Chapter 4

Early phonological development in the speech of bilingual-learning infants and toddlers: The interplay of universal and language-specific processes

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Abstract

This chapter explores ways to conceptualise productive phonological development within and across the two languages of an emerging bilingual. It reports the achievement of language-general and language-specific milestones of a group of bilingual infants studied by the University of Miami Bilingualism Study Group, focusing on the onset of canonical babbling at 6 months, the emergence of incipient ambient language effects on syllable structure at 1 year, and increasing faithfulness to language-specific phonetic and lexical targets in their two languages at 24 and 36 months. The bilinguals' developmental path was shown to be quite similar to comparison groups of monolinguals in one or both of their languages, although different patterns of exposure led to differences in the rate of development, especially if one language received considerably less input than the other. While the two productive phonologies appeared to be distinct from each other for the children, certain interactions between them were observed. At 3 years, standardised tests in each language were used for descriptive purposes only. That is, since there are no current measures standardized on children in bilingual circumstances, no tests at present provide meaningful standardized scores. Comparisons to monolinguals can often be illuminating for researchers to estimate the challenges particular languages present to learners, but caution is recommended for interpreting direct comparisons between monolinguals and bilinguals.

1. Introduction

Studies of infants' language perception confirm the current consensus that bilingual infants treat their languages as separate systems from the time they are born, or soon after (Werker and Byers-Heinlein 2008; Sebastián-Gallés and Bosch 2005). However, motor immaturity and perhaps cognitive limitations prevent children from producing the phonetic elements of two distinct phonologies from the outset even while they are perceiving them as distinct receptively.

Thus, the old questions in bilingualism research about language differentiation are still relevant for productive phonology. Like monolingual children, bilingual children begin with a limited repertory of syllable types and a small stock of sounds listeners often associate with a small class of universal segments (Locke 1983). These early, pre-phonemic vocalizations gradually pattern according to the system of contrasts in the languages around them (Vihman 1992; Oller et al. 2007). As children are learning receptively to limit their attention to only those distinctions needed for their ambient languages (Werker and Tees 1984, 1992), they are expanding their productive repertory to articulate more sounds and more complex sounds that are more stable and increasingly faithful to targets in the specific languages they are learning. Normative descriptions of phonological production at different ages, then, include inventories of phoneme-level units and syllable types used in contextually sensitive ways, as well as common substitution patterns for articulations that are beyond the child's current capabilities. In the case of bilingual development, the comparison of inventories and processes across languages is inevitable and more difficult than it appears at first blush.

This chapter addresses the question of how one might conceptualize phonological development within and across the developing bilingual's languages. It reports the achievement of language-general and language-specific milestones from 6 months to 3 years of a group of bilingual learners studied by the University of Miami Bilingualism Study Group (BSG). Analyses by the BSG explored answers to the following questions:

1. What are the landmarks in the process by which bilingual children develop two phonological systems?
2. To what extent is the developmental path the same or different in each language?
3. How is the process different for bilinguals and monolinguals?

Each BSG analysis highlighted the cautions that must be observed in making comparisons between monolinguals and bilinguals.

2. Previous research on bilingual phonological development

Studies of developmental bilingual phonology have been relatively scarce. Reviews and studies of early bilingual production by Paradis (2001), Goldstein (2004), and Gildersleeve-Neumann et al. (2008) indicate that, for the most part, bilinguals follow the same developmental sequences as monolinguals in each language. With respect to rate of development and error processes, bilinguals are sometimes thought to demonstrate similar processes (Goldstein, Fabiano, and Washington 2005) but some studies have pointed to substitution and syllabic processes which are unlike monolinguals' (Goldstein and Washington 2001; Dodd, So, and Li Wei 1996). Whether the differences originate from the influence of the child's other language, or from general phonological immaturity in one or both of the child's languages is also unresolved.

2.1. Inconsistencies between studies

Some inconsistency between studies may result from fundamental differences in the participants' background as well as different characterisations of the bilingual subjects and their bilingualism. Werker and her colleagues (2006) note patterns of dominance, or faster development, of one language over the other as early as 12 months in simultaneous learners, so both languages need to be taken into consideration, separately and together. Separate consideration of the languages is even more crucial for sequential learners, those adding a second language three or more years after first language acquisition has begun (Genesee, Paradis, and Crago 2004; Pearson 2008). Not all studies provide sufficient detail on children's language histories to provide a solid basis for comparison across studies. In addition to age of onset, one must always consider the source and strength of the children's language models. Some children who exhibit delay in a language may not yet have experienced optimal circumstances for development of two languages, and thus they may resemble younger children in their less developed language. Other inconsistencies may stem from different conceptual frameworks for describing children's progress in different languages, especially at the earliest stages.

2.2. A conceptual framework for describing relative progress

In phonology, as in other domains of language acquisition, the comparison between development in two languages – whether for two monolinguals or for a bilingual – is not straightforward. Each phonological system has a large universal component as well as unique, or less common, more marked features, both specific phonemes and phonotactic structures (like closed syllables or consonant clusters). To describe the progress of monolingual children toward their target languages, it is not crucial to distinguish language-general from language-specific elements, as all progress counts toward the acquisition of their ambient language, be it French, Chinese, or Greek. For bilingual children, by contrast, some progress will count toward both languages, and some for only one language *or* the other. The emergence of language-specific elements is not a discrete event, but happens gradually in small increments and at different times for different individuals.

Developing differences between language groups are first observed in analyses of corpora pooled from several children of a language group (Boysson-

Bardies and Vihman 1991). When differences in the proportions of fricatives or coronals have been calculated, for example, such differences are rarely statistically significant within the corpus of a single child. At a next stage, one might see values changing within a child's aggregated utterances (Levitt and Utman 1992) but they may not be evident in a single session and much less, within a single utterance. Until the appearance of later-developing, language-specific phonemes and phonotactic structures, children's utterances are most likely so similar across languages that researchers cannot with confidence assign them to one language or the other based on phonetics alone, without inference from the context of an interaction. Therefore, one must determine for each language pair which elements are found in common and which elements are unique to one language and can thus be markers of that language as distinct from the other.

2.3. Relative timetables

In order to determine whether one language is more developed than the other within a single individual, a simple listing for each language of phonemes mastered will not suffice. The evaluation of each language must be calibrated not just to the development of the child's other language, but also to what is expected of monolingual groups and individuals confronting the particular challenges of the languages under consideration. A child who produces five phonemic-level units in Language A and three such units in Language B may be equivalent in the two languages, or even more advanced in Language B, depending on the levels observed for monolingual growth in the respective languages. This does not mean we will expect the bilingual to be like two monolinguals in one person (Grosjean 1989), but monolingual development is our best indicator of the relative difficulty for children of elements in each language. So, while direct comparisons to monolinguals are generally misleading, facts about different languages are often illuminated by observations of monolingual development in the respective languages (Pearson, Navarro, and Gathercole 1995).

For example, the voiced interdental fricative /ð/ is a rather late-developing phoneme in English, and it is also found in Spanish as the allophonic variation of /d/ in intervocalic position. At age 3, the bilingual group studied by the BSG produced English phonemic /ð/ correctly an average of 36% of the time, but the Spanish allophone only 20% of the time. What looked like a dominance phenomenon of better articulation in English than Spanish is viewed in a different perspective when one looks at how monolingual English and monolingual Spanish learners were acquiring the phone at that age: 46% for English versus 25% for Spanish. The bilingual pattern appeared to reflect the cross-linguistic pattern. A strong paradigm for comparisons across languages, then, includes two control groups, one for development in each language.

Differences in language-specific characteristics also complicate measures of relative language progress in other ways. Consider the child learning two languages with different basic syllable structure, like French and English for example, one with primarily open syllables (CV) and one language with a preponderance of closed syllables (CVC). Open syllables (like "ba") or strings of reduplicated open syllables (like "dadada") are the first to develop and will be the most commonly observed syllable shape in early babbling, regardless of the child's target language (Kehoe and Lleó 2003). But many languages in their adult form, like French and Spanish but not English or German, are also characterized by a preponderance of open syllables. Lleó et al. (n.d.) estimate for adult German, for example, is 67% closed syllables compared to an average of 26.5% in Spanish. (Consider the sentence you are reading now which contains 7 of 31 words ending in a vowel, or 77% words ending with a coda, not an unusual proportion in English.) For monolingual children learning either an open-syllable language like French or a closed-syllable language like English, open syllables will be expected early for both groups. For the English children, this pattern is characteristic primarily of immature English whereas for French children, it is expected of both immature and mature speakers. When the proportion of closed syllables in the stream of a child's speech is observed to increase to levels consistent with the occurrence of closed syllables in mature English, those syllables can be considered evidence of development in English phonology (and perhaps lexicon, as children at that age are often attempting closed-syllable word targets). If at that same point, a young French child's speech has predominantly open syllables, it is consistent with mature French, and thus is not on its own a sign that the child is lagging behind the English-learning child. On the other hand, when a bilingual child produces mostly open syllables, before the time when monolingual children would be expected to produce a larger percentage of closed syllables (cf. Poulin-Dubois and Goodz 2001), it cannot be said that that the child is "speaking French," except in a metaphorical way.

Another area where the status of the same structure may differ according to the language under consideration is in the vowel inventory. A five-vowel system, as in Spanish, is very common among the world's languages, and happens to be a near subset of the 11-vowel system found in English (Hammond 2001; Goldstein 2004). Suppose a Spanish and English-learning child has learned four of the Spanish vowels plus the English /ə/. The Spanish vowels also occur in English as the base for vowel diphthongs and are heard in child English while the diphthongs are still developing (and they are also present in the adult vowels of some English dialects [Wolfram 1991]). Is that child's Spanish-learning in advance of her English, or vice versa? On the one hand, she knows more English than Spanish vowels; on the other hand, she knows 80% of the Spanish vowel system, but less than half of the English system. Further, it is an unresolved question whether a young bilingual whose languages exhibit a subset relationship like this should be expected to develop that subset ahead of the monolinguals of one or both languages. If she is merely equivalent to one or the other of the language groups, can she be considered to be behind schedule?

Like the vowels, many or even most of the "same" consonants are realized differently across languages. The /d/s in English and Spanish, for example, are articulated at a slightly different position within the mouth. Likewise, the voiced-voiceless contrasts involve different relationships of the voice onset timing in different languages (Caramazza et al. 1973; Zampini and Green 2001). And some phonemes are harder in one language than the other. The correct production of /n/, which is in the "early" set of phonemes mastered in both English and Spanish, is generally unremarkable. In contrast, /b/ is in the early set for English and the late set for Spanish (Shriberg [1993] for English and Fabiano, Goldstein, and Washington [2003] for Spanish). When Deuchar and Clark's (1996) subject produced the contrast between voiced and voiceless stops in English at 27 months, but not for a year or more later in Spanish, both of her languages were fulfilling age-appropriate expectations. Similarly, the different instantiations of the r-phoneme in the two languages are in the late set in both languages, but the Spanish appears to be more challenging. At age 3, English learners in our sample (both monolingual and bilingual) were credited with pronouncing the retroflex /ɻ/ with around 40% accuracy, compared to 6% accuracy for the Spanish trilled /r/. In fact, only two of 18 Spanish-learners were observed to produce some trilled /r/s some of the time.

One might think that the early-middle-and late sets act like a loose implicational hierarchy. That is, children generally do not produce elements in the harder sets before those in the easier sets. However, while one of the children with a trill in the BSG cohort appeared to follow such a hierarchy, the other child with a trill had almost no correctly articulated middle consonants – only the very hardest late one. Phonemic or allophonic status appears to make a difference, too, but in the two instances of that type of contrast between English and Spanish, in our corpus the effect worked differently for each of them. Opposite to /ð/ above, the /ɾ/ is phonemic in Spanish and allophonic in English, but here the English allophone appeared to be easier than the Spanish phoneme for both the monolingual and bilinguals groups (Table 3, row 7).

2.4. Uniquely bilingual processes: Interactions between languages

Another issue is whether the bilinguals experience interactions between elements of the two languages. Is there evidence of either facilitation or interference across languages? Lexical mixing is well-attested. Can we expect children to mix phonetically as well? When could one see it? It is actually a sign of rather advanced development for a child to be perceived as speaking with an accent (Pearson and Navarro 1998). It requires the use of a language-specific element clearly enough enunciated that it stands out in the context of the other language. Two factors mitigate against this, at least in young simultaneous bilinguals. One is the relatively weak enunciation of young children in general, such that we understand them not solely on the basis of what they produce "acoustically," that is, what can be identified in the physical wave forms derived from their speech. Rather, we understand them largely thanks to hearing their utterances in a supportive context. The large role context plays in understanding what children say (Navarro 1998; Navarro et al. 2005) is not often acknowledged. In a study of 26-month-olds, who were very intelligible in the context of their language samples, Navarro (1998) found only one child in 30 who was understood out of context as much as half of the time (a young monolingual Spanish speaker). The second highest level of being understood was 35% (a bilingual), and the others ranged down from there to about 10%, with an average around 24%. So, young bilinguals would have to be more intelligible than most young children are for a sound to appear as if it were from the "wrong" language.

The second factor working against finding an accent is that language-specific elements tend to be late developing, so we will be unlikely to see them before age 2 or 3 years. In an analysis focused on foreign accent in a study of 3-year-old simultaneous bilinguals reported in Pearson and Navarro (1998), accents from commission – from producing the wrong phoneme – were less likely than accents caused by omission. At age 3, there were a handful of misarticulations we thought might qualify as accent, but they were not more common among the bilinguals than the monolinguals. What one did see that registered as accent in one child was the absence of aspiration where one would expect it. However, the child suspected of accent was not the only child who failed to produce aspiration on her initial unvoiced stops in English (e.g. *car* [kɑr] versus [k^hɑr] in English, using the same /k/ as in Spanish [karo] *carro* 'car'). At least half of the English learners likewise did not use aspiration but, unlike this child, the others were not consistently producing other language-specific elements of English. Therefore, in addition to an average timetable, one would need an implicational hierarchy for language-specific sounds, such that a sound higher on the hierarchy could be considered missing only if most of the lower-ranking elements were present.

Fine-grained timetables and implicational hierarchies that would permit such evaluations for different language pairs do not exist. Even were we to have such a framework, it is an open empirical question whether bilinguals would follow it in the same way as monolinguals. Bilinguals may be more advanced in the sounds that distinguish their two languages, or it is equally possible that they will exploit the commonalities between their languages and concentrate on the areas where their two languages are the same.

3. The Bilingual Infant Vocalizations Project

In this landscape of unresolved questions, the University of Miami Bilingualism Study Group investigated the phonological development of 27 bilingual babies over their first two years of life and 11 of them through age three. The bilingual babies were studied in the context of a large longitudinal study of infant vocalizations involving several groups of monolingual children: middle class, working class, full-term, pre-term, deaf and Down Syndrome (NIH Grants R01 HD30762 and DC00484 to D.K. Oller, P.I.). Monolingual English and Spanish control groups were drawn from the full-term typically developing subgroups. At every stage, the BSG tried to establish how the bilinguals' languages compared to each other and to the language of children in the single-language control groups. Not surprisingly, the results were not clear-cut.

3.1. Participants and procedures

Bilingual families who were committed to providing equal amounts of exposure to Spanish and English were recruited before the birth of their child. In eight of the families, the children's parents were themselves bilingual, and they talked to their children in both languages. In the remaining families one parent and their relatives (and in two cases, a nanny) were speakers of the minority language, the one that was not the language of the broader community. At each visit the families updated a language environment questionnaire, helped by project staff to make the estimates of language exposure on a weekly basis. As it happened, only one child was reported to have 50% exposure to each language. The babies averaged 60-65% of one language and 35-40% of the other, with four families less balanced than 75/25. For two-thirds of the families, exposure patterns were relatively consistent over time, but for the other third, the patterns changed over time, with four children experiencing changes in which language predominated. Note that, given the bilingual nature of the Miami community, the monolingual children also had some minimal exposure to the other language, and so they might be somewhat different phonologically from monolingual children recorded in monolingual environments (Oller and colleagues are currently investigating this issue through comparisons of children from Memphis, TN and Mexico).

Children were audio-recorded in free play sessions with their parent and a research assistant monthly or more often and at designated intervals were given standardised tests: the *Bayley Scales of Infant Development* (Bayley 1969) at age 1, the *Sequenced Inventory of Communication Development Revised, SICD-R* (Hedrick, Prather, and Tobin 1984) at age 2; the *Peabody Picture Vocabulary Test (PPVT*) in English (Dunn and Dunn 1981) and Spanish (Dunn et al. 1986) and a phonological process assessment at age 3 (Hodson 1985, 1986). Preliminary versions of the *MacArthur Communicative Development Inventory (CDI*) in English (Fenson et al. 1991) and Spanish (Jackson-Maldonado and Bates 1988) were completed by the parents every two months. Analyses of phonemic inventories and selected phonological processes in each language at 6-months, 1 year, 2 years, and 3 years are reported here.

3.2. At 6 months

At the babbling stage, bilinguals and monolinguals were very similar, neither group in advance or delayed. Each group began canonical, or mature, babbling at 27 weeks on average. The bilinguals were a non-significant four days in advance of the monolinguals (Oller et al. 1997). Nor did bilinguals' babbling differ qualitatively from monolinguals', and one could not distinguish, as some say, "babbling in English versus babbling in Spanish" consistent with the Babbling Drift Hypothesis (Brown 1958; Edmondson 1998; Thevinin et al. 1985; Vihman 1996; but see Boysson-Bardies, Sagart, and Durand 1984, and Edmondson 1996. See Navarro et al. 2005 for a review.) Lleó et al. (n.d.) and Redford (n.d.) also found little reflection of ambient languages at the babbling stage, Lleó with German and Spanish bilinguals, Redford with monolinguals. Rather, the authors provided universal explanations to account for the children's babbling in their respective languages.

For the most part, investigators who claim to show differences based on ambient language in babbling, like Poulin-Dubois and Goodz (2001) and Maneva and Genesee (2002), looked at somewhat older children who may already have had specific word targets. Boysson-Bardies and Vihman (1991) looked at four time points and began to discern movement toward language-specific values for general developments like the percentage of fricatives versus stops, but these were tendencies just beginning to emerge at the group level, and were not necessarily discernable in the output of a single child and not within a single utterance (see discussion in Navarro et al. 2005).

3.3. At 11 months

At this age, children are sensitive to words in their languages. Most respond to their own names and names for other salient objects and relationships (e.g. "more," "allgone") in their environment (Golinkoff and Hirsh-Pasek 2007). Whether it is general global shaping of the babbling inventory, or the child's response to the language-specific phonetic characteristics of his target words, it is reasonable to expect some language-specific development to emerge around this time. Instrumental analyses of 10-month-olds' vocalizations by Boysson-Bardies et al. (1989) show formant values beginning to diverge in children learning four different languages, but these are not differences that listeners can hear without instruments.

Levitt and Utman (1992) pinpointed 11 months for the emergence of one set of perceptible differences. They found that their two subjects, one learning French and one learning English, were not different in the proportion of closed syllables at 8 months, but began to diverge in their output at 11 months. Following up these findings, the BSG looked at 11-month-olds learning English and Spanish to see if the same pattern could be observed (Pearson et al. 2001). For this study, only the monolingual controls were analyzed because without recognisable words in the corpus, one could only infer imperfectly from context whether the bilinguals were intending to interact in English or Spanish.

Indeed, there was a non-significant trend among the English speakers to “babble” with more closed syllables than the Spanish learners. (“Babble” is in quotes because there is no way to know whether the child’s utterances were non-linguistic vocalizations, or referential speech that others could not understand.) In any event, the tapes were analyzed without reference to either language for proportion of closed syllables above a baseline of around 3% found by Levitt and Utman for their French learner. Half of the English learners (five of 11) had values for this variable between 12 and 20%, and only one Spanish child (of seven) had a value that high, giving a non-significant between-group difference (Means [*s.d.*]= .09 [.05] versus .05 [.04)], $t = 2.27$, $p = .06$). Conceivably, if others were doing a two-child study like Levitt and Utman, they could expect a 3 in 8 (5/11*6/7, or 30/77) chance of being as lucky as Levitt to find children who showed a language-specific contrast at that age. Clearly the English-learning children were heading toward more closed syllables, although one cannot be sure this was not primarily the result of targeting specific words that had closed syllables in English. The BSG does not have exactly comparable analyses at later ages, but even at age 2, Navarro (1998) found only about 25% of words ending in a non-Spanish consonant for the English speakers (bilingual and monolingual). As noted in section 3.5. below, at age 3, monolingual and bilingual children were by then about 90% and 86% accurate respectively on final consonant targets in English, but less accurate (44% and 65%) on the rarer targets in Spanish (Pearson, Navarro, and Gathercole 1995). So one can presume that the trend observed in the one-year-olds’ levels of consonant production was en route to being a clear difference at a later age.

3.4. At 26 months, indirect evidence of language-specific development

At this age, the BSG analyses targeted indirect evidence of language-specific development: the question was whether there were enough language-specific elements (phonemes and phonotactic structures) so that blinded listeners could tell which language was being spoken in a no-context situation in cases where they did not recognise the meaning of the word or phrase (Navarro 1998). For this project, ten utterances each were extracted from tapes of 30 children (10 monolingual English [MLE], 10 monolingual Spanish [MLS], and 10 Spanish-English bilinguals. Each bilingual child had two tapes, one in English [BLE] and one in Spanish [BLS].) In addition there were 15 English and 15 Spanish utterances from bilingual adults on the same tapes. All utterances selected were intelligible in the tapes; otherwise they were not chosen for the stimuli. They were presented by computer in random order to bilingual listeners who were asked to identify the targets. Stimuli that were not recognised lexically were input for the language-identification task. Based on a subsequent analysis, Navarro determined that listeners required at least one language-specific feature – e.g. aspiration of voiceless plosives or spirantization of intervocalic plosives – to identify the language of the utterance at levels above chance. (Utterances with two through five language-specific features were recognised at the same level as those with just one.)

Initial comparisons made it look like the MLs (both Spanish and English) were better than the BLs, but that initial impression may have been a misleading result of language (im)balance in the bilinguals' languages and how we averaged the bilingual group's scores (a danger in almost every cross-group comparison). In this task, half of the children had relatively equal or balanced skill in both languages, and half were dominant in one language or the other. Therefore, the scores of the English dominant children appear to have pulled down the Spanish average, and vice versa for Spanish-dominant children. In fact, in each ML group, there were six children whose language was correctly identified more often than chance, and in the BL group, there were seven, but only one with that capacity in both languages, that is, with the capacity to produce language-specific elements well enough that they were audible to the listeners out of context.

3.5. Age 36 months, direct comparisons to monolinguals

At age 3 years, 31 children (11 bilingual, 13 English and seven Spanish learners) were given a standard test of phonological processes in English and Spanish (Hodson 1985, 1986). As in the studies of younger children, the bilinguals' performance in each language was compared to monolingual controls' (Navarro et al. 1995).

The tests used were phonetically balanced and designed to allow a context-sensitive analysis of children's production in English or Spanish. The English version contains 50 words and the Spanish version 40 words. In each approximately 30-minute session, the examiner, with the help of the parent, showed the child a set of toys in order to elicit each relevant word. If the child did not name the item, the examiner provided a spoken model for the child to imitate. All 42 sessions, one for each monolingual child and two for each bilingual child, were audiotaped and transcribed by an English-L1 and a Spanish-L1 bilingual (the first and second authors) using LIPP, Logical International Phonetic Programs, designed by Oller and Delgado (Oller 1991). The level of transcription was narrow enough to allow analysis of allophonic segmental variants conditioned by phonetic environment. To assess reliability, 13 of the files were re-transcribed independently by the first author, with 95% agreement on segments (in samples that averaged 226 segments).

LIPP analyses of the phonological evaluations produced a set of measures for each child as well as a set of averaged values for each group. The first analysis compared the corpus as a whole across groups (MLE, MLS, and BLE versus BLS). Measures compared were proportions of correctly articulated consonants, correct vowels, and correct syllable structure. The first two are a straight ratio of correct productions to the number of elicitations; the Correct Syllables measure was a weighted average, based on how damaging different errors are to intelligibility. Thus it counted deletion of stressed initial syllables, for example, as more damaging than final syllable deletion. Similarly, "Phonological Accuracy," a built-in subroutine in LIPP, measured overall accuracy of pronunciation, weighted according to which deviations were more or less common error processes and more or less damaging to intelligibility.

Table 1 . Group means and standard deviations for Correct Syllable Structure (CSS), Correct Consonants (CC), Correct Vowels (CV), and general Phonological Accuracy (PhonAcc)

	Monolinguals		**Bilinguals**	
	Mean	(S.D.)	Mean	(S.D.)
English				
CSS	.894	(.057)	.904	(.040)
CC	.643	(.168)	.681	(.123)
CV	.801	(.129)	.825	(.073)
PhonAcc	.925	(.037)	.936	(.025)
Spanish				
CSS	.856	(.081)	.866	(.058)
CC	.516	(.165)	.561	(.161)
CV	.783	(.142)	.814	(.068)
PhonAcc	.918	(.040)	.916	(.032)

Table 1 shows that in each language the groups were nearly identical on these measures of development (which include both shared and unshared elements). A multivariate ANOVA showed that for neither language was the difference between the groups on any of these measures significant ($F < 1$, n.s. in both English and Spanish). Since by the time they were tested in two languages on separate days the bilinguals were two months older on average than the monolinguals, the analysis was also done with Age as a co-variate. ANCOVA showed once again no significant differences in either language between bilinguals and monolinguals on these measures ($F < 1$, n.s.).

Analysis of correct production by manner and place of articulation showed similar close correspondence between the linguality groups: in English .767 for the monolinguals versus .783 for the bilinguals for manner and .725 versus .762 for place; and in Spanish .579 versus .639 and .611 versus .673 respectively for manner and place.

3.5.1. Language-specific versus language-general analyses

Although global phonological development was very similar, the question remained whether the bilinguals and monolinguals achieved their equivalent levels of correct production by the same means. In particular, were bilinguals more or less advanced than monolinguals in the areas that their two languages shared (language-general) or in the specific elements that differentiated their languages. Elements investigated included language-specific versus language-general vowel and consonant phoneme articulations, allophones, syllable structures, and error processes, as outlined in Table 2.

Table 2. Shared and Unshared Language-general and Language-specific Elements

	Unshared Specific to English	**Shared Language General**	**Unshared Specific to Spanish**
Vowel Phonemes	/æ/ /ɑ/ /ə/ /ɛ/ /ʊ/ /ɪ/ /ɔ/ (plus diphthongs)	"Point" vowels, that is 4 of the 5 points of the canonical vowel space: /e/, /i/, /o/, /u/	/a/
Consonant Phonemes	/v/, /z/, /θ/, /ʃ/, /ð/*, /dʒ/ and /ɹ/	/p/ /b/ /m/ /f/ /t/ /d/ /n/ /s/ /l/ /k/ /g/ /h/ /w/ /tʃ/ /ŋ/***	/r/, /ɾ/** (/ɲ/ and /χ/ not attested)

Table 2 (cont'd). Shared and Unshared Language-general and Language-specific Elements

	Unshared Specific to English	**Shared Language General**	**Unshared Specific to Spanish**
Allophones	[p^h], [t^h], [k^h] (voiceless stops aspirated in initial position)		[β], [ð], [ɣ] (voiced stops spiranti-zed in medial position)
Syllable Structure / Error Processes	Almost all consonants may appear word-finally (i.e. many closed syllables) Numerous consonant clusters		Only 5 consonants may appear word finally (/s/ /n/ /r/ /l/ /d/) Few consonant clusters

* phonemic in English, allophonic in Spanish
** phonemic in Spanish, allophonic in English
*** found in Caribbean Spanish

3.5.2. Four-way comparisons by language and linguality

Table 3. Measures of Language-Specific Elements by Language and Group, Mean Percents (and Standard Deviations)

Measure	**MLE (n=13)**	**MLS (7)**	**BLE (11)**	**BLS (11)**
Correct Production				
Language-specific phonemes (correct)	.49 (.22)	.14 (.14)	.59 (.16)	.16 (.14)
Language-specific allophones (correct)	.69 (.30)	.45 (.27)	.61 (.34)	.34 (.18)
Point-vowels (correct)	.88 (.11)	.74 (.18)	.93 (.04)	.80 (.07)
Non-point vowels	.81 (.13)	–	.83 (.10)	–
Retroflex r (correct)	.37 (.25)	–	.41 (.24)	–
Trilled r (correct)	–	.07 (.19)	–	.05 (.15)
Flap r **(correct)	.30 (.48)	.21 (.18)	.45 (.52)	.26 (.22)
/ð/ *(correct)	.46 (.52)	.25 (.36)	.36 (.50)	.20 (.19)

Table 3 (cont'd). Measures of Language-Specific Elements by Language and Group, Mean Percents (and Standard Deviations)

Measure	MLE (n=13)	MLS (7)	BLE (11)	BLS (11)
Error Processes				
Aspiration (errors)	.19 (.20)	.01 (.01)	.28 (.35)	.001 (.01)
No spirant (errors)	0	.02 (.06)	0	.23 (.21)
Final C deletion	.10 (.07)	.56 (.30)	.14 (.05)	.35 (.18)
Cluster reduction	.33 (.19)	.60 (.31)	.41 (.17)	.56 (.20)

* phonemic in English, allophonic in Spanish
** phonemic in Spanish, allophonic in English

In general the differences between the groups appear smaller than the similarities. The biggest difference was seen in phonemes versus allophones and the allophonic processes of aspiration and spirantization. In both languages, bilinguals were slightly ahead of monolinguals on the language-specific phonemes, but slightly behind in language-specific allophones. With respect to syllable structures which favoured the English-learners, the bilinguals were intermediate between the monolingual groups: for example, they were observed to delete more final consonants in English than the monolingual English speakers, but they deleted considerably fewer final consonants in their Spanish corpus compared to the monolingual Spanish speakers.

4. Questions about phonological impairment in young bilinguals

It may seem abstractly that with larger repertories to be mastered, bilingual children would be more susceptible to phonological errors, or have more to confuse between their languages. In fact, children with unequal exposure to their two languages may speak like younger children in one of their languages, or use phonological processes from one language in their other language (Genesee, Paradis, and Crago 2004). In their case, "delay" is not a sign of impaired language processing, but insufficient exposure (Pearson et al. 1997). It is not at all unusual to see some mixing at an early stage of development. Some influence of one language on the other is to be expected, just as in language contact situations, phonetic and morphosyntactic elements of two languages may converge slightly, depending on how usage patterns for them are related (Silva-Corvalán 1994).

There is no reliable evidence, however, that bilinguals are in general either more or less susceptible to language impairment than are monolinguals (Genesee, Paradis, and Crago 2004; see also Bernstein Ratner 2004, for likelihood of stuttering in bilinguals compared to monolinguals). Still, it is clearly harder to determine whether they are impaired or not. No measures are calibrated on bilinguals (although some are being developed for school-age children). It is also not always clear which language a child should be tested in, and clinicians are very often unable to test a child in the language that would be most revealing (Kohnert and Derr 2004). In general, it is safe to say that standardised age-appropriate expectations for developing bilinguals that are sensitive to their two languages individually and together have yet to be developed.

5. Discussion and conclusions

Returning to our questions from Section 1:

1. What are the landmarks in the process by which bilingual children develop two phonological systems?
2. To what extent is the developmental path the same or different in each language?
3. How is the process different for bilinguals and monolinguals?

The general picture that emerges is that the bilingual group follows the same path of productive phonological development as the two monolingual groups, but rate of growth for all groups is very individual, as evidenced by the high standard deviations for all the mean values. No significant differences were observed between the BSG monolingual and bilingual groups, but some interesting trends may point to ways in which monolingual and bilingual groups differ.

At age 3, bilinguals in the BSG studies showed a small advantage in language-specific phonemes, and a small disadvantage in language-specific allophones. The small bilingual deficit in language-specific allophones is mirrored in the groups' language-specific error patterns (in Table 3, rows 9-12). Neither bilingual nor monolingual children were observed to spirantize stops in English as they were learning to do in Spanish, nor to introduce aspiration in Spanish, as they were learning to do in English. At age 3, the monolingual children were near perfect on Spanish spirantization (98% of the time) and quite good in knowing when to aspirate English initial stops (around 80%). (Note that at age 2, some of these mixed sounds like aspirated stops in Spanish targets were occasionally observed.) By contrast, the bilingual group's average values for the allophonic processes were 77% and 72% respectively. One might speculate that bilinguals' priority may have been to learn the two sets of contrasts that constituted the phonological base structures of the two languages, and allophones may have been a luxury for them. On the other hand, it is also possible that dominance patterns may have accounted for at least some of the monolingual-bilingual difference. That is, bilingual children with less exposure to Spanish would pull down the Spanish average of a group of bilingual children with more exposure to Spanish, and the same for English. Unfortunately, dominance patterns were not controlled for in this analysis.

More intriguing was the pattern found in the syllable structure differences between the bilinguals' two languages, such as the relatively large differences in the rates of final consonant deletion in English and Spanish by both monolinguals and bilinguals. (See row 11 in Table 3.) These differences correspond to differences in the extent to which closed syllables are found in the two target languages. It is possible that the bilingual children in this study were being trained by their experience with English to perceive and produce the wide range of final consonants found in English words, so that they showed less difficulty producing the more restricted set of Spanish consonants that can close a syllable. For example, one very precocious two-year-old bilingual did not yet know the word for "doll" in English, but already realized that it would likely not end in a vowel, so she took the Spanish *muñeca* ('doll') and coined the word "muñec". Monolingual Spanish children, by contrast, had much less experience with words with final consonants because they are not very salient in their language, and so they appeared much slower as a group to reproduce them. The same pattern was seen less dramatically with cluster reduction errors, with more such errors among the bilinguals in Spanish than in English. Similarly, the bilinguals reduced more clusters in English than the MLE, but reduced fewer in Spanish than the MLS.

In general, we did not see more development in either language-specific or language-general processes in bilinguals compared to monolinguals, but the distinction was potentially illuminating in our analyses. It may explain, for example, the lower levels of accuracy in consonants for the Spanish speakers compared to the English speakers (shown in Table 1). The difference may be carried almost exclusively by the greater difficulty of the language-specific r-phonemes in that language. All of the r-phonemes are later developing but the trill is especially hard (only one child in each group of Spanish learners produced it some of the time), so Spanish learners' overall consonant accuracy may be more equivalent to English learners' without /r/ in the equation. We also uncovered the interesting allophonic differences noted above.

The findings reported here appear to differ somewhat from quantitative findings in other studies (Gildersleeve-Neumann et al. 2008; Goldstein and Washington 2001). Part of the explanation may come from social class differences between subjects, which are known to have a large effect on language development. The BSG subjects were for the most part middle- to high-SES in a relatively supportive community, whereas large populations of bilinguals in the U.S. and Europe are immigrants subject to subtractive environments. On the other hand, even where our quantitative findings are similar to other laboratories', like the Maneva and Genesee (2002) and Poulin-Dubois and Goodz (2001) studies, our interpretations sometimes differ. We offer evidence for our claims, but recognise that no single piece of evidence is conclusive. What is clear is that caution must be taken in the tricky task of comparing phonologies crosslinguistically. The same issues arise even more for comparing across languages within bilingual individuals.

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