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A crosslinguistic study of the relationship between grammar and lexical development*

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ABSTRACT

The relationship between grammatical and lexical development was compared in 233 English and 233 Italian children aged between 1;6 and 2;6, matched for age, gender, and vocabulary size on the MacArthur Communicative Development Inventories (CDI). Four different measures of Mean Length of Utterance were applied to the three

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longest utterances reported by parents, and to corrected/expanded versions representing the 'target' for each utterance. Italians had longer MLUs on most measures, but the ratio of actual to target MLUs did not differ between languages. Age and vocabulary both contributed significant variance to MLU, but the contribution of vocabulary was much larger, suggesting that vocabulary size may provide a better basis for crosslinguistic comparisons of grammatical development. The relationship between MLU and vocabulary size was non-linear in English but linear in Italian, suggesting that grammar 'gets off the ground' earlier in a richly inflected language. A possible mechanism to account for this difference is discussed.

INTRODUCTION

Crosslinguistic studies have played a central role in child language research for decades (Braine, 1976; Slobin, 1985, 1992, 1997; MacWhinney & Bates, 1989; Choi & Bowerman, 1991; Berman & Slobin, 1994; Bates, Devescovi & Wulfeck, 2001; Bowerman & Choi, 2001). As Slobin has pointed out repeatedly in his own pioneering work on the topic, this is the research strategy that stands the best chance of helping us to disentangle universal versus language-specific phenomena in language development. Through such studies, we have learned that children commit surprisingly few errors in the course of language learning (although the errors they do produce are quite informative (Slobin, 1985), that the content or concepts that 1–2-year-olds try to express are remarkably similar from one language to another (negation, possession, location, disappearance, etc. (Braine, 1976), but that variations in the forms used by very young children to express these concepts are strikingly different from one language to another (Demuth, 1990; Fortescue & Lennert Olsen, 1992). All these phenomena suggest that children are conservative, 'sticking to their input' as they figure out how to express a common stock of ideas, and some language-specific ideas as well (Choi & Bowerman, 1991; Bowerman & Choi, 2001).

Despite these admirable advances in our understanding, serious methodological problems remain that are acknowledged by virtually all researchers who engage in crosslinguistic research. One of the most vexing problems is the establishment of equivalence between samples of children: when children from different language groups are compared to unveil similarities and differences, how shall they be matched? The simplest strategy is to match children by age, e.g. comparing the speech produced by Italians at 2;0 with the speech produced by children acquiring English at 2;0. However, the variation that can be observed within any given language in this age range is so vast (e.g. children at 2;0 can have virtually no speech at all, or they can display complex syntax with vocabularies of more

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than 600 words (Dromi, 1987; Ogura, Yamashita, Murase & Dale, 1993; Fenson, Dale, Reznick, Bates, Thal & Pethick, 1994; Caselli, Bates, Casadio, Fenson, Fenson, Sanderl & Weir, 1995; Caselli, Casadio & Bates, 1999; Maital, Dromi, Sagi & Bornstein, 2000) that this strategy is necessarily risky. This is especially true when the samples in question are small (as is often the case in detailed longitudinal studies of free speech). In many years of comparative research on early language, attempts have been made to match children based on length of utterance in content words or total words. However (as we shall also see below), this strategy does not guarantee a match in language level, since languages can vary in their 'wordiness' (e.g. the difference between languages that do and do not permit omission of subjects and sometimes also objects in free-standing declarative sentences; variations over languages in the obligatory status of articles and other functors). Attempts have also been made to match based on mean length of utterance in morphemes, but this strategy raises a host of definitional issues around which no consensus has emerged, as evidenced by a lively exchange on the Info-Childes mailing list (*info-childes@mail.talkbank.org*, as archived at *http://linguistlist.org*). Indeed, the most successful and thorough efforts have typically been tailored to individual languages, with no attempt to generalize across languages (e.g. Dromi & Berman, 1982).

In the present study, we will illustrate an alternative approach to the issue of cross-language matching. Recent studies have shown that, within a single language, vocabulary size is a more powerful predictor of grammatical development than age or gender, contributing significant variance to measures of grammar after age and gender are controlled (Marchman & Bates, 1994; Bates & Goodman, 1997; Dale, Dionne, Eley & Plomin, 2000). Studies in Italian, Japanese, Spanish and Hebrew have illustrated the same point (Jackson-Maldonado, Thal, Marchman, Bates & Gutierrez-Clellen, 1993; Ogura *et al.*, 1993; Caselli *et al.*, 1999; Maital *et al.*, 2000). Taking advantage of this finding, we used the large norming data bases for the MacArthur Communicative Development Inventories in two languages, English and Italian, to explore grammatical development and the relationship between vocabulary and grammar (controlling for age and gender as well). To obtain estimates of structural complexity under different coding schemes, we compared the three longest utterances reported by parents for 466 children (233 Italian; 233 English), matched for age, gender, and vocabulary size on the MacArthur Communicative Inventories for each language. For each reported utterance, a corrected version is constructed in which errors are corrected and (by conservative criteria) obligatory elements are restored (e.g. from 'Kitty sleeping' to 'The kitty is sleeping'). This will permit us to compare the distance between actual and 'target' (attempted) constructions in each language. Four different measures of utterance length are applied to each actual and expanded utterance, yielding

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eight averages (MLUs) for each child. The four measures are designed to represent a continuum from a conservative estimate that should differ minimally over languages (MLU in content words) to increasing rich and complex measures of bound morphology. We want to stress that the set of possible morphological coding schemes is potentially infinite, and there is (as noted) no consensus on the 'right' measure to use across languages. We have designed two morphological coding schemes that are likely to reveal language differences. Both favour Italian (e.g. credit for gender agreement on modifiers, and multiple aspects of verb morphology that are marked in Italian but not in English), but one allows for multiple contrasts in pronoun choice that are marked in both languages and may help English to 'catch up'.

The present study builds on two previous crosslinguistic studies by our research group comparing results from the CDI norming data for English and Italian.

The first of these (Caselli *et al.*, 1995) focused on both expressive and receptive vocabulary in the period from 0;8 to 1;4, prior to the onset of grammar. We examined the relative proportions of nouns, predicates (verbs and adjectives), social words (games, routines, proper names) and function words at different ages, and at different levels of expressive and receptive vocabulary size. Similarities between languages far outweighed differences in this age range when children were matched for total vocabulary size, including early predominance of common nouns and later appearance of verbs and other predicates. However, we did find that Italian children use a higher proportion of social words across this range of development compared with American children acquiring English, reflecting cultural differences (including the tendency for extended families to live in the same city in Italy).

The second study (Caselli *et al.*, 1999) focused on both expressive vocabulary and grammar in the period from 1;6 to 2;6. Grammatical development was assessed with a 37-item complexity scale comprising pairs of sentences that vary in degree of complexity (e.g. 'Kitty sleeping' versus 'Kitty is sleeping'). Parents were asked to check the sentence within each pair that 'sounds more like the way that your child is talking right now.' Previous studies (Dale, Bates, Reznick & Morisset, 1989; Dale & Cole, 1991; Jackson-Maldonado *et al.*, 1993; Marchman & Bates, 1994) have shown that this measure of grammatical complexity is highly correlated with Mean Length of Utterance in Morphemes based on free-speech samples. When children were matched over languages for overall vocabulary size, Caselli *et al.* confirmed an early predominance of common nouns and later onset of predicates, with no significant differences between languages in proportions of nouns or verbs at any point from 1;6 to 2;6. However, they continued to observe (as they had at a younger stage) higher

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proportions of social words in the Italian sample. There were also interesting differences in the shape of development for function words as a proportion of total vocabulary, reflecting continuous linear change in Italian from 50–600+ words, versus non-linear growth in English (i.e. no change in proportions of function words from 0–400 words, but a marked acceleration after 400 words).

Caselli *et al*. (1999) found no differences between English and Italian on the grammatical complexity scale when total vocabulary was controlled. Indeed, the shape of the strong non-linear growth function connecting grammatical complexity to total vocabulary size was identical in the two languages. This may seem rather surprising, given known differences between these two languages in richness of inflectional morphology. However, the authors note that the complexity scales themselves are designed to discourage quantitative differences in the growth of grammar between these two languages, because the scales in both languages each contain exactly 37 items, designed to reflect grammatical structures that are known to occur in that language between 1;6 and 2;6. To underscore this point, Caselli *et al*. presented some informal examples of the longest utterances reported by parents in a separate part of the CDI. When English and Italian children were matched for total vocabulary size, there appeared to be a marked advantage in grammatical complexity for the Italian children, in accord with the well-known differences in complexity between these two languages.

The present study builds on the prior two by focusing in much more detail on the three longest utterances reported by the parents of American and Italian children between 1;6 and 2;6. We acknowledge from the outset that there is no substitute for 'live' measures of free speech of the sort that are obtained in small-sample studies, and we present our conclusions as working hypotheses for future studies using videotaped observations. However, we believe that results of the present study are provocative, and of sufficient heuristic value to merit consideration despite the limits of parental recall regarding the three longest utterances recently produced by their infants. Using this methodology, we will address the following questions.

(1) Within and across the four different measures of structural complexity, will vocabulary account for more developmental variance than chronological age?
(2) When age, gender and vocabulary size are controlled, will there be differences between Italian and English speaking children in structural complexity, reflecting the greater morphological complexity of Italian compared with English? And if so, will this difference be observed only on MLU in morphemes, or will we find crosslinguistic differences in MLU measured in total words and/or content words?

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(3) Following on earlier reports by Caselli *et al.* (1999) for growth in function words, will we find differences between English and Italian in the shape of change, reflected in non-linear growth patterns for English (initially flat growth with subsequent acceleration) and linear patterns for Italian? And will these trajectories be affected by the coding system adopted?

(4) When growth in structural complexity is evaluated in terms of the ratio of 'complexity obtained' (the actual utterance) versus 'complexity attempted' (the expanded/corrected versions), will there be developmental and/or crosslinguistic differences in the proportion of attempted utterances that children are able to realize in their reported speech? Will we find a greater gap between actual and attempted speech in the richer inflectional system of Italian, at least in the early stages, and might this be revealed by different coding systems? Or will we see that children in each language are able to express roughly the same proportion of their targets within and across levels of development, suggesting some kind of developmental constant in the distance between effort and success (i.e. a kind of linguistic 'zone of proximal development')?

METHOD

Participants

Participants were the parents of 466 children aged between 1;6 and 2;6, 233 in each language, 120 females and 113 males in each language, with reported expressive vocabularies on the MacArthur CDI ranging from 50 to 680 words. The children were selected from larger norming samples for each language (Fenson *et al.*, 1994; Caselli & Casadio, 1995), including 618 Americans and 304 Italians for whom parents had completed the Three Longest Utterances section of the CDI. To match children for the purposes of the present study, we eliminated all children with vocabularies under 50 words (on the assumption, confirmed by direct inspection, that any word combinations reported by parents were likely to be frozen phrases). Because there were more American than Italian children in the norming samples, we took the Italian children as the basis for comparison and sought, for each child, an American child of the same chronological age in months, gender, and approximate vocabulary size. This yielded the set of 233 children per language used for all analyses below. A two-tailed *t*-test confirmed that the two samples did not differ significantly in vocabulary size after matching.

Groupings for analyses over age were determined on the basis of chronological age in months (at 1;6 at 1;7, etc.). Groupings for analyses over vocabulary size followed precedents from our previous studies, as

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follows (eliminating children with vocabularies under 50 words): 50–100 words; 101–200 words; 201–300 words; 301–400 words; 401–500 words; 501–600 words; >600 words.

Materials

Data for the English sample are based on the CDI: Words and Sentences (Fenson, Dale, Reznick, Thal, Bates, Hartung, Pethick & Reilly, 1993; Fenson *et al.*, 1994), designed for use with children in the 1;4–2;6-year age. This scale includes a 680-word vocabulary production checklist, organized into 22 semantic categories (for details, see Fenson *et al.*, 1993, 1994). Data for the Italian sample are based on the Words and Sentences Scale for the Italian version of the MacArthur CDI (Caselli & Casadio, 1995). For the Italian version of this scale, norms are available between 1;6 and 2;6. The Italian word production checklist contains 670 items, organized into 23 semantic categories. The English and Italian versions of the CDI both contain several different subscales designed to measure aspects of grammatical development, e.g. the grammatical complexity checklist based on pairs of sentences that vary in structural complexity. The grammar section of the CDI also has a final section: three lines were provided where parents were asked 'Please list three of the longest sentences you have heard your child say recently' (on the grounds that these would be sufficiently striking events to have acceptable validity, similar to diary studies). This longest-utterance section furnished the speech samples analysed in the present study. Because of the lack of informations about intonative cues, pauses and dialogical patterns, in our analyses we considered a sequence of words reported by the parents on a given line to be an utterance.

Coding

Clean-up. Prior to coding the longest utterances reported by each parent, we first eliminated all utterances that were partially unintelligible, or were obviously frozen phrases (taken from songs, prayers, counting, and other formulae). There were also instances in which parents failed to write down three separate utterances. For those cases, and for those in which items had to be eliminated, all averages are based on the total number of utterances available. For 82·8% of the children, averages were based on three utterances. For 12·9%, averages were based on two utterances, and for a small number of cases (4·3%) only a single novel utterance was available for coding after frozen and/or partially unintelligible forms were removed.

MLU coding schemes. Four different coding schemes for mean length of utterance were applied to these data: in total content words, in total

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words (both content and function words), in a conservative count of total morphemes (treating pronouns as single uninflected lexical forms), and in an expanded count of total morphemes (evaluating proforms along multiple dimensions).

The distinction between total words and total content words is not straightforward. In fact, there is no consensus on the categorization of items into content versus function words, and there are also cases in which the boundary of a single word is in question. To assure inter-rater reliability over languages, a series of rules were written to define content words and function words. For example, compound proper names (e.g. 'Santa Claus') were treated as a single content word, but proper names that involve a potentially productive element (e.g. 'Uncle Charlie', 'Uncle Fred') were treated as two content words. Pronouns, articles and quantifiers, prepositions, copulae and auxiliary verbs were treated as function words. Modal verbs were treated as content words if they served as the main verb (e.g. 'I want ice cream') but as function words if they served as modals with another verb (e.g. 'I want go'). Elided forms (e.g. 'She'll' in English, or 'della' in Italian) were unpacked into two separate words (e.g. 'She will' in English, and 'di la' in Italian) prior to coding. A handful of high-frequency adverbial and adjectival forms (e.g. 'very') were treated as function words, with classifications made by agreement between raters.

Matters become more complex as we moved from word counts to morpheme counts. We began by attempting to construct a coding scheme that did not require assumption of any specific form as the unmarked form. Briefly put, this effort failed, both within and between languages. Therefore, for each language, we established the unmarked forms for nouns, verbs, modifiers and (for the enriched pronoun count) pronominal forms. If the child produced the unmarked form only, a single morpheme was credited. For each marked contrast added to the item, an additional morpheme was credited (for more details see the examples reported below and the Appendix 1).

For the conservative count of MLU in morphemes, rules were established that necessarily differ for English and Italian. English has a zero form for all nouns and verbs, which we chose as the unmarked form in all cases. This decision is further justified by the fact that English children tend to begin with the unmarked form of nouns and verbs in their early speech (with some interesting item-based exceptions (Bloom, Lightbown & Hood, 1975; Tomasello, 1992), and singular before plural for both nouns and pronouns (Brown, 1973). As is well known, there are relatively few morphemes marking grammatical inflection that can be added in English, consisting almost entirely of plurals on nouns, and a handful of contrasts on verbs that are mutually exclusive (past tense, participial, third person singular, progressive). By contrast, Italian has no zero form for

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nouns or verbs. The singular-plural contrast for nouns is marked syncretically (e.g. singular for boy is 'ragazzo' while the plural is 'ragazzi'). Verb markings are also syncretic rather than agglutinative, but several separate contrasts can be marked simultaneously (e.g. 'he/she eats'='mangia'; 'they will eat'='mangeranno'; 'I used to eat'='mangiavo'). In light of these facts, we considered the following forms to be unmarked: (a) the singular forms for all lexical items; (b) the third person singular of the indicative present tense for verbs; and (c) the nominal singular forms for pronouns (only in the expanded count). This decision is supported by the fact that the forms chosen as unmarked in this coding system for Italian appear earlier in child language (Pizzuto & Caselli, 1992; Caselli, Leonard, Volterra & Campagnoli, 1993; Leonard, Caselli & Devescovi, 2002).

- For nouns in both languages:
  *book/libr-**o*** unmarked =singular →no additional points
  *book-**s**/libr-**i*** marked =plural →one additional point
- For verbs in English (e.g. to eat/mangiare):
  eat unmarked =zero form →no additional points
  *eat-**s*** marked =any non-zero form →one additional point
  (i.e. 3 rd person singular, progressive, past tense)
- For verbs in Italian (e.g. mangiare/to eat):
  *mangi-**a*** unmarked =3rd person singular present
  →no additional points
  *mangi-**o**/**i*** marked =1st or 2nd person
  →one additional point
  *mangi-**amo/ate/ano*** =1st, 2nd or 3rd person plural
  →one additional point
  *mangi-**ava**/mangi-**ato*** =any tense/aspect other than simple present
  →one additional point
- For modifiers in Italian (e.g. buono/good):
  buon-**o/a** unmarked =singular
  → no additional points
  buon-**i/e** marked =plural
  → one additional point
  tort-**a** buon-a gender agreement (masc. or fem., modifiers only)
  → one additional point

For the conservative count, all pronouns (except modifiers) were treated as single morphemes. By contrast, for the enriched/expanded count we also attempted to give credit for marked morphological dimensions on all proforms. This coding scheme will necessarily result in longer estimates

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than the conservative count, because it is cumulative. However, because English and Italian tend to indicate the same contrasts on pronouns through lexical choice, this coding scheme provides an opportunity for English children to 'catch up' to some extent with their Italian peers. Stemming from developmental studies (Pizzuto & Caselli, 1992) the assumed unmarked proform was a nominative singular third-person pronoun in both languages. One additional point each was given for first- or second-person pronouns, for plural pronouns, and for any deviations from nominative case (accusative, genitive, dative).

For pronouns in both languages:

he/lui	unmarked	= singular	→ no additional points
we/noi	marked	= plural	→ one additional point
your/tuo	marked	= 2nd person + genitive	
→ two additional points			
yours/vostri	marked	= 2nd person + plural + genitive	
→ three additional points			

Hence the count for a single pronoun could range from one ('he' in English, 'lui' in Italian – nominative singular third person-) to four (e.g. 'ours' in English, 'nostri' in Italian).

Observed versus expanded utterances

Prior to the application of the above coding schemes, all utterances were written in two forms: that original form reported by the parent, and a form that was conservatively expanded/corrected to restore grammaticality, if necessary. So, for example, if a parent reported 'Kitty sleeping', the expanded form would be 'The kitty is sleeping.' We will refer to these two forms as 'observed' and 'attempted', respectively, on the assumption that the corrected form represents the child's target, whereas the observed form represents that portion of the target that the child was able to realize in his/her speech. The four coding schemes described above were applied to both the observed and attempted form of every utterance, resulting in eight scores for each child, plus an additional four scores representing the ratio of observed to attempted for each coding scheme. To illustrate the latter, the ratio of 'Kitty sleeping' to 'The kitty is sleeping' would be 2/4 (50%) in total words and 3/5 (60%) in total morphemes by the conservative count. The idea behind the corrected codings was to assess, for each coding scheme and for each language, whether there are developmental or cross-linguistic changes in the proportion of their presumed target utterances that children are able to produce.

Appendix I provides examples of observed and expanded utterances at each vocabulary level, for each language. For each of these utterances,

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illustrative scores are provided in Appendix I for each utterance, for each of the four coding schemes.

RESULTS AND DISCUSSION

As we reported above, previous studies on English speaking children have demonstrated a strong correlation between MLU rising from the three longest sentences reported by parents and the grammatical complexity subscale of the CDI (Fenson *et al.*, 1994), as well as with MLU in free speech (Dale & Cole, 1991). However, similar data for Italian children are not available in the literature. To verify the existence of a similar relationship between MLU obtained from the CDI and from free speech, we computed correlations between MLU in free speech and MLU in the three longest sentences reported by parents on the CDI in a sample of 11 children extracted from the larger sample using all four of the coding schemes developed for this study (see below). There was a positive (but nonsignificant) correlation between MLU in content words on the CDI and in free speech ($r = 0{\cdot}33$, ns.), and strong, positive correlations between MLU in total words ($r = 0{\cdot}93$, $p = 0{\cdot}00$), and MLU in total morphemes (conservative, $r = 0{\cdot}77$, $p = 0{\cdot}006$; expanded, $r = 0{\cdot}78$, $p = 0{\cdot}005$) on the CDI and in free speech.

Results will be presented in an order that reflects the four main questions posed in the introduction.

(*1*) *Does vocabulary predict growth better than age?*

We first addressed this question with two omnibus mixed analyses of variance: one for language × age group × coding scheme, with age and language as between-subjects variables and coding scheme as a within-subjects variable; another for language × vocabulary size × coding scheme, with age and vocabulary size between-subjects and coding scheme within-subjects. All within-subjects effects are Greenhouse-Geiser corrected.

In the analysis over age, there were significant main effects of all three variables (language, $F(1, 440) = 8{\cdot}58$, $p < 0{\cdot}004$; age, $F(12, 440) = 13{\cdot}99$, $p < 0{\cdot}0001$; coding scheme, $F(3, 1320) = 456{\cdot}28$, $p < 0{\cdot}0001$). The coding scheme effect was inevitable, given the cumulative nature of the four measures, and the age effect reflects an unsurprising increase in complexity with age. The language effect reflects an overall better performance for Italian. In addition, there were two significant two-way interactions: code × language ($F(3, 1320) = 19{\cdot}81$, $p < 0{\cdot}0001$) and code × age ($F(36, 1320) = 11{\cdot}22$, $p < 0{\cdot}0001$). The code × language interaction reflects a larger Italian superiority on the coding schemes that tap into morphological complexity. The code × age interaction reflects bigger gains over time for the coding schemes that involve inflections and function words. There was no language × age interaction ($F < 1{\cdot}0$), nor did the three-way interaction reach

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significance, indicating that age effects are parallel for English and Italian, despite the overall Italian advantage in morphology. Although the three-way interaction did not reach significance, age × coding scheme effects are plotted separately for English and Italian in Figures 1a–b, so that readers can more easily examine the shape of developmental effects involving age, and compare them with the vocabulary size effects below.

In the corresponding analysis of language × vocabulary level × coding scheme, all three main effects again reached significance (language, $F(1,452) = 14{\cdot}38$, $p < 0{\cdot}0001$; vocabulary level, $F(6, 452) = 56{\cdot}40$, $p < 0{\cdot}0001$; code, $(3,1356) = 1035{\cdot}2;0$, $p < 0{\cdot}0001$), all in the predicted directions. There was no significant language × vocabulary interaction ($F(6{\cdot}452) = 1{\cdot}51$, n.s.), indicating that changes tended to occur in parallel across the two languages when conflating over coding schemes. However, there were significant two-way interactions of code × language ($F(3, 1356) = 39{\cdot}81$, $p < 0{\cdot}0001$) and code × vocabulary level ($F(18, 1356) = 46{\cdot}79$, $p < 0{\cdot}0001$), as well as a significant 3-way interaction ($F(18, 1356) = 2{\cdot}10$, $p < 0{\cdot}04$). To illustrate these effects, the code × vocabulary level interactions are plotted separately for English and Italian in Figures 2a–b. In general, growth appeared to start earlier in Italian for the measures involving inflections and function words. The conservative morpheme measure (pronouns treated as whole forms) and the expanded morpheme measure (pronouns scores on multiple dimensions) appeared to differ more for English, whereas the conservative morpheme measure and the measure in total words appeared to differ more for Italian. More detailed explorations of all these effects follow below, when we investigate the shape of developmental and crosslanguage effects within each coding scheme.

Comparing Figures 1a–b for age and 2a–b for vocabulary size, it is evident at a glance that results are far more regular and lawful when developmental effects are plotted as a function of vocabulary size. To investigate this more directly, with an emphasis on finding out which of these developmental predictors does a better job, we repeated the above two omnibus analyses, covarying out the effects of vocabulary in the analysis over age, and then covarying out the effects of age in the analysis over vocabulary levels. When age effects were covaried out, the three-way relationship of language × vocabulary × coding scheme remained significant ($F(18, 1353) = 2{\cdot}08$, $p < 0{\cdot}04$), and the main effect of vocabulary size remained strong ($F(6, 451) = 30{\cdot}53$, $p < 0{\cdot}0001$). In the corresponding analysis over age with vocabulary size (total number of words) covaried out, the 3-way interaction still failed to reach significance ($F(36, 1370) < 1{\cdot}0$, n.s.), and although the main effect of age remained significant ($F(12, 439) = 3{\cdot}67$, $p < 0{\cdot}0001$), it was relatively weak.

In a final look at the relative predictive value of these two developmental measures, we also conducted regression analyses within each coding

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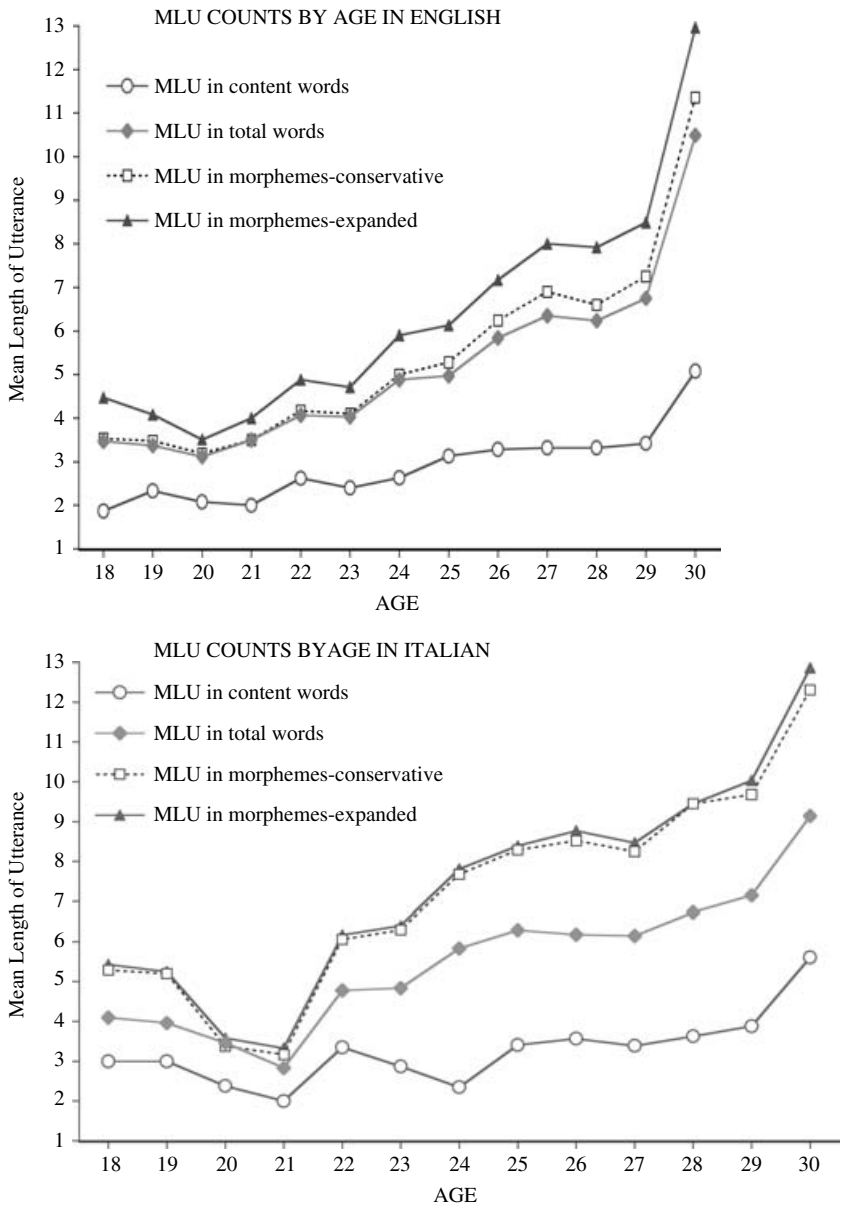


Fig. 1. MLU coding schemes over age levels in (a) English; (b) Italian.

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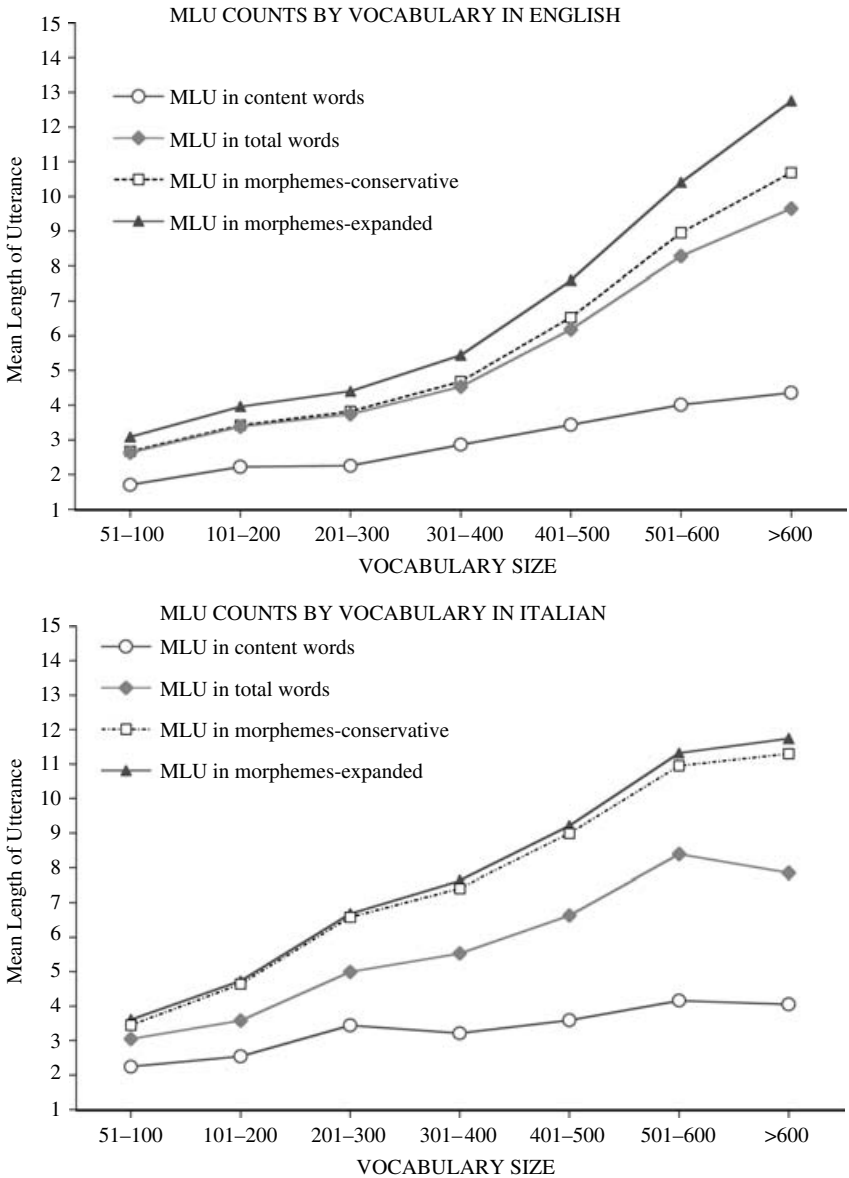


Fig. 2. MLU coding schemes over vocabulary levels in (a) English; (b)Italian.

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TABLE 1. *Joint and unique effects of age, vocabulary size and language on four coding schemes*

MLU in	Total variance accounted for	Percent unique variance due to		
		Language	Age	Vocabulary
Content words	28·8%***	+2·1%***	+1·5%**	+12·7%***
Total words	43·9%***	+0·7%*	+2·4%***	+20·5%***
Conservative morpheme count	48·5%***	+7·7%***	+2·3%***	+19·5%***
Expanded morpheme count	46·9%***	+2·9%***	+2·5%***	+20·9%***

scheme, using age, vocabulary size (in total words) as well as language as predictors. Results are summarized in Table 1. In all four analyses, the joint variance accounted for by the three predictors was significant ($p < 0{\cdot}0001$), ranging from a low of 28·8% of the developmental variance for MLU in content words, to a high of 48·5% (almost half the variance) for the conservative measure of MLU in morphemes. In all four analyses, significant unique contributions were observed for all three predictors when the other two were controlled. However, in every case, vocabulary accounted for more than five times the amount of unique variance explained by age.

To summarize, chronological age and vocabulary size are both effective developmental predictors, and they are partially independent in the variance that they explain. But vocabulary size is clearly a much stronger predictor than age for all our measures of complexity.

In all remaining analyses, we will concentrate on changes over vocabulary levels rather than age, to learn more about crosslinguistic differences in the nature and shape of changes in structural complexity.

(2) *How do structural complexity of children's utterances reflects language differences?*

The omnibus analyses suggest that Italian children display higher scores in structural complexity, conflating across coding schemes. Furthermore, language interacts with coding scheme, suggesting that the Italian performance may be greater for measures involving inflectional morphology. To explore these crosslinguistic differences in more detail, we conducted separate language × vocabulary analyses of variance for each of the four coding schemes, with both language and vocabulary serving as between-subjects variables. To simplify the text, statistical details of these analyses are presented in Table 2. Briefly summarized, significant main effects of vocabulary size were observed for all four measures, in the predicted direction. Main effects of language favouring Italian were observed on

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TABLE 2. *Statistical results of language by vocabulary analyses of variance for each coding scheme*

	Effects of		
Coding schemes	Language $F(1, 452)$ =	Vocabulary $F(6, 452)$ =	Lang. × Voc. $F(6, 452)$ =
MLU content words	8·50, $p < 0.004$	26·19, $p < 0·0001$	2·22, $p < 0·05$
MLU total words	1·06, n.s.	55·85, $p < 0·0001$	1·95, $p < 0·08$
MLU-conservative	39·35, $p < 0·0001$	55·07, $p < 0·0001$	1·33, n.s.
MLU-expanded	11·41, $p < 0.001$	58·26, $p < 0·0001$	1·57, n.s.

the two measures involving morphological complexity. However, only one of the four coding schemes yielded a significant language × vocabulary interaction, and that was (to our surprise) mean length of utterance in content words. For the other three, the presence or absence of a differing performance in Italian appears to be a statistical constant across levels of vocabulary.

Although the language × vocabulary interactions were non-significant in three out of four cases, for purposes of comparison, Figures 3a–d illustrate crosslinguistic differences across vocabulary levels for each of the four coding schemes. In addition, asterisks indicate whether, in planned two-tailed *t*-tests, the language difference reached significance within each vocabulary level (a tilde indicates a trend at $p < 0·10$). Except for the content word coding scheme, *post hoc* results reflecting a higher score for Italian children were generally significant in the middle range of development, where the shape of change is most different for English and Italian (see analyses of shape, below). This was true even for the measure of MLU in total words, which did not yield an overall main effect of language. All *post hoc* tests failed to reach significance at the highest level (>600 words), a result that probably reflects ceiling effects that will be discussed later.

To summarize, as expected higher scores in structural complexity are evident in Italian children in all coding systems used. Using the MLU content-word measure, the difference between the two languages reached significance at 300 words; for all other measures, the Italian children have higher scores in the middle range of development.

The content word effect merits further exploration, because both its existence and shape are unexpected (Figure 3a). Why should there be any difference between English and Italian in Mean Length of Utterance in content words? And why should this effect be restricted entirely to children at the earlier stages of vocabulary development, from 50 to 300 words (a distribution that is responsible for our only significant

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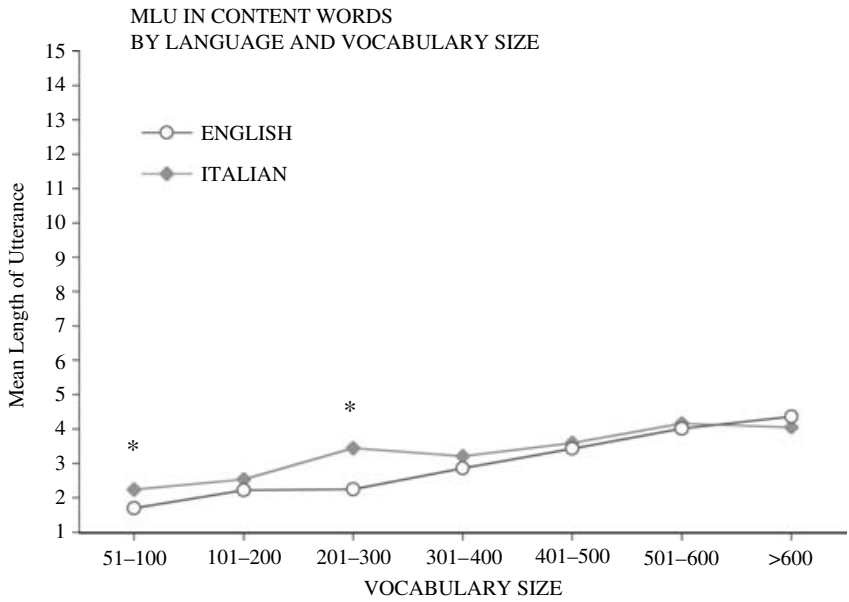
language × vocabulary interaction)? We entertained two hypotheses that might explain the early Italian higher score for length in content words:

(1) Italian children tend to have a higher proportion of social words, and therefore may produce more utterances containing proper names, especially at the earlier stages of development. This would inflate the content word count.
(2) Italian is a pro-drop language in which the subject can be omitted from free-standing declarative sentences. When the subject is included, it tends to be new information, typically expressed with a noun rather than a pronoun. By contrast, English is a language in which the subject is obligatory in free-standing declarative sentences. Therefore it is more common to find sentences with pronominal subjects, a factor that might decrease the overall length of utterances in content words.

In pursuit of the first hypothesis, we reanalysed all of the utterances produced by children in the first three vocabulary levels, and coded them for the number of proper nouns that they contained. We then calculated a simple proportion score reflecting number of proper nouns divided by number of utterances. A two-tailed t-test comparing means for English (67·1%) and Italian (88·9%) was significant ($t(170) = -2{\cdot}82$, $p < 0{\cdot}005$). This finding is consistent with the social-word hypothesis, but it would also be consistent with the hypothesis that Italians produce fewer sentences with pronominal subjects. To determine whether the enhanced presence of proper nouns was sufficient to explain the Italian higher score in MLU in content words, we repeated the language × vocabulary level analysis of variance just for those children at the first three levels, covarying out proper-noun proportion scores. The presence of the covariate did not eliminate the Italian advantage, reflected in a persistent significant main effect of language ($F(1, 165) = 17{\cdot}73$, $p < 0{\cdot}0001$), and a significant language × vocabulary interaction ($F(2, 165) = 6{\cdot}63$, $p < 0{\cdot}0001$), reflecting growth in the magnitude of the performance difference over these early levels. These results suggest that enhanced presence of proper nouns is not sufficient to explain the Italian higher score in the content word count.

Turning to the nominal/pronominal-subject hypothesis, we again recoded all utterances for children at the first three vocabulary levels, coding the subject of the sentence (if one was present) as nominal or pronominal. These were used to construct two simple proportion scores: mean number of pronominal subjects per utterance, and mean number of nominal subjects per utterance. These ratios were quite different for English and Italian. For pronominal subjects, the mean ratio for English-speaking children was 23·6%, compared with 5·4% for Italian, significantly different by a two-tailed t-test ($t(170) = 4{\cdot}95$, $p < 0{\cdot}0001$). For nominal subjects, the mean ratio

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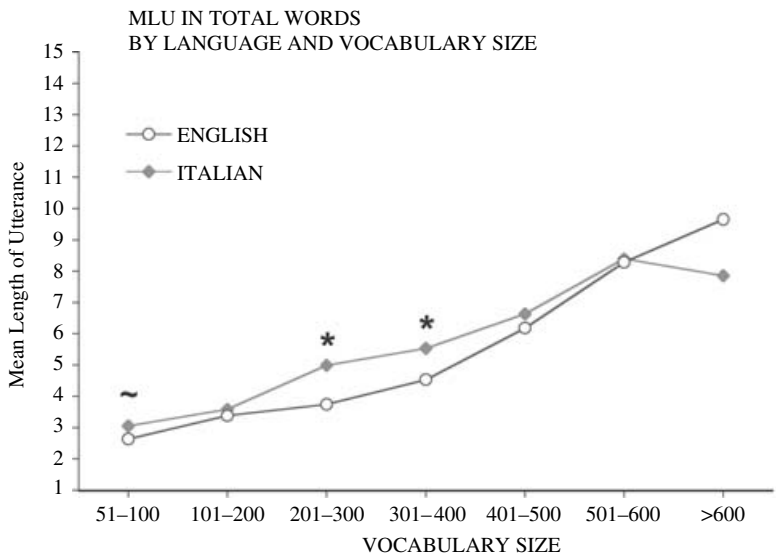


Fig. 3. (*Contd.*)

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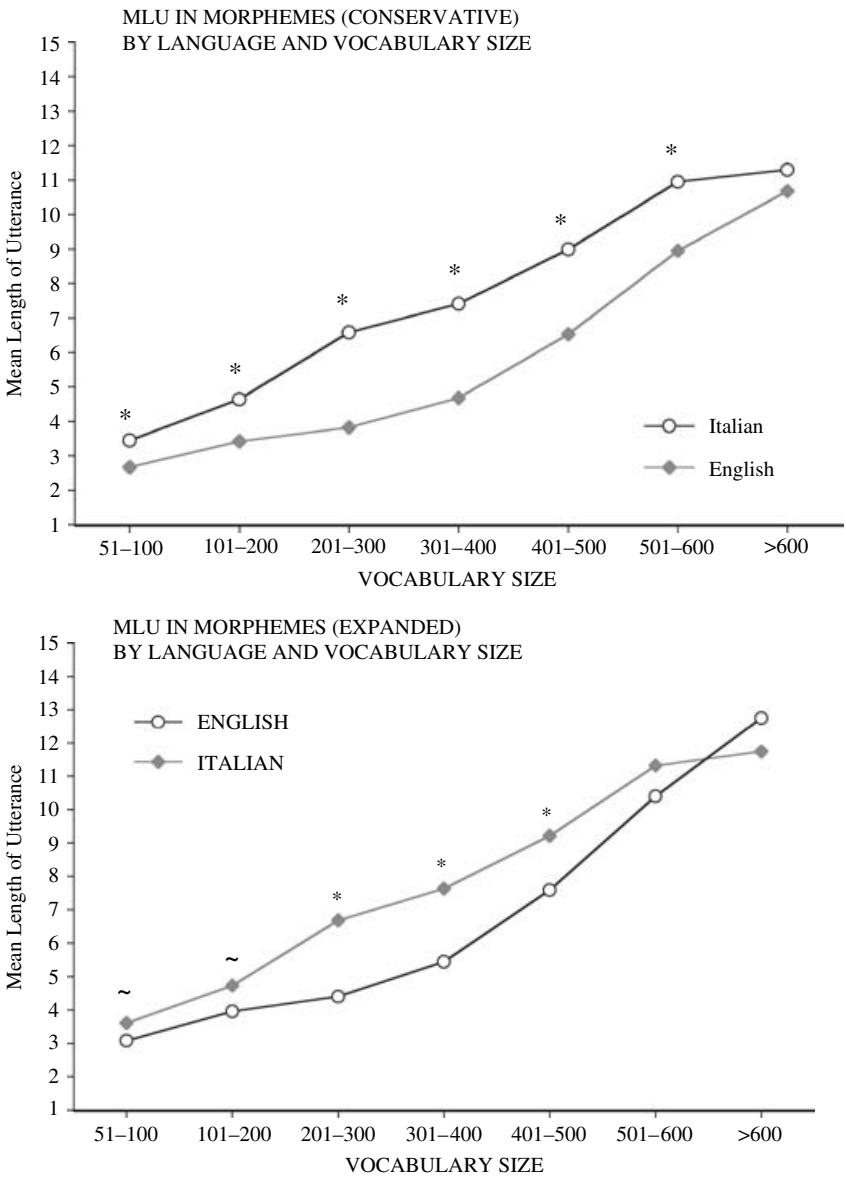


Fig. 3. Language by vocabulary level for MLU in (a) content words; (b) total words; (c) morphemes (conservative count); (d) morphemes (expanded count).

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for English speaking children was 39%, compared with 69·3% for Italians, again significantly different by a two-tailed *t*-test ($t(170) = -4{\cdot}27$, $p < 0{\cdot}0001$). To determine whether this clear difference in subject type might be responsible for the Italian score in content words, we repeated the language × vocabulary level analysis of variance just over the first three levels, covarying out nominal subject proportion scores. This covariate did not manage to knock out the Italian score in content words. There was still a significant main effect of language ($F(1, 165) = 10{\cdot}63$, $p < 0{\cdot}001$), and a significant language × vocabulary interaction ($F(2, 165) = 3{\cdot}17$, $p < 0{\cdot}05$), reflecting slight growth in the Italian score from 50 to 300 words. We repeated the analysis covarying on pronominal rather than nominal subjects, and the same results obtained.

We may conclude that greater use of social words and greater use of nominal subjects both contribute to the Italian increased scores in mean length in content words, but neither of these hypotheses is wholly responsible for the effect. Hence, even controlling for these known language differences, Italians have a temporary greater utterance length even by a conservative measure that eliminates their known greater competence in inflectional morphology. This appears to be true even in a study like the present one, in which children are matched for age, gender and vocabulary size.

(*3*) *Does the shape of change differ in English and Italian?*

In an earlier study of growth in function words as a proportion of total vocabulary, Caselli *et al.* (1999) discovered that growth is linear in Italian (getting off the ground sooner, and growing smoothly from 0–>600 words) while the corresponding function is non-linear in English (proportionally flat until approximately 400 words, and accelerating thereafter). Here we will ask whether such differences in the shape of development are also observed in these measures of structural complexity. Towards this end, oneway analyses of variance were performed across vocabulary levels, separately for each language and each coding scheme. In each analysis, we tested for significance of both the linear and the quadratic component. Statistical details are presented in Table 3.

Briefly summarized, results indicate that the linear component is significant for all four coding schemes, in both languages. For MLU in content words, the quadratic component does not reach significance in either language, although both show a non-significant trend ($p < 0{\cdot}10$). For the other three coding schemes, the two languages differ in accord with predictions. For English, the quadratic component is significant for MLU in total words (including function words), for the conservative MLU count, and for the pronoun-enriched MLU measure. For Italian, there is no significant quadratic component for any of these measures. These results

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TABLE 3. *Linear and quadratic effects in one-way analyses of variance for each coding scheme, in each language*

	English		Italian	
Coding Schemes	Linear	Quadratic	Linear	Quadratic
MLU content	$F=87{\cdot}88$***	$F<1{\cdot}0$	$F=39{\cdot}76$***	$F=1{\cdot}10$
MLU total	$F=165{\cdot}05$***	$F=9{\cdot}59$**	$F=9{\cdot}40$***	$F<1{\cdot}0$
MLU-conservative	$F=170{\cdot}66$***	$F=12{\cdot}02$***	$F=105{\cdot}66$***	$F<1{\cdot}0$
MLU-expanded	$F=175{\cdot}44$***	$F=13{\cdot}92$***	$F=109{\cdot}96$***	$F<1{\cdot}0$

* $=p<0{\cdot}05$; ** $=p<0{\cdot}01$; *** $p<0{\cdot}001$.

are similar to those reported by Caselli *et al*. (1999) for function words out of context, as a proportion of total vocabulary.

To summarize, grammatical complexity 'gets off the ground' earlier in Italian (as is also clear from Figures 3b–d), while it tends to lag in English-speaking children until a critical mass of approximately 400 words has accrued (see also Marchman & Bates, 1994).

Some possible reasons for these robust results are presented in the summary and conclusions.

(*4*) *Do languages vary in observed versus attempted complexity?*

For each coding scheme, a ratio was constructed dividing observed by attempted utterance length. The point of these analyses is to determine whether there is a systematic 'zone of proximal development' between what children are able to do and the closest correct version of that utterance, and to determine whether these ratios vary over languages and vocabulary levels. A mixed language × vocabulary × coding scheme analysis of variance was conducted on these proportion scores, with language and vocabulary as between-subjects variables and coding scheme as a within-subjects variable.

Summarizing briefly, there was a significant main effect of vocabulary level collapsed in all four coding schemes ($F(1, 465)=26{\cdot}05$, $p<0{\cdot}0001$), indicating the children tend to 'close the gap' between observed and attempted utterances as vocabulary size goes up. There was, however, no significant main effect of language and no significant interactions involving language. The complete absence of language effects on observed/attempted ratios is particularly interesting in view of the consistent difference in favour of Italian that is observed within and/or across developmental levels. Even though Italian children tend to produce more complex utterances, the gap between their performance and their presumed targets is no greater than the corresponding gap in English, for any coding scheme. To make certain that the absence of language effects really does hold for all four coding schemes,

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TABLE 4. *Statistical results of analyses of variance on proportion scores for observed/attempted MLU for each coding scheme*

	Effects of		
Coding Schemes	Language $F(1, 452) =$	Vocabulary $F(6, 452)$	Lang. × Voc. $F(6, 452)$
MLU content words	2·17, n.s.	13·55, $p < 0·0001$	< 1·0, n.s.
MLU total words	< 1·0, n.s.	21·56, $p < 0·0001$	1·67, n.s.
MLU-conservative	< 1·0, n.s.	24·31, $p < 0·0001$	1·48, n.s.
MLU-expanded	< 1·0, n.s.	23·25, $p < 0·0001$	1·45, n.s.

we also analysed each MLU code separately in Language × Vocabulary analyses of variance, summarized in Table 4. In every case, the main effect of vocabulary was significant, but there were no significant main effects of language and no interaction. These results suggest there may be some kind of conservative crosslinguistic constant in the *proportion* of their utterance targets that children are able to produce, even though the complexity of those targets can vary over languages and over levels of development.

Despite the absence of language effects, the coding scheme × vocabulary interaction did reach significance ($F(18, 1353) = 10·34$, $p < 0·0001$). This interaction is illustrated in Figure 4. It is clear from Figure 4 that gains are relatively shallow for MLU in content words, which starts out relatively high (close to 88%) in children with 50–100 words, increases primarily within the first developmental levels, and reaches asymptote by 400 words. In contrast, the other three coding schemes all show steady growth from 50–>600 words, from around 70% for children between 50–100 words to more than 95% for children with >600 words. It's also worth noting that observed/attempted ratios for the three coding schemes involving function words and inflections are very close together in Figure 4, even though we know that the absolute numbers differ (see Figures 2a–b). Finally, separate one-way analyses were conducted over vocabulary level for each of the four observed/attempted ratios, to investigate the shape of these developmental effects. All effects proved to be significantly linear, with no significant quadratic effects.

To summarize, children appear to try out utterances that are close to their current capacity to a similar extent in English and Italian.

SUMMARY & CONCLUSIONS

We will summarize results in terms of the four main questions raised in the introduction, and then consider some potential theoretical accounts for our most important effects.

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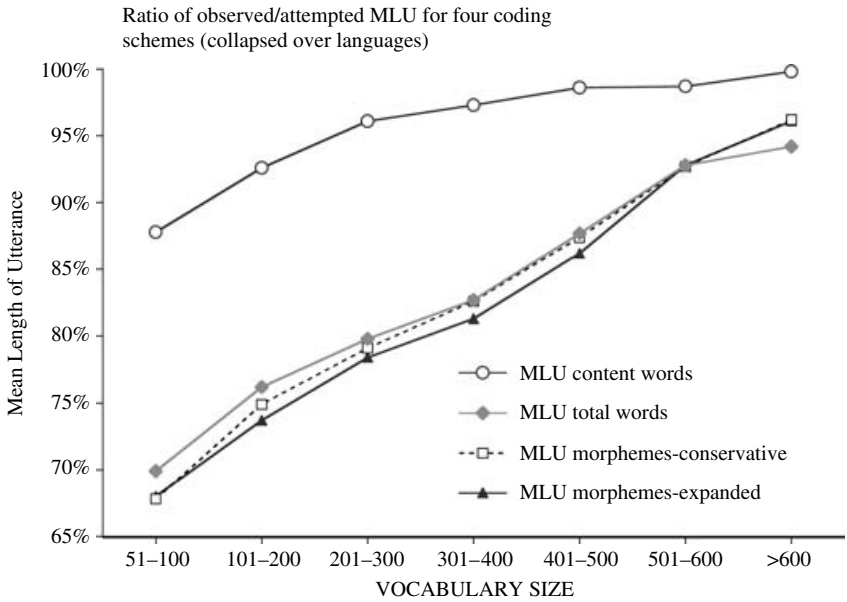


Fig. 4. Ratio of observed/expanded MLU for four coding schemes as a function of vocabulary size, collapsed over languages.

(1) *Within and across four different measures of structural complexity, will vocabulary account for more developmental variance than chronological age?*

Age and vocabulary both contributed significant variance to all four measures of MLU. However, the effects of vocabulary were much larger than the effects of chronological age, in both languages, for all measures of complexity. From a methodological perspective, this result suggests that vocabulary size (when available) may provide a better basis for cross-language matching in comparative studies of grammatical development. From a theoretical perspective, as discussed by Bates & Goodman (1997) and Marchman & Bates (1994), this finding is also compatible with lexicalist theories of grammar, that is, theories in which grammatical forms are stored and accessed as constructions within the same lexical component in which content and function words are listed. Vocabulary development drives grammar (and vice-versa) because these two aspects of language are inextricably linked, represented together and accessed together.

(2) *When age, gender and vocabulary size are controlled, will there be higher scores for Italian in structural complexity, reflecting the greater morphological complexity of Italian compared with English? And if so,*

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will this difference be observed only on MLU in morphemes, or will we find crosslinguistic differences in total words and/or content words?

With age, gender and vocabulary size controlled, regression analyses showed a significant contribution from language for all four measures, reflecting an increased performance in Italian. In addition, in the expanded count of total morphemes (MLU2) – in which the evaluation of pronouns along several dimensions could have produced the effect of levelling out language differences – Italian children showed a better performance. The Italian better score for MLU in content words interacted with vocabulary level, and was restricted to the early stages of development. *Post hoc* explorations of the data suggested that the differences between Italian and English scores for content words is partially due to a larger number of proper nouns in Italian children, and to a tendency toward pronominal subjects in English versus nominal subjects in Italian (a pro-drop language in which pronominal subjects are rare).

From a methodological perspective, we may conclude that it is possible to capture crosslinguistic differences in complexity using parental report, when parents are allowed to report their recollections in an open-ended format (as opposed to the closed 37-item scales used by Caselli *et al.*, 1999). From a more substantive perspective, we add to a large body of crosslinguistic work in child language showing that the pace and complexity of development varies with complexity in the child's input. Finally, the existence of higher scores for Italian in content words and total words (at least at some ages) raises a note of caution for crosslinguistic studies that try to use length in content words or total words as a matching criterion.

(3) *Will we find differences between English and Italian in the shape of change, reflected in non-linear growth patterns for English (initially flat growth with subsequent acceleration) and linear patterns for Italian?*

Although vocabulary was a powerful predictor of MLU in both languages, there were significant crosslinguistic differences in the shape of the relationship between MLU and vocabulary size. Specifically, for all measures except MLU in content words, the MLU/vocabulary functions were non-linear in English (slow increases in MLU up to 400 words, followed by a sharp burst), while the corresponding functions in Italian were all linear (steady growth in MLU across all levels of vocabulary). These results indicate that grammar may 'get off the ground' earlier in a richly inflected language.

One possible explanation for this result can be derived from connectionist models of learning in both linguistic and non-linguistic domains (Plunkett & Marchman, 1993; Plaut, McClelland, Seidenberg & Patterson, 1996; Elman, 1998). In a system in which learning takes place through parallel

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distributed processing, it may actually be easier to learn systems with a large but consistent set of regularities, compared with systems in which regularities are sparsely represented in the input. In other words, more can be better, if by 'more' we mean more information, consistently marked, forming a coherent system. If this general tendency applies to language learning in children, then the relatively rich, regular and consistently marked grammatical system in Italian may provide an easier target, requiring fewer exemplars (and smaller vocabularies) to support extraction of strong generalizations. Our colleague J. Elman (personal communication) is currently conducting simulations of morphological learning in neural networks, designed to parallel the contrasts between English and Italian that underlie the work we have presented here.

(*4*) *When growth in structural complexity is evaluated in terms of the ratio of* '*complexity obtained*' (*the actual utterance*) *versus* '*complexity attempted*' (*the expanded/correct versions*), *will there be developmental and/or crosslinguistic differences in the proportion of attempted utterances that children are able to realize in their reported speech? Will we find a greater gap between actual and attempted speech in the richer inflectional system of Italian, at least in the early stages? Or will we find that children in each language are able to express roughly the same proportion of their targets within and across levels of development, suggesting some kind of developmental constant in the distance between effort and success* (*i.e. a kind of linguistic* '*zone of proximal development*'*?*

We found clear evidence for a linear decrease with vocabulary size in the ratio of observed-to-attempted utterances, on all four coding schemes (although content word ratios started high and reached asymptote early). Hence children do appear to be 'closing the gap' between performance and their attempted target. However, despite the overall Italian advantage in MLU, ratios of actual to expanded (target) MLUs did not differ over languages, for any measure. In other words, children appear to maintain a similar distance between actual and attempted constructions in each language.

This result was not inevitable. Given the substantially greater complexity of Italian, we might have expected to find a larger gap in this language at the early stages, reflecting the greater load of morphological marking that these children must take on. Instead, the children appear to try out utterances that are close to their current capacity, to a similar extent in English and Italian. Although it remains to be seen whether this finding will prove to be a cross-language universal, the absence of a difference in observed/attempted ratios for English and Italian provides support for models that assume a conservative, 'piecemeal' approach to language learning (Tomasello, 1992, 2003).

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All of these conclusions are tentative, and we acknowledge again the fact that they are based on a limited and unusual data base of utterances recalled by parents. These 'best utterances' have more in common with diary methods than with the averages in MLU that are observed using free-speech transcriptions. Aside from the problem of representativeness and generalizability, the 'best utterance' approach is subject to ceiling effects for children at the highest levels of functioning. We have noted informally, for example, that English-speaking children with vocabularies over 600 words were able to achieve remarkably lengthy utterances despite the impoverished nature of English morphology, by creating chains of people and events as in 'We went to the zoo, and got ice cream and saw the tigers and bears and monkeys and giraffes.' Such utterances, though interesting, are unlikely to characterize larger samples of speech from the same children.

Despite the acknowledged limits of the present study, all of these hypotheses could be tested against free-speech data, using smaller but well-matched samples of children in English, Italian and other languages. Based on our findings, we suggest that such matches include vocabulary size (most conveniently estimated by parent report). And we would also propose that, for purposes of comparison, it might be useful to consider the 3, 5, 10 or 20 'best utterances' produced by children in free speech, in addition to averages based on a larger proportion of the data.

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APPENDIX

Vocabulary Level	Child's Language, Age, Vocabulary Size	Sentence Type	EXAMPLES	Mean Length of Utterance Coding Schemes			
				Content Words	All Words	MLU 1	MLU 2
51–100	English	Child	Me milk	1	2	2	4
	Female; 22 m; 68 w	Expanded	I want milk	2	3	3	4
	Italian	Child	Mamma nao mae nonna	4	4	4	4
	Female; 22 m; 62 w	Expanded	Mamma il nao fa mae a nonna	4	7	7	7
101–200	English	Child	Where Kity go?	2	3	3	3
	Female; 23 m; 196 w	Expanded	Where did Kitti go?	2	4	4	5
	Italian	Child	Pesce mangio io	2	3	4	5
	Female; 23 m; 198 w	Expanded	Il pesce lo mangio io	2	5	6	8
201–300	English	Child	Daddy at work	2	3	3	3
	Male; 23 m; 253 w	Expanded	Daddy is at work	2	4	4	4
	Italian	Child	Lascia pappa mia	2	3	6	6
	Male; 23 m; 260 w	Expanded	Lascia la pappa mia	2	4	7	7
301–400	English	Child	Motorcycle scared me	2	3	4	6
	Male; 26 m; 359 w	Expanded	The motorcycle scared me	2	4	5	7
	Italian	Child	Mamma papi e' ato tuola	4	5	6	6
	Male; 26 m; 345 w	Expanded	Mamma papi e' ato a tuola	4	6	7	7
401–500	English	Child	I go outside Daddy water grass	5	6	6	7
	Female; 25 m; 451 w	Expanded	I go outside with Daddy to water the grass	5	9	9	10
	Italian	Child	Allora chetta la foglia vedde e chetta gialla	3	8	9	11
	Female; 25 m; 451 w	Expanded	Allora chetta e' la foglia vedde e chetta e' quella gialla	3	11	12	15
501–600	English	Child	Time to go nightnight	3	4	4	4
	Female; 27 m; 580 w	Expanded	It's time to go nightnight	3	6	6	6
	Italian	Child	Guarda come sono bella con la gonnellina	3	7	11	11
	Female; 27 m; 586w	Expanded	Guarda come sono bella con la gonnellina	3	7	11	11
>600	English	Child	Those guys working in Daddy's garden	4	6	9	9
	Female; 27 m; S29 w	Expanded	Those guys are working in Daddy's garden	4	7	10	10
	Italian	Child	Ti ricordi mamma a il mare a Viareggio in pineta	5	10	11	13
	Female; 27 m; 604 w	Expanded	Ti ricordi mamma a il mare a Viareggio in pineta	5	10	11	13