1$, $p < .05$. The full range of exposure levels, however, was represented in each age range (younger: range = 9 to 90% English; older: range = 6 to 90% English).

Parent report questionnaires

Parent report language assessments were completed by one or more adults in English (CDI) and Spanish (El Inventario del Desarrollo de Habilidades Comunicativas: Palabras y Enunciados [IDHC]; Fenson, Dale, Reznick, Thal, Bates, Hartung, Pethick & Reilly, 1993; Marchman & Martínez-Sussmann, 2002). Both instruments were designed for and normed on monolingual toddlers in the US (for the CDI) and Mexico (for the IDHC), and have documented success in the assessment of early language milestones (see http://www.sci.sdsu.edu/cdi/). A recent study demonstrated their validity in children who are learning both English and Spanish (Marchman & Martínez-Sussmann, 2002).

Reporters were selected to complete the CDI or IDHC based on their ability to read and write in that language, as well as their familiarity with the child’s use of that language. For 49 children, different reporter(s) completed the two forms (e.g. mother completed the CDI, day care provider completed the IDHC). All reporters received detailed verbal and written instructions highlighting relevant aspects of the process for completing both forms. Completed forms were examined following a set of guidelines to insure their completeness (e.g. no blank pages) and consistency (e.g. items in the complexity section were marked, but it was reported that the child was not combining words). Parents were contacted by telephone, generally within a few days after they returned the forms, to clarify and make the necessary corrections.

Both the CDI and IDHC contain vocabulary checklists in which reporters indicate which words (out of 680) the child ‘understands and says’ (‘comprende y dice’). These checklists capture the reporters’ general knowledge about whether or not the child ‘knows’ a particular word in English or Spanish, rather than specific information about the contexts in which a word is used or the accuracy of its pronunciation. As in previous studies (e.g. Bates & Goodman, 1997; Caselli et al., 1999), children were grouped in terms of size of production vocabulary into the following levels: <50, 51–100, 101–150, 151–200, 201–300, 301–400, >400 words.

Because of the analogous checklist formats and commonalities across early language development, translation equivalents of many (but not all) of the words on the CDI also appear on the IDHC, and vice versa. Following Pearson and Fernández (1994), responses were integrated into a composite score that reflects the number of ideas or ‘concepts’ (of 804 total) the child is reported to produce in English only (e.g. the child produces ‘dog’ but not ‘perro’), Spanish only (e.g. produces ‘gato’ but not ‘cat’), or both languages (e.g. produces ‘shoe’ and ‘zapato’). This score is not simply the sum of the number of words reported on both forms; the child receives credit for only one concept when equivalents are reported in both languages. In some cases, a concept is represented by different numbers of items on the two forms (e.g. the ‘watch/clock’ concept is mapped to both ‘watch’ and...
Progress in grammar is assessed in two ways. First, reporters provided examples of the ‘three longest utterances that you have heard your child say recently’ (‘Por favor, escriba tres ejemplos de las frases más largas que recuerde que su hijo haya dicho últimamente’) and Mean Length of the Three Longest Utterances in words (M3L-words) was computed. Second, reporters read a series of 37 pairs of phrases; in each one they were asked to indicate which of a pair of phrases ‘sounds more like what your child is saying right now’ (‘la que más se parezca a la forma como habla su hijo, en este momento’). The first is an example that lacks grammatical markers or is syntactically simple, whereas the second provides a more complex alternative (e.g. ‘Kitty sleep’ vs. ‘Kitty sleeping’; ‘Paloma llorando’ vs. ‘Paloma está llorando’). The grammatical complexity score is the number of times the second sentence was selected (37 maximum). The complexity items on the CDI and IDHC are not direct translations, but rather were selected to capture those constructs that are relevant to emerging grammatical knowledge in English and Spanish, respectively. Hence, scores reflect the child’s grammatical accomplishments in terms of those skills that have been shown to be characteristic of early acquisition for that particular language (see Jackson-Maldonado et al., 2003, for discussion).

Laboratory sessions
In addition to the CDI and IDHC parent report measures, behavioral language data were also available from a partially overlapping sample from a related study (n = 26). These participants were identified using identical exposure and exclusion criteria and represented a similar range of socioeconomic and language exposure levels as the full sample (see Marchman & Martínez-Sussmann, 2002, for detailed information). Language samples were obtained using two parallel behavioral protocols, one in English and one in Spanish. In each language session, a minimum of 30 minutes of free-play was conducted with a ‘home partner’ and a bilingual RA. All ‘home partners’ were comfortable conversing with the child in that language. A different RA participated in the English and Spanish session for a given child. The order of the sessions was counterbalanced across children and generally occurred about 2 weeks apart. The target language for each session was noted when the appointment was made and upon greeting the participants in the parking lot (e.g. ‘Remember, today we will be speaking English’).

Orthographic transcription of the language samples followed standard protocols (MacWhinney & Snow, 1985, 1990), and were conducted by trained bilingual RAs. As reported in Marchman and Martínez-Sussmann (2002), reliability estimates were obtained by comparing independent transcriptions for a randomly selected sub-sample of the English (5 of 26) and Spanish (5 of 26) sessions. Reliability was computed as the number of matches out of total number of opportunities for agreement per transcript. Prior to resolving discrepancies, reliability coefficients were 88.9% for the English sessions (range = 74.2 to 100.0%) and 97.6% for the Spanish sessions (range = 94.9% to 100.0%). For all discrepancies, the two RAs reviewed the transcripts and video-recordings together and sought to obtain a consensus. If no agreement could be obtained, a third coder resolved the disagreement.

After transcription, each child’s utterances were evaluated as produced in English, Spanish, or a mix of the two languages. Further analyses indicated that language samples from four children contained too few non-imitative utterances in the target language (i.e. English utterances in the English session; Spanish utterances in the Spanish session) to provide stable estimates of production abilities in that language; they were excluded from further analyses. Thus, the analyses presented here included only those 22 children with adequate productive language during the language samples in both English (M = 105.6, SD = 52.0, 45 to 228 utterances) and Spanish (M = 95.6, SD = 43.6, 42 to 203 utterances). Two measures were derived from the samples, parallel to the vocabulary and grammar measures from the parent reports: Number of Different Words produced (NDW) and Mean Length of Utterance in words (MLU-words). To facilitate comparison across the two languages, inflected forms of a given root were treated as separate word forms in the computation of NDW. Mixed-language utterances were excluded from the computation of MLU-words; however, identifiable words in the target language that occurred in mixed utterances were included in counts of NDW.

Results

Language outcomes
Tables 1 and 2 present descriptive statistics for vocabulary and grammar indices from the CDI and IDHC for the full sample (n = 113) and the sub-sample with behavioral data (n = 22). Note that children in the sub-sample were generally demonstrating higher levels of both lexical and grammatical accomplishments than children in the
Table 1  Mean, standard deviation (SD) and range on parent report measures of vocabulary and grammar for full sample (n = 113)

<table>
<thead>
<tr>
<th></th>
<th>Mean (SD)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>English CDI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vocabulary size</td>
<td>124.2 (130.1)</td>
<td>5–638</td>
</tr>
<tr>
<td>Grammatical complexity</td>
<td>2.4 (5.5)</td>
<td>0–25</td>
</tr>
<tr>
<td>M3L-words</td>
<td>2.3 (1.8)</td>
<td>1.0–9.0</td>
</tr>
<tr>
<td>Spanish IDHC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vocabulary size</td>
<td>151.4 (154.9)</td>
<td>6–612</td>
</tr>
<tr>
<td>Grammatical complexity</td>
<td>3.6 (7.1)</td>
<td>0–34</td>
</tr>
<tr>
<td>M3L-words</td>
<td>2.6 (1.4)</td>
<td>1.0–7.0</td>
</tr>
<tr>
<td>Composite CDI/IDHC</td>
<td>230.3 (174.7)</td>
<td>10–687</td>
</tr>
</tbody>
</table>

Table 2  Mean, standard deviation (SD) and range on parent report measures of vocabulary and grammar in children for whom language samples were available in both English and Spanish (n = 22)

<table>
<thead>
<tr>
<th></th>
<th>Mean (SD)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>English CDI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vocabulary size</td>
<td>188.6 (124.3)</td>
<td>24–424</td>
</tr>
<tr>
<td>Grammatical complexity</td>
<td>6.7 (8.4)</td>
<td>0–25</td>
</tr>
<tr>
<td>M3L-words</td>
<td>3.4 (2.2)</td>
<td>1.0–7.3</td>
</tr>
<tr>
<td>Spanish IDHC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vocabulary size</td>
<td>159.1 (159.7)</td>
<td>6–629</td>
</tr>
<tr>
<td>Grammatical complexity</td>
<td>6.4 (11.4)</td>
<td>0–37</td>
</tr>
<tr>
<td>M3L-words</td>
<td>3.4 (2.6)</td>
<td>1.0–12.0</td>
</tr>
<tr>
<td>Composite CDI/IDHC</td>
<td>280.6 (161.1)</td>
<td>39–663</td>
</tr>
</tbody>
</table>

Table 3  Correlations between vocabulary and language outcomes and age, and reported exposure levels for full sample (n = 113)

<table>
<thead>
<tr>
<th></th>
<th>Age (months)</th>
<th>Proportion English to Spanish exposure</th>
</tr>
</thead>
<tbody>
<tr>
<td>English CDI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vocabulary size</td>
<td>.31**</td>
<td>.30**</td>
</tr>
<tr>
<td>Grammatical complexity</td>
<td>.33**</td>
<td>.25*</td>
</tr>
<tr>
<td>M3L-words</td>
<td>.25*</td>
<td>.37**</td>
</tr>
<tr>
<td>Spanish IDHC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vocabulary size</td>
<td>.54**</td>
<td>-.47**</td>
</tr>
<tr>
<td>Grammatical complexity</td>
<td>.50**</td>
<td>-.37**</td>
</tr>
<tr>
<td>M3L-words</td>
<td>.47**</td>
<td>-.35**</td>
</tr>
<tr>
<td>Composite CDI/IDHC</td>
<td>.57**</td>
<td>-.16</td>
</tr>
</tbody>
</table>

Note: * p < .01; ** p < .001.

Table 3 presents correlations between the parent report lexical and grammatical measures in each language and chronological age and proportion of English exposure for the full sample. Not surprisingly, all outcomes are significantly correlated with age, reflecting the fact that older children are more likely to have larger vocabularies and use more complex grammatical constructions than younger children. In addition, vocabulary and grammar outcomes in English were positively correlated with estimates of the proportion of English input that the child received; whereas Spanish-language outcomes were negatively correlated with proportion of English input. Thus, consistent with previous studies, there is a significant relationship between quantitative indices of input to the child and the achievement of English- and Spanish-language milestones (e.g. Pearson et al., 1997). Total conceptual vocabulary, the total number of ideas (or concepts) that children were reported to express regardless of language, was significantly related to age but unrelated to the exposure score. Thus, this language-general measure of lexical progress appears to be independent of the particular language learning environments that these children experience.

Vocabulary–grammar relationships

Following Bates and Goodman (1997) and Caselli et al. (1999), Figures 1 and 2 display reported grammatical complexity (maximum = 37) as a function of reported vocabulary level for English and Spanish, respectively. (Error bars represent standard error at each vocabulary
In comparison to these monolingual populations, we should note that the distribution of children falling into these levels was skewed downward. That is, relatively few children fell into the upper vocabulary levels, with the majority (71% for English; 63% for Spanish) falling into the first three category groupings. Nevertheless, the overall shapes of these functions are similar in the two languages and they share a remarkable resemblance to those previously reported for monolingual children learning English (Figure 2 in Bates & Goodman, 1997) and Italian (Figure 9 in Caselli et al., 1999).

In addition, correlations between vocabulary and grammatical complexity within each language ($r = .74$ and $.79$, for English and Spanish, respectively) are in the same range as those previously reported for monolingual learners. However, as observed in previous studies, there is an early period in which increases in vocabulary size are not met with corresponding increases in grammar. After a certain vocabulary level, grammatical skills move forward as a linear function of vocabulary size. Thus, because of the non-linear nature of these relationships, linear correlation coefficients are likely to underestimate the true strength of association between vocabulary and grammar.

The next series of analyses incorporates both linear and non-linear components in predicting vocabulary–grammar relationships. Figure 3 presents multiple correlation

![Figure 1](image1.png)  
**Figure 1** Grammatical complexity (Mean and Standard Error) as a function of level of reported word production based on the English CDI ($n = 113$).

![Figure 2](image2.png)  
**Figure 2** Grammatical complexity (Mean and Standard Error) as a function of level of reported word production based on the Spanish IDHC ($n = 113$).

![Figure 3](image3.png)  
**Figure 3** Within- and cross-language multiple correlation coefficients ($R$) between vocabulary and grammatical complexity.

*p < .0001
coefficients \((R)\) within and between reported word production and grammatical complexity in English and Spanish for the full sample. Like the linear correlation statistics reported above, these values provide an estimate of degree of association, but do so using linear and nonlinear curve estimation regression models. As expected, within-language vocabulary–grammar estimates of degree of fit using the multiple coefficients were stronger than with the linear coefficients alone.

Looking at the pattern of multiple \(R\)s across the entire set of relationships, note that within-language (cross-domain) associations are substantially stronger than the within-domain (cross-language) relationships. Statistical comparisons of dependent correlations (Bruning & Kintz, 1987) indicated that the number of words a child is reported to know in English is more strongly related to their lexical, \(t(110) = 6.19, p < .01\), or grammatical level, \(t(110) = 8.81, p < .01\), in Spanish. Likewise, reported vocabulary in Spanish is more strongly related to grammatical complexity in Spanish than to either vocabulary size, \(t(110) = 6.96, p < .01\), or grammatical level, \(t(110) = 8.92, p < .01\), in English.

The two parental report measures of grammar (M3L—words and complexity) were significantly intercorrelated within each language \((r = .78\) for English, \(r = .66\) for Spanish). Although the within-language lexical–grammar estimates of association were somewhat weaker using M3L, a similar pattern of results are observed overall. That is, reported English vocabulary was more strongly related to English M3L \((R = .75)\) than to either Spanish vocabulary \((R = .32)\) or reported M3L in Spanish \((R = .07)\). Similarly, Spanish reported vocabulary was more strongly associated with Spanish M3L \((R = .69)\) than with English M3L \((R = .07)\). As above, analyses indicated that the within-language associations were reliably stronger than the between-language associations \((all\ p < .01)\).

The data presented so far suggest that both the strength and overall shape of the function underlying the observed lexical–grammar associations appear to be similar in monolingual and bilingual language learners. However, it is still unclear whether these relationships are attributable to language-general factors that operate outside the specific tasks of learning either words or grammar. That is, are the observed lexical–grammatical relationships attributable primarily to factors that have parallel effects on both lexical and grammatical abilities, for example, age, the amount of exposure to each language and general language learning skill?

A series of multiple regression analyses were conducted in order to evaluate the specificity of the observed relationships between lexical and grammatical outcomes in each language. Looking first at predictors of grammar in English, results indicated that English vocabulary size accounted for significant unique variance \((r^2\text{-change} = 35.8\%, p < .001)\) after age, proportion of English input, and vocabulary size and grammatical complexity score in Spanish were taken into account. In contrast, both age \((r^2\text{-change} = 3.3\%, p < .05)\) and Spanish vocabulary size and complexity \((r^2\text{-change} = 3.0\%, p < .05)\) each contributed only a small, though significant, amount of additional variance to the prediction of English grammar after English vocabulary was taken into account. Proportion of English input made no unique contribution to the prediction of English grammar \((r^2\text{-change} = <.01\%, ns)\).

Similarly, reported vocabulary in Spanish accounted for significant unique variance in Spanish grammar \((r^2\text{-change} = 24.5\%, p < .001)\), over and above general factors (age, proportion of exposure to Spanish, English vocabulary and English complexity). In contrast, none of these general factors contributed any significant unique variance \((all\ r^2\text{-change} < 1\%, ns)\) in Spanish grammar after Spanish vocabulary size was taken into account.

An analogous pattern was observed when general language learning skill was indexed by composite vocabulary score. Recall that the composite vocabulary score reflects an estimate of the number of ‘concepts’ that the child can express regardless of the language used. Although composite vocabulary is strongly correlated with both English \((r = .74)\) and Spanish \((r = .83)\) vocabulary assessed individually, this measure does not contribute unique variance to the prediction of grammatical complexity after the language-specific scores were taken into account. In contrast, for both English and Spanish, language-specific scores contribute significant unique variance \((r^2\text{-change} = 31.6\%\ for\ English;\ r^2\text{-change} = 15.0\%\ for\ Spanish)\ over and above composite vocabulary \((p < .0001)\). Taken together, these analyses suggest that general factors influence progress in language development in both languages; however, there is an independent and more substantial contribution of specific lexical progress in the specific language.

**Are these findings an artifact of reporting?**

It is important to rule out the possibility that these results are a consequence of the particular methodology employed. In most studies using parent report, the form is completed by one parent, most typically the mother. Correlations between lexical and grammatical skill could be inflated because a single reporter is providing information about both skills (i.e. a type of a ‘halo’ effect). For example, a parent who tends to overestimate the number of vocabulary words that their child can produce may also be likely to overestimate his/her grammatical
accomplishments. For children who are learning both English and Spanish, reporter bias remains an issue, but also applies in an additional way. For many bilingual language learners, the individual who is in the best position to report on a child’s language abilities is different for the two languages. Many children in our sample hear English and Spanish in distinct contexts (e.g. Spanish at home and English in day care) and thus, different reporters were selected to complete the CDI and IDHC forms. In these cases, the between-language correlations could be underestimated due to the possibility that different reporters would have differing biases or tendencies.

Additional analyses were conducted comparing those children for whom the same reporter(s) completed the CDI and IDHC (n = 64) versus those for whom different individuals did so (n = 49). If reporter bias was operative, we should see cross-language relationships that are higher in the same reporter versus different reporter groups, reflecting a ‘halo effect’ that spills over from one language to the other. Results indicated modest elevations of cross-language relationships for vocabulary (same: $R = .22$; different: $R = .04$), consistent with a possible halo effect. However, cross-language grammar relationships were equally low in the different ($R = .02$) and the same groups ($R = .03$). In addition, within-language vocabulary–grammar relationships were consistently stronger than any other relationship in both groups for English ($Rs = .57$ and .66) and Spanish ($Rs = .60$ and .65). In general, the results for both reporter groups are virtually identical to those reported in Figure 3, suggesting that the findings are not an artifact of the parent report methodology.

**Vocabulary–grammar relationships in naturalistic language samples**

A similar pattern was seen when lexical and grammatical abilities were measured with behavioral data obtained in the laboratory, rather than with parent report. Using the sample of children for whom free-speech data were available ($n = 22$), Figures 4 and 5 reflect substantial correlations ($r = .71$ and .89, for English and Spanish, respectively) between behavioral measures of lexical and grammatical progress. Further, as indicated in Figure 6, strong and significant multiple correlation coefficients ($R$) are observed between laboratory-based NDW and MLU-words for both English and Spanish; whereas, within-domain relationships were consistently low and substantially weaker (all $p < .01$).

Finally, multiple regression analyses indicated that English NDW was the only unique predictor of English MLU-words, accounting for 37.7% ($p < .001$) of the variance after age, degree of English exposure and Spanish NDW and MLU-words were taken into account. None of these factors contributed unique variance (all $r^2$-change $< 6\%, ns$). Similarly, Spanish NDW uniquely accounted for 48.6% of the variance in Spanish MLU-words; whereas, none of the general factors contributed significant unique variance (all $r^2$-change $< 2\%, ns$). Thus, the overall pattern and specificity of the associations observed in the laboratory data are consistent with the findings in the full sample based on parent report. It should be noted that the correlations in Figure 6 are somewhat higher than those in Figure 3, although the pattern is identical. Because the computation of NDW counted...
inflected forms of root words as separate items, children with more advanced inflectional morphology are credited with higher vocabulary scores. In this way, the vocabulary–grammar correlations are somewhat inflated. However, it is not the absolute level of the correlations that supports the hypothesis of this paper, but rather the difference between within-language, cross-domain correlations and cross-language, within-domain correlations, a difference which is highly consistent in the two analyses.

Discussion

The source of the lexical–grammar relationships that have been consistently observed during the early phases of language learning is a central issue in our understanding of the nature of the language learning faculty. Children who are simultaneously learning both English and Spanish allow us to explore the contribution of language-specific and language-general effects on relationships between lexical and grammatical development. The results of the current study indicated that bilingual language learners display grammatical skills in a given language that are strongly tied to vocabulary growth in that language. At the same time, grammatical outcomes were only weakly related to lexical level or grammatical accomplishments in the other language. Crucially, analyses demonstrated that these relationships were not attributable to general factors that could be seen to influence both lexical and grammatical development in a parallel fashion (e.g. age, amount of exposure to each language and general language learning skill). These results suggest that it is safe to rule out the possibility that the cross-domain correlations observed here and in earlier studies can be explained in terms of only general individual difference factors. Thus, it appears that the mechanisms connecting lexical and grammatical development operate in a highly language-specific manner, even in children who are learning two languages at the same time.

Two additional series of analyses indicated that lexical–grammar associations have not been artificially inflated (relative to lexical–lexical and grammar–grammar) due to the use of the parent report technique. Within-language associations were high and between-language associations were low regardless of whether the same individual(s) completed both the CDI and IDHC. In conjunction with recent demonstrations of the validity of the CDI and IDHC with this population (Marchman & Martinez-Sussmann, 2002), these results suggest that reporters can successfully discriminate accomplishments in the two languages, even when they are asked to report on a single child. Second, behavioral indices indicated similar patterns of within- and across-domain relationships. Although language sample data are not without their own sources of bias, it is reassuring that the behavioral and parent report techniques offered converging evidence regarding the specificity of the associations between lexical and grammatical acquisition in this population. Taken together, these findings indicate that the lexical–grammar links that have been reported here and elsewhere are not a methodological artifact.
The lexical–grammar relationships reflected non-linear patterns of development for both English and Spanish, in spite of the fact that these children were learning English and Spanish to different degrees. The developmental trajectories were strikingly similar to those observed in monolingual children (e.g. Bates & Goodman, 1997; Caselli *et al.*, 1999). Thus, it appears that non-linear lexical–grammar associations are characteristic of a variety of language learning situations, regardless of whether a child is learning one language or two. Further, the acquisition of one language appears to be relatively independent of the degree of proficiency in the other language. These results are consistent with evidence that young bilingual language learners differentiate their languages early in development (e.g. Genesee, Nicoladis & Paradis, 1995), but they do not imply that between-language ‘cross-talk’ is non-existent for these bilingual language learners. Even proficient bilinguals demonstrate cross-language transfer in both lexical–semantics and grammar (e.g. Kilborn & Ito, 1989; Kohnert, Bates & Hernandez, 1999). Young bilingual language learners produce mixed-language utterances (i.e. code-switch) and ‘doublets’ (i.e. translation equivalents) that are systematically related to features of the languages and their contexts of use (Paradis, Nicoladis & Genesee, 2000). Instead, we conclude from these results that bilingual language learners approach the task of learning two languages in ways that are strikingly similar to those learning only one, at least in aspects that are relevant to this important early transition into the onset of grammar. At some level, it must be the case that the mechanisms and/or representational content that underlie lexical and grammatical acquisition are interrelated in the context of learning a particular language, rather than being attributable to general child-based or input factors.

We do not want to imply that general factors have no role to play in lexical or grammatical acquisition. Clearly, degree of exposure to a language must strongly determine outcomes in very basic and important ways (e.g. children who are not exposed to English will not learn either words or grammar in English; children who have more exposure to high quality talk will tend to acquire larger and more varied linguistic knowledge). Indeed, first-order correlations between exposure level and outcomes were similar to those reported in previous studies (Pearson *et al.*, 1997). Further, the results indicated that a significant, albeit small, amount of unique variance is attributable to general measures of how efficiently or effectively a child incorporates the input that they receive, regardless of language. It is certainly possible that the measures used here underestimated the true significance of these effects, relative to the language-specific accomplishments in each language. Alternative ways to index general verbal abilities and exposure levels might have yielded a more substantive role for these general factors than the parent report estimates used in the current study. Future studies should seek to replicate the current findings with different and converging measures. Regardless of what future studies reveal, however, it should be emphasized that the current findings are not incompatible with demonstrations of a strong role for input and child-based influences on particular levels of vocabulary and grammatical accomplishments. Instead, the goal of the current study was to evaluate the theoretically significant claim that the relationship between vocabulary and grammar is best viewed as a language-specific, rather than language-general, phenomenon.

In conclusion, the strength, specificity and shape of lexical–grammar relationships in these bilingual language learners suggest important language-specific continuities in the mechanisms underlying early lexical and grammatical acquisition. In particular, the non-linear relationships observed here and elsewhere are consistent with the view that the mastery of a body of lexical knowledge is a core part of what makes early grammatical acquisition possible. Of course, the current study cannot offer a more specific characterization of precisely how lexical knowledge drives grammar learning (but see Marchman & Bates, 1994; Tomasello, 2001). Further, the cross-sectional nature of the data limits our ability to completely address questions regarding the direction of effects. For example, a longitudinal study by Anisfeld *et al.* (1998) demonstrated that the onset of combinatorial speech was coincident with a burst in vocabulary growth. This finding can be interpreted as evidence for the impact of grammatical analysis on continued acquisition of vocabulary, though it might still be argued that a sufficient lexical base was necessary for the onset of combinatorial speech to occur. In the other direction, and also based on longitudinal data, Dionne, Dale, Boivin and Plomin (2003) concluded that early in children's transition into grammar, the major direction of influence is from lexical to grammatical development, although influences are evident in both directions from 3 to 4 years of age. Clearly more studies using complementary methodologies are needed to provide a more comprehensive account of the dynamic interplay of lexical–grammatical influences as children first move into grammar and beyond. In the meantime, the current findings provide a solid empirical basis for the further development and evaluation of the lexically-based mechanisms that have been proposed to underlie the acquisition of grammar and offer additional support for an integrated view of the language faculty during this important early period of acquisition.

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**References**


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