

# Differentiation, Carry-over and the Distributed Characteristic in Bilinguals: Differentiation in Early Phonological Adaptation?

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## 1. (Early) phonological adaptation in bilingual-learning babies

### 1.1 *What language(s) do bilingual-learning babies babble in?*

This is a question often asked by parents and teachers of young bilinguals, but as yet not satisfactorily answered. It is unremarkable to claim that English babies babble in English and French babies babble in French. All phonetic adaptations monolingual babies make toward more faithful productions of phonemes is progress toward the language of their community. They do this by default: the context of their utterances is the language they are hearing, and if they have word targets, the targets will be in that language as well. There is no requirement for early utterances, whether babble or speech, to actually “sound” distinctly English or distinctly French, as both babble and early words can easily be composed of universal syllables (Locke, 1983).

The question is more complicated for bilingual learners. To answer this question for infant bilinguals, we must explore the relationship of the child’s PHONETIC PROGRESS IN TWO LANGUAGES and take into account the relationship of the phonetic elements of the two languages to each other. As in our work on lexical development (Pearson, Fernandez, & Oller, 1993, 1995; Pearson & Fernandez, 1994), we approach the issue from the perspective of the bilingual’s overlapping knowledge in two languages. The child’s two languages have different phonological inventories; some elements of the two inventories will be found in common in both languages, but some elements will be specific to the individual languages. Such elements will be

characteristic of Language X and  
distinct from Language Y.

For a child learning Spanish, for example, correct production of the alveolar fricative in the proper environments can be considered progress in Spanish phonology. However, it would not be differentiated from progress toward English targets. The bilabial fricative, by contrast, occurs only in Spanish and not in English, so its correct production would be considered progress in Spanish, but not in English. Existing evidence is unclear as to whether BABBLING inventories are sufficiently developed that they can be said to be both characteristic of Language X and distinct from Language Y.

Why is this question important? For monolinguals, listeners automatically assume they are attempting the language of their community. There is no requirement that the utterances contain distinctive language-specific phonetic elements. Learning to mark utterances as consistent with the phonetic inventory of a particular language is a by-product of learning to talk. But for bilinguals, signaling to the listener which language they are attempting may have utility in itself. It could help make their utterances more intelligible. Suppose that a child says [a p u]. A Spanish-learning child standing next to a tree might be targeting “arbol” (*tree*); but an English learner standing next to the same (apple) tree, will probably be targeting “apple.” If the listener could tell from the phonetic characteristics of the utterance which language the child was attempting, he or she might know which language “set” to use to interpret it. The means by which children signal what language they are targeting are relatively unstudied. That investigation, it seems to us, begins with monolinguals learning different languages.

This study explores the following three questions cross-linguistically and across linguality (mono- and bilingual):

### Question 1:

When does a Chinese-learning child sound Chinese?

When does an English-learning child sound English?

In typically-developing monolingual children, when can we reasonably expect to be able to tell for a given utterance (with no lexical content to “give away” the language) WHAT LANGUAGE it was TARGETING? When do monolingual-learning babies’ utterances contain language-specific phonetic elements capable of communicating on phonetic grounds alone what the language of the child’s target is. (The target might be a word, or it might be “pre-linguistic”--or babbled--aimed at matching the sounds of the child’s environment without reference to any meaning for the sound. Since we do not know yet if children can reliably produce the language-specific elements of their language(s) in babbling, any such gradual movement toward the phonetic norms of a language cannot with confidence be called “babbling drift” (Brown, 1958). We substitute instead the more neutral term “phonological adaptation.” Phonological adaptation might take place in babbling, but might not be established until after babbling, when lexical targets begin to constrain the phonetics of children’s utterances.)

### Question 2

What elements of an utterance contribute to language intelligibility? Does faithful pronunciation of universal elements found in the utterances of children (in the linguistic communities of a bilingual) correlate with greater levels of language intelligibility? Or do language-specific phonetic elements, once they are present, provide the most effective CUES to tell listeners which language a child is targeting?

### Question 3 (the bilingual corollary):

Does the potentially different level of utility of language intelligibility for monolinguals and bilinguals create different paths of progress toward language-specific phonology among different learners?

- Do bilinguals appear to FOCUS ON language-specific phonetic elements which will help them mark the language of their utterances to promote greater intelligibility?
- Or do bilinguals AVOID elements identified with one language—and not the other-- and concentrate on sounds that will serve them equally well in both languages?

## 1.2. *Applicable literature*

There is a large literature relevant to early phonological adaptation, often called “ambient language effects.” That is, certain vocal developments might be considered maturational and will be the same for infants learning all languages. To the extent that children’s vocalizations are shaped by the particular language surrounding them, the effect will be specific and attributable to the experience of hearing the ambient language. We are looking for evidence of “language intelligibility,” an observable consequence of ambient language effects. If a child’s utterance is well-enough articulated that a blinded listener can correctly identify the language of the utterance from phonetic information alone, then the child has achieved “language intelligibility” (for that utterance). However, not all studies of ambient language effects will be helpful for the question of language intelligibility in bilinguals. For bilingual differentiation, one needs to know which adaptations apply to language X but not language Y and vice versa. One can distinguish different LEVELS of ambient language effects (or language specific development) according to the method used to establish their influence. In the discussion that follows we distinguish three levels:

- Level 1: Influences identified from differences between groups of individuals (ie. differences between corpora pooled from groups of differently exposed children).
- Level 2: Differences between individual children (corpora pooled across utterances of a single child compared to the corpus of another child or another language group)
- Level 3: Differences observed between individual utterances

We suggest that only Level 3 evidence will suffice for conclusions about distinct paths of adaptation to two languages, as required for early differentiation of bilingual phonologies. Methodological considerations also require Level 3 evidence.

For Levels 1 and 2, the appearance of distinctive language-specific phonemes is not necessary. Level 1 analyses (DeBoysson-Bardies, Halle, Sagart, & Durand, 1989, DeBoysson-Bardies & Vihman, 1991) exploit differences in the distributions of universal elements in different languages. For example, DeBoysson-Bardies and Vihman (1991) showed that a group of five French-learning infants produced fewer stops in their babbling and early words than five like-aged Swedish infants. This difference reflects the greater proportion of stops in adult Swedish compared to adult French. It might be the case that no single Swedish child's values on stops differed reliably from any single French child's values, but in the aggregate, the five children's productions taken together showed differences from the other five children's pooled vocalizations.

Similarly for Level 2, most studies do not establish that any single utterance of a child is identifiable as English or Chinese, but a corpus of many utterances from one child may differ from the corpus of another child. For example, in a two-child study of one infant learning English and one learning French, the proportions of closed and open syllables were compared (Levitt & Utman, 1992). Both languages have both types of syllables, but English utterances typically have many more closed syllables than French do. Both children had a preponderance of open syllables, reflecting what appears to be a universal preference in babbling and early speech regardless of target language. However, the English child at 11 months had about 10% closed syllables, which was high compared to the French child's corpus where only about 3% closed syllables were observed. The increase in closed syllables may be considered a step in the direction of values characteristic of English, but not French. Still, open syllables cannot be considered a criterion for French as it is the less marked alternative. In a study of 10 typically-developing English learning and 7 Spanish learning 11-month-olds (Pearson, Navarro, Oller & Cobo-Lewis, 2001), half of the English-learning children had closed and open syllable values identical to the Spanish-learning children's, and one of the Spanish children's closed syllable percentage was higher than most of the English learners'. Even the aggregated values of the two groups were not statistically different despite having half of the English learners with elevated closed-syllable percentages.

A similar interpretive dilemma was faced in a study comparing a corpus identified as 13-month-olds babbling in the company of the English-speaking parent and a corpus of the same children babbling in the company of the French-speaking parent (Poulin-Dubois & Goodz, 2001). Using the kinds of measures that distinguished the cross-linguistic groups in DeBoysson-Bardies and Vihman's study (1991), Poulin-Dubois and Goodz found no reliable difference between the two corpora. Both corpora resembled the DeBoysson-Bardies and Vihman French values more than the English ones. However, since the French values were least different from the babbling of the other language groups in the DeBoysson-Bardies & Vihman study, they probably represent the less marked alternative as well. Similarly, Maneva and Genesee (2003) also separated a bilingual corpus into English sessions and French sessions and observed some suggestive rhythmic differences between them. However, with only one subject, many fewer utterances than Levitt and Utman, and no control for whether transcribers could hear occasional words that might bias their transcriptions (Oller & Eilers, 1975), their findings must be considered very preliminary.

"Blind language identification" tests also provide Level 2 evidence. In this type of study, listeners who do not know the nationality of a child are asked to listen to several utterances from the child and tell which of two or three languages the child is targeting. Results of such tests are mixed. DeBoysson-Bardies, Sagart, and Durand (1984) report that listeners could identify which child was from an Arabic background and which was French. The listeners in her study were successful in distinguishing the 6- to 8-month-olds but not the 10-month-olds. In similar studies conducted with 5- to 17-month-olds by Atkinson, MacWhinney and Stoel (1969), 6 to 18-month-olds by Olney and Scholnick (1976), and 7- to 14-month-olds by Thevenin, Eilers, Oller and LaVoie (1985), listeners were not reliable at this task. Note that by 16 months, most children have uttered some words (Hart & Risley, 1999), so "babbling" by children of that age also includes words which can reveal the language regardless of their pronunciation. That is, if we hear a child say [kh a row] for Spanish "carro" (car), even if the pronunciation contains phonetic elements more characteristic of English than Spanish, it will still count as an attempt at Spanish.

For evidence at Level 3, to distinguish between individual utterances with no lexical content and to decide whether they are in Spanish or Swahili, for example, one must look for language-specific phonetic elements that characterize one language but not another. That is, if the child can produce a

trilled /r/, one might recognize it as progress in learning Spanish, regardless of whether the child is attempting any Spanish words.

To determine whether a monolingual child's phonology reflects the patterns of a given language or exhibits a "universal" pattern neutral between specific languages, one might look for evidence at Level 2 or Level 3. Even when no language specific elements are observed, one might still look at a set of the child's utterances and see if there is a tendency in the more universal features toward values that have been associated with a given linguistic community (ie. a decrease in [h] in children learning a language like French, which has no /h/ phoneme [Vihman, 1992], or an increase in fricatives relative to a baseline established across several different languages, DeBoysson-Bardies & Vihman, 1991).

For methodological reasons as well, Level 2 will not suffice for identifying the language of bilingual babbling. Unlike a monolingual French-learning baby who one knows is speaking "proto-French," listeners cannot know from context alone what language a bilingual baby is attempting in any given utterance, so one does not know if it belongs in the child's Spanish corpus or her English corpus. One does not have a set of utterances to call "100% Spanish" to compare to a set of utterances called "100% English," so the comparison cannot be made. Other groups studying bilinguals, from Montreal for example, have performed their analyses of early bilingual phonology separating corpora by context (see above). In Montreal, they argue, there is a tradition of "one-parent-one-language," which trains the children to use only the language of their interlocutor. (But see also Goodz (1989), Quay, (1995), Genesee, Boivin, & Nicoladis, 1966 among others for evidence to the contrary.) Whatever its plausibility, this practice was not at all the norm in the 24 bilingual families enrolled in the University of Miami study. Miami parents reported mixing languages freely with their children. In fact, no parents reported following the one-parent-one-language strategy. Although there were some monolingual parents who did no mixing, the bilingual spouse spoke both languages to the child. For children in the Miami study, then, it was not possible to know by context which language the child was targeting. In this circumstance, only with the appearance of distinctive phonetic elements (Level 3) can one point to language specific progress.

Level 3 literature that bears on the development of language specific phonetic elements is sparse, and no phonetic differentiation in production has been noted in a babbling or non-lexical context. Stoel-Gammon, Williams, and Buder (1994) tried to see if the dental /d/ produced by Swedish 30-month-olds and heard in isolation could be distinguished from the alveolar /d/ targeted by 30-month-olds learning English. Even at that advanced age, the task was very difficult and only 3 of 5 trained phoneticians could distinguish them reliably by language group. Pearson, Navarro, and Gathercole (1994) report similar difficulties determining the language of young child speech without supporting context. In several studies of two-year-old children in the context of word production, language-specific distinctions are still weak. There are mentions of aspirated stop consonants in a 24-month-old bilingual-learner (Major, 1977), but even at that age, the aspiration was not consistently realized. Leopold (1970) suggests that his subject Hildegard used essentially the same phonetic inventory in both languages until age two. Deuchar & Clark (1996) followed the development of a voice-onset time contrast in Spanish and English stop consonants in corpora taken from Spanish words and English words. Before 19 months they observed no differences on this feature between the child's production in either context. Schnitzer and Krasinski, (1994) also point out language-specific developments in their case studies, but much later than at the babbling stages and always in the context of words, once again with no provision for blinding the transcriber to the expected language, so expectations may have influenced the perception of any differences noted (Oller & Eilers, 1975).

### *1.3 Goals of the present study*

To test the "language intelligibility" of monolingual and bilingual-learning children, we devised a protocol which satisfied the following requirements:

1. It provides no lexical content (to give away the language targeted).
2. Listeners are completely blinded to the context of the children's utterances, so their judgments are not influenced by expectation.
3. A sufficient number of participants are sampled to make reliable comparisons between monolingual and bilingual learners, as well as English-Spanish comparisons within-child for the bilinguals, and

4. There is a means to evaluate which elements in an utterance contributed to its language intelligibility.

Using this protocol to measure degrees of Language Intelligibility, we can propose answers to the questions set out in section 1.1. Analyses of monolingual individual and group values for language intelligibility informed the answer to Question 1 (when can we expect reliable language intelligibility in young children?) Analyses of the intelligibility of individual utterances, and the phonetic elements realized in the children's pronunciation of them informed the answers to Question 2 (what elements are effective CUES to language intelligibility?) Analyses of monolingual and bilingual group values provide evidence to answer Question 3 (do bilinguals and monolinguals differ in language intelligibility and do they appear to have different strategies to achieve it?)

## **2. Method**

### *2.1 Overview*

The experiment reported here is an updated version of the "blind" listener language identification task (DeBoysson-Bardies et al. 1984; Atkinson et al., 1969; Thevenin et al. 1985), using digitized utterances from 30 English and Spanish monolingual and bilingual children presented by computer in randomized order. In the analyses of which utterances were more or less intelligible and/or language intelligible, special attention was paid to distinguishing elements the two languages shared from elements which were found in only one or the other language: eg. both languages have a bilabial stop contrast, but only English has a retroflex /r/ and only Spanish has a trilled /r/.

The Bilingual Infant Study was part of larger project on early vocal development in several populations (over 100 children). Groups were high-SES term, low-SES term, high-SES pre-term, low-SES pre-term, Downs syndrome, deaf, and bilingual, all followed longitudinally from ages 3 to 36 months. Children were audiotaped monthly (or more often) for the first two years, quarterly for the third year, and various standardized tests were performed (the Bayley, MacArthur CDI, SICD, PPVT, and the Hodson Phonological Processes Assessment). The Early Phonological Adaptation substudy was done on 10 bilingual children and 20 monolingual learning children from the parent study.

### *2.2 Participants*

Ten monolingual Spanish learners, ten monolingual English learners, and ten Spanish and English learning bilinguals, average ages 25.7, 24.9, and 26.1 months respectively, were selected for the study. Audiotapes were available from 3 months on, but 24-28 months was the first age when 10 different intelligible utterances were found for 30 children, plus 10 in each language for the bilinguals. The first ten children in each demographic group whose 100-utterance tapes provided adequate stimuli were selected. They were all mid-SES from an urban environment (Miami). All children were typically developing according to the various standardized tests that had been administered to that point. The bilinguals were experiencing "simultaneous" acquisition of English and Spanish, monitored bi-weekly to 12 months, then monthly. By parent report, they averaged 30-70% English exposure. (It turns out, from the findings of this study, that there were 5 relatively "balanced" bilinguals, 2 Spanish dominant, and 3 English dominant. There was one outlier, a monolingual Spanish 24-month-old, who was much better than the others. All analyses were done with her data and without her data.)

All stimuli were intelligible to both the interlocutors in the session and the researchers transcribing the tape, with as little extraneous or overlapping noise as possible. The sessions which provided the 10 utterances were analyzed for phonological adequacy ("phonadqcy") using a LIPP program (Oller, 1991) to ensure that the groups were at the same approximate level of phonological development.

Table 1. Phonological Adequacy Scores by Group

		N	Mean (and SD) "Phonadqcy"
English			
	BL	10	.880 (.02)
	ML	10	.869 (.03)
Spanish			
	BL	(10)	.89 * (.02)
	ML	10	.93 * (.02)

\*  $p < .01$

The small significant difference in adequacy in Spanish was noted, but appeared to have little impact on the results and so no corrections were applied.

### 2.3 Procedures

430 fully intelligible utterances were digitized, 10 for each child and each linguality, as described above, plus 30 adult utterances, 15 in English and 15 in Spanish, drawn from the same audiotapes. Using the LIPP-Output utility, the 430 utterances, 2/3 single words and 1/3 short phrases, were presented in randomized order to 10 blinded bilingual listeners, who listened to the stimuli through headphones.

Listener characteristics. Listeners were 10 bilingual women, ages 22 to 52. Seven were Cuban-Americans who spoke unaccented English and Spanish. Most reported Spanish to be their first language and English their stronger language. Three were "Americanas," two of whom were married to an Hispanic and had extended residence in Latin America. All were college educated, but not necessarily trained in linguistics. They were paid by the hour for their participation.

The task took about four hours, typically at one sitting. Listeners' directions were: "Tell what word or phrase you hear. If you don't understand the word(s), tell WHICH LANGUAGE the utterance is spoken in, or mark 'no clue.' Listen as many times as you need to by just pressing the space bar."

### 2.4 Coding

Listeners' answers were coded as follows:

- A. Right target
- B. Almost right target (1 phoneme off, ex. "trick" for "brick")
- C. Wrong language
- D. Right language/ wrong (or no) target
- E. No clue

Individual utterances were coded for the number of English Language-Specific Elements or Spanish Language-Specific Elements (and whether they were mono- or polysyllabic).

English L-S Elements:

- Final consonant specific to English (eg. not [s], [d], [n] )
- Aspiration of initial voiceless stop consonants
- Retroflex /r/
- English cluster ([s] + consonant)
- Diphthong "ow"
- Postalveolar fricative "esh"
- Vowels other than /a/, /e/, /i/, /o/, /u/, the "points of the vowel space" --> "non-point" vowels

Spanish L-S Elements

- Final "point vowels" (except [i])
- Fricatives "beta" [β] and "gamma" [γ]
- Trilled /r/

(Contrasted with Shared Phonetic Elements

- b-d-g, p-t-k
- n, m
- [tch]
- l
- f, v )

## 2.5 Measures

1. Right Targets (and nearly Right Targets) **RT** = As + Bs
2. “Ratio” Percent of Right Language given No Right Target

$$\mathbf{RL/NRT} = D (+ 1/2 E) / C + D + E$$

3. **L-S Features:** Number of language-specific phonetic elements
  - a. by Word
  - b. by Child (and Language Group)
  - c. by Listener (These were control studies which will not be treated here, but are found

in Navarro, 1998.)

## 2.6 Analyses

1. Testing language-ID ratios against chance
2. Binomial tests (individuals)
3. One-sample t (average ratios)
4. Comparing linguality groups and word groupings (by features)
5. Two-sample t
6. Correlation
7. (Regression Analyses)
8. Descriptives

## 3. Results

### 3.1 Preliminary results

(This step eliminated the Right Targets from the stimulus pool. That is, the language intelligibility stimuli for each listener were the set of stimuli the listener failed to identify the lexical target for.)

Table 2. Lexical Identification by Language Group

		N	Percent of Right Targets
English			
	ML	100	25.3
	BL	100	22
	adults	15	93.3
Spanish**			
	ML	100	27.7*
	BL	(100)	13*
	adults	15	93

\* p < .01

One child had 60% of her targets understood. The next highest was 35%. Analyses were done with her data and without her data. No differences in significance were observed, and so results are reported including her data.

Average RT overall = 24%. This left 76% (or 760) stimuli for the language intelligibility analyses.

This was a stunning result in itself, illustrating the large role context plays in promoting the intelligibility of child speech. In order for there to be an “answer key,” the correct answer had to be known. 100% OF THE UTTERANCES WERE FULLY INTELLIGIBLE IN CONTEXT (or else they would not have been chosen as stimuli). The near perfect adult results show that the procedure is not unduly difficult. For the most part, the children were considered quite easy to understand. They were speaking in short sentences and fitting in well as apprentice English or Spanish speakers.

### 3.2 Language identification results by language group

Table 3. Correct Language Identification by Language Group

		Percent of Right Language Identifications (RL/NRT)
English		
	ML	.64*
	BL	.58
	adults	.90*
Spanish		
	ML	.64*
	BL	.58
	adults	.89*

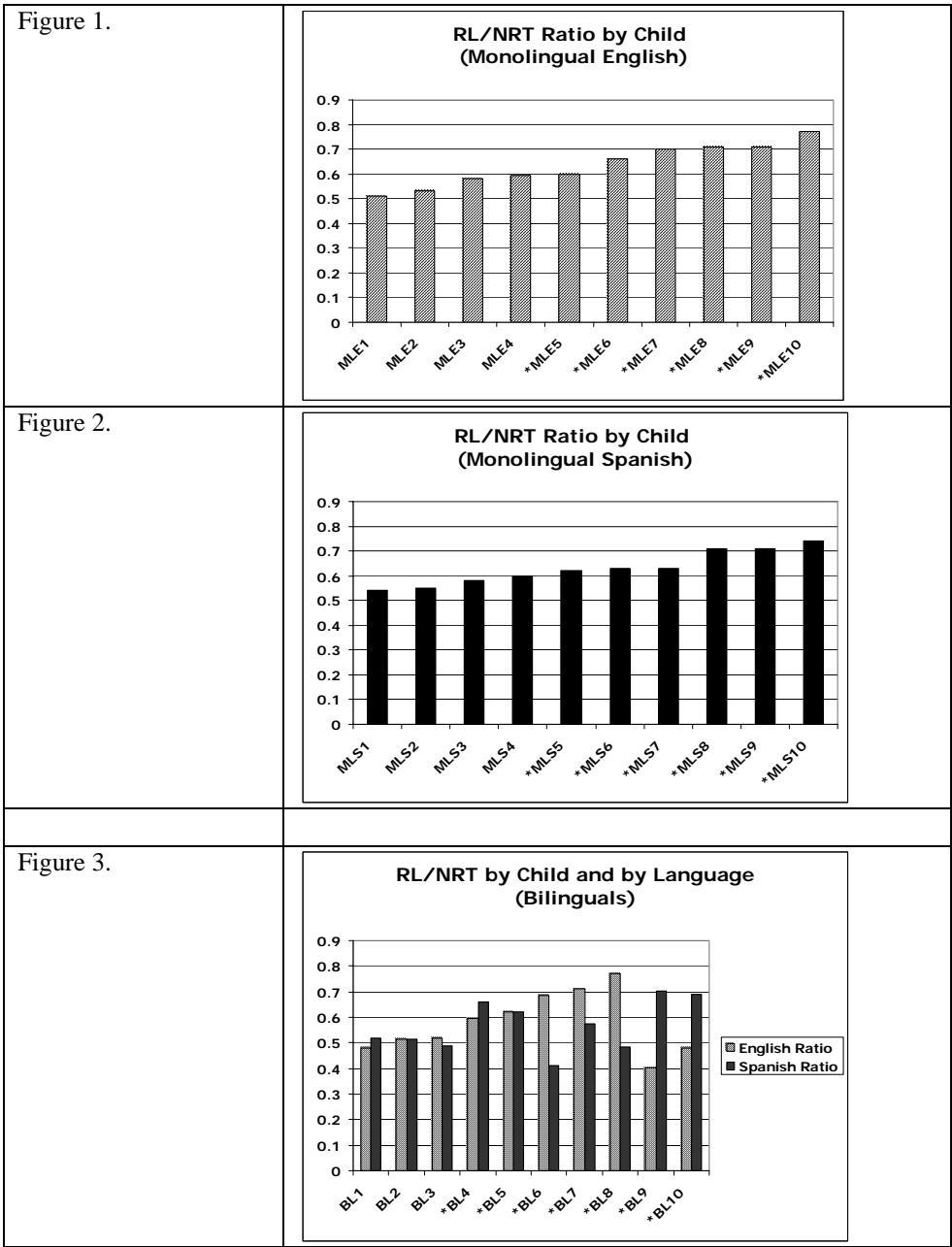
The ML/BL differences are not statistically significant. Both ML “ratios” (Right Language given No Right Target RL/NRT) and the adults are significantly different from chance (.5) by one-sample t-tests, whereas neither of the bilingual ratios are. (In the following section, the apparent bilingual decrement relative to the monolinguals is examined from a different perspective.)

These, too, were surprising results. The children were capable conversational partners by this point, well beyond the initial stages of language learning. It would have been very difficult in a normal conversation not to know which language they were speaking as almost every utterance contained words and sentences which gave away the language. Context appears to have contributed to lexical identification which would contribute to language identification. When the lexical support was eliminated in this procedure, the phonetic information was just barely sufficient to communicate which language the child was speaking. The adult values, once again, are near perfect, (but they represent very few items. Since there were so few items whose lexical targets were not given correctly, there were almost no adult stimuli for this part of the procedure. 5 words times 10 listeners = 150 x 7% = 10.5. 10% of 10 = 1 adult error language ID error per language!)

### 3.3 Language identification results by child (and by group)

The following figures show the RL/NRT ratios for each child. As one can see, in each monolingual group, there are six children with ratios greater than chance. That means that there were six children who could communicate to a listener the language of their utterances on phonetic grounds alone, with no lexical cues to tell the language. There were also four children in each group whose utterances were so ambiguous phonetically that listeners would have done as well identifying the language if they had not bothered to listen, but merely chose English or Spanish at random.

In the bilingual group, there were seven children with enough phonological skill to convince a listener that they were attempting English or Spanish. Three had RL/NRT ratios above chance in English, three in Spanish, and only one in both languages. Rather than showing less skill in this domain, the bilinguals were equivalent to the monolinguals or even slightly better. But English dominant children, with perhaps only 30% of their time in a Spanish environment, contributed their Spanish scores to the bilingual average and pulled down the bilingual average in Spanish. Similarly, the English scores of Spanish-dominant children pulled down the bilingual average in English. When only the better performance of each child is put into the appropriate average, the bilingual ratio rose—to the level of the monolingual averages. BLE = MLE = MLS = BLS = RL/NRT .63.



\* RL/NRT ratios labeled with an asterisk are significantly different from chance (.5) by binomial test. Child BL4 only in Spanish; Child BL5 in both languages.

3.4. Correlations between measures

To evaluate the relative contribution of faithful production of universal and language-specific elements to general intelligibility and language intelligibility, correlations between the study measures were performed.

Table 4. Correlations of Phonadqcy and Language-specific Elements by Language

	ENGLISH	SPANISH
Phonad/ Right Targets	.574*	.834*
Phonad/ RL/NRT	.156	.199
Lang-spec Elem/ Right Targets ++	.045	.111
Lang-spec Elem/ RL/NRT ++	.235**	.245*

\*  $p < .01$ ; \*\* $p < .001$

++ N= 189 (English) and 194 (Spanish), ie. 200 minus the number of targets identified by all 10 listeners as they had no RL/NRT score.

Not surprisingly, general phonological maturity, as measured by the “Phonadqcy” measure contributed to having one’s words understood. That measure, by contrast, appeared unrelated to language intelligibility, as the low correlation of the RL/NRT ratio and Phonadqcy indicates. Similarly, there appeared to be little relationship between the presence of language specific elements in one’s speech and right targets, but the significant correlation between language-specific elements and language intelligibility suggests a stronger link between them.

### 3.5 Right target comparisons by stimuli

Different stimuli were understood by different numbers of listeners. A large number were understood by none of the listeners (87 of 200 in English and 100 of 200 in Spanish), but all the others were understood by at least one person. Another way to illustrate the lack of relationship between the number of features and general intelligibility is to compare the number of features in words understood by everyone to those in words understood by half or none of the listeners.

Table 5. Right Target Judgments by Mean Number of Language-specific Features

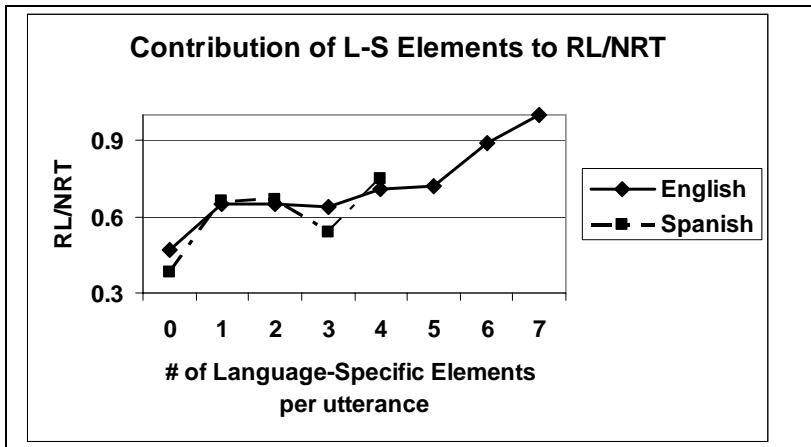
	Right Targets	# of utterances	Mean # of features	Range
English	none	87	1.6	0 – 5
	5	10	2.0	0 – 4
	10	11	2.0	0 – 4
Spanish	none	100	.86	0 – 3
	5	3	1.25	0 – 2
	10	6	1.00	0 – 2

It is clear from the figures in Table 5, that some stimuli with many features (up to 5 in English and 3 in Spanish) were not understood, while there was at least 1 word in each language that had NO language specific features, but was understood by all of the listeners.

### 3.6 Right language (RL/NRT) comparisons by stimuli

We can better understand the low but significant correlation between language intelligibility and language-specific features by plotting the ratio RL/NRT by number of features.

Figure 4. Language Intelligibility (RL/NRT) plotted by number of Language-Specific Elements



The line representing the average ratio is generally a diagonal, indicating that the ratio rises as the number of features rises, ie. the two measures are correlated. But there is also a strong plateau between 1 and 5 features. The biggest jump is between zero features and 1 feature. It took just one language-specific feature to go from language intelligibility below chance to about .65, which we saw in sections 3.2 and 3.3 was generally reliably above chance. Beyond that, there seemed to be little further gain until an utterance had more than five features, which very few of them did.

(One may be tempted to ask, as we did, which of the language-specific features were more effective in promoting language intelligibility than others—but that is the subject of another paper: Navarro, 1998; Navarro, Pearson, Cobo-Lewis, & Oller, in progress).

#### 4. Is there a bilingual strategy with respect to language-specific elements?

We see in the Phonadqcy measure that the bilinguals and monolinguals had similar levels of phonological development generally, but did the groups differ in the number of language-specific features they used at this age? In particular (as in Question 3 above), do bilinguals develop language-specific features to a greater or lesser extent than monolinguals? Table 6 shows the comparison by language group.

Table 6. Mean Number of Language-specific Elements (tokens) by Language Group

		Mean (SD)	Range
English			
	ML	20.5* (6.4)	12-29
	BL	13.6 *(6.2)	5-23
Spanish			
	ML	10.5 (2.0)	8 - 15
	BL	8.5 (2.8)	3 - 13

\*p < .05 by independent sample t-test: t(18df) = 2.441

Despite the potential utility for bilinguals of language intelligibility and by extension the language-specific phonetic features which can promote it, the bilinguals did not use more of them than the monolinguals. In English, they used statistically fewer (although since the bilingual group includes five children clearly dominant in one language or the other, we can have limited confidence in differences between total-group averages such as these are).

Furthermore, we have seen that one needs just one language specific feature to considerably boost the language intelligibility of one's utterances, and so it may be less urgent than we hypothesized for the bilinguals to place a special focus on them, once they have mastered one or two.

## 5. Discussion and limitations

The present work provides reasons for caution in accepting the popular belief that ambient language effects on phonology occur very early in life. Prior studies have suggested both drift in babbling (DeBoysson-Bardies et al., 1984, 1989; Levitt & Utman, 1992) and a verifiable tendency of infants to perceive the sounds of the ambient language differently from the sounds of other languages as early as the second half-year of life (Werker & Tees, 1984; Best, 1994; Fennell, Polka & Werker, 2003). The results here, in contrast, suggest that while phonological adaptation to language-specific sounds is reliably present for most children early in the third year of life, the tendency is relatively weak even though the children have been hearing the language in question for more than two years and speaking it for more than a year. The results suggest that most of the utterances from children 24-28 months do not provide clear evidence of language-specific phoneticity. In fact, once context is stripped away, most utterances that would otherwise be easy to understand are no longer interpretable lexically by adult listeners. This finding reinforces the importance of context in understanding infants and enhances the basis for concern about the potentially biasing effect of context in research on ambient language effects.

This is not to say that subtle early signs of convergence to the phonetic norms of the target language may not be observable in very early speech and perhaps babbling. Some studies have analyzed the frequency of consonants (by manner and place of articulation) produced by groups of children at several stages between 0 and 25 words. The fact that as children learn more words the frequency distribution of their consonants agrees more and more closely with that of the targets they attempt may represent more of a response to lexical pressure than to a general shaping force exerted by the linguistic environment (even though some researchers report evidence of drift at the 0-word stage).

There might be other elements not directly evaluated here where drift may be manifest (in prosodic features, for example, Paradis, 1995). But even if those features constitute stronger language cues than the ones specifically analyzed in this study, their presence, too, appears to be inconsistent in the speech of 26-month-old toddlers, since the average listener was only weakly able to identify the language of utterances that were unintelligible to them lexically.

The present study also bears on the issue of bilingual phonetic differentiation. These results provide at least one kind of evidence that bilingual children early in the third year of life may not be able clearly to differentiate two language-specific phonetic systems. They suggest further that bilingual differentiation in phonological acquisition may appear gradually, and may be more difficult to discern than has been suspected. The evidence of different patterns of convergence found among these ten bilingual children suggests how cautious one should be in making claims on the basis of case studies, or studies with low N's and no context control.

*This work was supported in part by NIDCD Grant RO1 DC00484 at the University of Miami Mailman Center to D. K. Oller, P.I. and an NIH predoctoral minority supplement to A. Navarro.*

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# **ISB4: Proceedings of the 4th International Symposium on Bilingualism**

edited by James Cohen, Kara T. McAlister,  
Kellie Rolstad, and Jeff MacSwan

**Cascadilla Press   Somerville, MA   2005**

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ISBN 978-1-57473-210-8 CD-ROM  
ISBN 978-1-57473-107-1 library binding (5-volume set)

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