Early Phonological Acquisition in a Set of English-Spanish Bilingual Twins

David Ingram, Arizona State University

Virginia Dubasik, Arizona State University

Juana Liceras, University of Ottawa

Raquel Fernández Fuertes, University of Valladolid

ABSTRACT

This study is the first attempt to examine the early phonological development of bilingual twins. It sought to determine the extent to which the phonological acquisition of twins was similar, and the extent to which the phonological acquisition of the two languages was similar. Language samples from twin boys acquiring English and Spanish simultaneously were taken at 18, 19 and 20 months of age, in English and Spanish. The samples were analyzed using nine measures of phonological acquisition. A scale of phonological similarity was developed to quantify comparisons between the languages and between the children. The results indicated that the phonologies of the twins were 92% similar in each language, showing highly similar, but not identical systems. The phonologies of the languages were 71% similar, indicating that being twin did not impede early language separation.

The study of twins has a long and extensive history dating back a century. Researchers have examined similarities between twins and non-twins, both in terms of the properties of language being acquired and the extent to which twin language acquisition is delayed relative to non-twin (singleton) children. Most generally, it has been found that twins tend to be more similar than non-twins, and that twins show more language delay in comparison to typically developing non-twin children. Likewise, there has been an extensive literature on bilingual language acquisition, addressing similar questions. Researchers have been interested in whether or not bilingual children acquire language in similar ways to monolingual children, both in terms of the specific aspects of language being acquired and the rate of language acquisition. For the early stage of bilingual acquisition, a particular interest has been in language separation, i.e. when do bilingual children begin to show signs of separating the languages? Most generally, it has been found that bilingual children show early language separation, as early as the second year of life.

Despite this diverse and active range of research on twin and bilingual language acquisition, no studies have addressed the topic of this study, which is the early phonological acquisition of bilingual twins. In particular, the present study is concerned with whether or not twin children show early separation of their phonological systems in the same way as monolingual children. Much of the literature on twin acquisition is not directly relevant for this study. For example, the study is not addressing issues of similarity between twins and non-twins, nor issues about the rate and course of their language acquisition. Likewise the relevant literature in bilingual acquisition is also limited, consisting of a small number of studies on early bilingual phonological acquisition. The following sections briefly review relevant studies on phonological acquisition in twins and bilingual children respectively.

The studies on phonological acquisition in twins have addressed the same questions as twin studies on language acquisition as mentioned above. They have found that twins are delayed in relation to non-twins in their speech acquisition (e.g. Matheny and Brugmann 1972), and that monozygotic twins are more similar than dizygotic twins (Lewis and Thompson, 1992). A series of studies by Dodd and colleagues has shown that twin phonologies are not only delayed but show disordered characteristics (e.g. Dodd and McEvoy, 1992). While twins may show similarities to each other, no studies have found identical acquisition. In fact, despite similarities in group studies, case studies have also shown how non-alike twins can be. Leonard, Newhoff and Mesalam (1980) found phonological differences in their case study of two-year-old twin girls. Clements and Fee (1994) reported on a set on twins in which one was developing typically but the other was phonologically impaired. The results have found that twins may show some similarities in their speech development, but are by no means identical.

The first studies on early bilingual acquisition proposed that bilingual children start out with a single linguistic system, then begin to separate the languages (Volterra and Taeschner, 1978). This point of view was extended to early phonological acquisition in Vogel (1975). One of the first studies to challenge this position was Ingram (1981/82). In a case study of a two-year-old English-Italian child, Ingram found some emerging differences in the early phonetic inventories, and differences in preferences for syllables. More recent research has supported this result or early language separation, though the ways in which this takes place are far from understood (Bunta, Davidovich and Ingram 2006, Johnson and Lancaster 1998, Keshavarz and Ingram 2002, Paradis 2001).

The present study was conducted to provide preliminary results on the interaction of being twin and being bilingual, by conducting a case study of bilingual twins. Given previous

research on twin phonology, it was hypothesized that the twins would show similar, but not identical, phonological systems. It was more difficult to determine a hypothesis regarding language separation. If bilingual twins acquire language like monolingual children, one would expect the twins to show early language separation. Given the shared genetic and environmental properties of being twin, however, it was equally possible that the twins would show delayed language separation. Both possibilities, therefore, were considered equally possible.

METHOD

Participants. The participants were twin boys Leo and Simon, acquiring Spanish and English simultaneously in Spain. Their mother was a native English speaker and their father was a native Spanish speaker. The boys were spoken to in both languages according to the parental native language. Their language acquisition was followed in an extensive longitudinal study from the ages of 1; 0 to 6; 0. Samples were recorded every two to three weeks, approximately 30 minutes in length. At each sample point, the twins were recorded separately in Spanish and in English. The present study examined the period of early word acquisition, using language samples of each language at 18, 19, and 20 months of age.

Language Samples. Each language sample was transcribed into CLAN format (MacWhinney & Snow, 1985), written in either English or Spanish orthography. Subsequently, the transcripts were used to identify utterances in the original audio recordings. Each child utterance was extracted into an individual sound file (.wav format) for a total of 1,415 sound files. Leo produced 280 English word tokens and 252 Spanish word tokens, while Simon produced 323 English word tokens and 307 Spanish word tokens. Other sounds files were excluded because the child speaking was not identifiable.

The extracted sound files were then examined for transcribable words, i.e. words that were clear enough to be transcribed phonetically. Nontranscribable words were the result of limited amplitude, ambient noise, and/or another speaker (sibling or adult interviewer), speaking concurrently. There were 254 words identified by this process, consisting of 124 words for Leo (64 English words and 60 Spanish words), and 130 words for Simon (67 English words and 63 Spanish words). The transcribable words were subsequently transcribed independently by two phonetically trained transcribers, with differences resolved by a third transcriber.

Phonological Analyses. The final transcriptions were then phonologically analyzed using an adaptation of the Basic Analysis system in Ingram & Ingram (2001), developed in turn from other work found in Ingram (1989) and Ingram (1981). This system examines four aspects of a child's early phonological system: whole word properties (Ingram, 2002), word shapes (syllables), independent consonantal inventories, and relational analyses of consonants.

Whole word properties examine the overall complexity of a child's word through two measures, the phonological mean length of utterance (pMLU), and the measure of whole-word proximity (Proximity). The pMLU assigns a score to each target word and each child production. The target word receives a point for each segment, and an additional point for each consonant. For example, a word such as 'cookie' receives 6 points since there are four segments and two consonants. The child pMLU is calculated by assigning a point for each segment, and an additional point for each correct consonant. If a child says 'cookie' as [gugi], the child receives a score of four, since there are four segments but no correct consonants. The scores for all target words and all child words are then averaged for a final pMLU score for each set of words. Proximity measures the fit between the child pMLU and the target pMLU by dividing the latter

into the former. The example above yields a Proximity of .67 (or 67%), by dividing the child score of four by the target score of six.

Word shapes are the syllabic structures that children use in their words. Research on early phonological acquisition has shown that children select from small number of word shapes in their first words, particularly CV, CVC for monosyllables and CVCV, CVCVC and VCV for multisyllabic words. Each child's words were broken down into their respective word shape from the five given above, and any other ones that occurred, e.g. V, VC. Two measures were then determined from this analysis. One was the proportion of monosyllables, determined by dividing the number of monosyllabic word shapes by the overall number of words. The second measure was the number of preferred word shapes. A preferred word shape was one that was found in at least ten percent of the total number of word shapes.

Independent analyses concern the consonants that children are using separately in onset and coda positions in words, without reference to the target sounds. Onsets were determined as either consonants used at the beginning of a word, or used intervocalically. Coda consonants were determined to be consonants either used at the end of a word, or intevocalically before an onset consonant. Once the frequencies of occurrence are determined for each consonant, a frequency criterion was used to separate the infrequently occurring consonants from the frequently occurring ones (Ingram, 1981). Consonants occurring two or three times as onsets or codas were considering marginal, those occurring four to six times were considered used, and those occurring seven or more times were considered frequent. The Articulation Score (Ingram, 1981) was calculated separately for onset and coda consonants. A child received two points for each consonant that was used or frequent, and 1 point for each consonant that was marginal.

A relational analysis was used to determine the use of the consonants in the independent analysis in relation to their targets in the adult words being produced (Ingram, 1989). For example, a child might use [t] frequently, and it might be used both for the correct production of /t/, and as a substitute for another phoneme such as /k/. The relational analysis identified phonemes that are being used correctly, i.e. matches, and those that were being produced by substituted sounds, i.e. substitutions. A match was defined as a phoneme attempted at least three times, and produced correctly in over 50% of words attempted. Articulation Scores were calculated separately for onset and coda consonants. A child received two points for each match.

In summary, nine measures were calculated for each child's Spanish and English. The nine measures were: pMLU of target words, pMLU of child words, proximity, proportion of monosyllables, number of preferred word shapes, articulation scores for onset and coda consonants in the independent analysis, and articulation scores for onset and coda consonant matches in the relational analysis.

A Measure of Phonological Similarity. The phonological analyses above provide an overview of a child's emerging system, but only indirectly provide a comparison between children. Children may be more similar in certain areas than others, but drawing conclusions from the analyses alone would involve subjectivity. To make these comparisons more objective, a measure of phonological similarity was developed to measure similarities across the four areas of phonology that were analyzed. For each of the nine measures the children were assigned points along a continuum. A problem arises at the onset concerning the determination of what differences should be considered within a normal range of variation, and which differences should be considered true variance. The final system used was the result of the first author's

intuitions about how such variation occurs based on his experience in conducting such analyses (see Table 1).

INSERT TABLE 1 ABOUT HERE

RESULTS

Phonological Analyses. The results of the phonological analyses for the whole word and syllable shape measures are given in Table 2. Concerning the whole word measures, the target pMLU measures ranged from 6.1 to 6.7, with the higher values occurring for the Spanish words. The child pMLUs ranged from 3.9 to 4.9, with the higher values again occurring with Spanish. Lastly, Proximity ranged from .63 to .78, with Spanish words showing the higher proximities.

The word shape analysis showed similarities between the children, but differences across the languages. The children showed a relatively equal use of monosyllables and multisyllables for English words, but a very high rate of multisyllabic words for Spanish. The preferred syllable shapes likewise showed a language difference. The shape VCV was not frequent for English, but was for Spanish. Conversely, CVC was the most common form for English but was uncommon in the Spanish samples. There was a within language difference for the children in English, with Leo preferring CVCV word productions while Simon showed a higher preference for CVC productions.

INSERT TABLE 2 ABOUT HERE

The results of the independent and relational analyses are given in Table 3. The independent analysis showed larger inventories for onsets than codas, especially so for Spanish. The onset stop consonants superficially appear to be different, with [b, d, g] appearing in the English inventory while [p, t, k] appear in the Spanish inventory. These two sets, in fact, are phonetically similar, i.e. an unaspirated stop that sounds to English speakers more similar to the

voiced rather than voiceless stops. The existence of an early stage of stop production in English when there is not voice contrast and both /b, d, g/ and /p, t, k/ are produced as closer to a voiced variant has been reported in Macken and Barton (1980a). These were thus recorded in that way. For Spanish, however, the early unaspirated stops are perceived as productions of voiceless stops, due to the differences in voice onset time between English and Spanish (Deuchar & Clark, 1996; Macken & Barton, 1980b). The use of unaspirated stops for Spanish voiced stops, therefore, is perceived as an error, and was scored as such. In this sense, the children's inventories are similar in their acquisition of this class of consonants, and the transcription represents the role of these as shown in the relational analysis. Differences in the children's inventories also appear among the fricatives, where [f] occurs in the English inventories while [s] is more prevalent in the Spanish inventories. All inventories show some productions of post-alveolar fricatives, though these vary from 'sh' to [x] to [h]. An impressionistic assessment would be that the inventories are similar but not the same, and that the inventories look more similar within languages than across them.

INSERT TABLE 3 ABOUT HERE

The relational analyses showed similarities between the children in that they both acquired nasals, a class of stops with three places of articulation, some voiceless fricatives, and at least one approximant (glide or liquid) consonant. Simon's English words showed the most advanced acquisition of coda consonants, though his inventory is smaller in Spanish.

Phonological Similarity. The analysis of phonological similarity applied the criteria from Table 1 to the data in Tables 2 and 3 to quantify more explicitly the similarities between the children and languages. It provides two comparisons, one between the children in each language, and one between the languages within each child.

INSERT TABLES 4 & 5 ABOUT HERE

The first column of Table 4 compares Leo's English with Simon's English. The children scored 80% or greater on eight of nine comparisons, indicating an overall similarity of 88%. The primary difference between the children was in the matching of coda consonants, where Simon matched four consonants compared to Leo who matched two. The Spanish comparisons yielded a percentage of 94% similarity, again with only one measure below 80%. Leo's Proximity was higher for Spanish than was Simon's (.78 vs. .71).

The comparisons between the languages for each child yielded lower percentages (see Table 5). Leo showed a similarity of 73%, while Simon's rate of similarity was 68%. For Leo, there were four measures that were below 80% similar, while Simon had five measures below 80% similar. Leo's languages differed especially in the whole word measures, with Spanish having higher child pMLUs and Proximity scores. His English, however, was much more monosyllabic. Simon's English and Spanish showed differences across all the measurement categories. He showed higher child pMLU scores and more monosyllables, as did Leo. In addition, he showed larger inventories of onset consonants in Spanish as well as a higher rate of matches. Conversely, he used more coda consonants in English, with more matches.

DISCUSSION

It was hypothesized that the twins would show highly similar phonological acquisition, given their genetic similarity and shared environment. They did not show identical phonological acquisition. There were three of the 18 measurements used in their English and Spanish that showed similarities less than 90%. One of these was the area on whole-word Proximity, where Simon's Proximity was higher in English than Leo's, while the reverse was true for Spanish.

Another difference was with coda consonants, where Simon's coda consonants were more advanced than Leo's. The third area of difference was in their preferences for word shapes. While both children used an equal percentage of CV words (21% vs. 19%), they differed in their most preferred word shapes. Whereas Leo demonstrated a preference for CVCV words (27%), Simon demonstrated a preference for CVC (29%). The latter is further evidenced by Simon's greater use of coda consonants.

Other differences can be identified by looking more closely at the consonantal inventories in the independent and relational analyses. When onsets are considered, Leo showed a preference for the use of alveolar consonants compared to labial consonants, while Simon showed the reverse. This difference can be captured by calculating the Articulation Score in the independent analysis for labial versus alveolar onset consonants. Leo's score for labials was 11 compared to 15 for alveolars. Simon's score, however, was 13 for labials, and 11 for alveolars. There were specific differences in the inventories themselves. Leo used an [l] at criterion in both English and Spanish, while Simon only used it marginally in Spanish. Additionally, Leo used the velar fricative [x] in his Spanish, while Simon used an [h] in similar contexts.

Turning now to the issue of bilingual acquisition, the hypothesis was that there would be a twin influence such that the similarities between the twins would extend to the two languages being acquired. The results of the study did not support this hypothesis in that the similarities between the languages were lower than between the children. Leo's English and Spanish phonologies were 73% similar, and Simon's were 68% similar.

The language differences were most noticeable with regards to the whole-word measures and word shapes measures. In the whole word measures, the Spanish target words were more complex as defined by pMLU. Also, the child pMLU measures were higher for Spanish, nearly a

single point. Similarly, the Proximity scores were higher for Spanish by nearly 10 percentage points. These overall differences reflect the fact that the children produced more complex forms for Spanish, along with closer approximations to the adult target words, despite the fact that the targets words were longer. The differences in word shapes concerned both the syllable structures of words and the preferred syllables. The twin's English words were equally divided between monosyllables and multisyllables, with a slight preference for monosyllables. Their Spanish words, however, were highly multisyllabic. Secondly, there were differences in syllable preferences. VCV syllables occurred over 10% of the time in Spanish, but not in English. Conversely, CVC syllables were highly used by both children in English, but by neither in Spanish.

Language differences were not as striking for the independent and relational analyses, but were found nonetheless. There were more coda consonants in English than in Spanish. The Articulation Score for English coda consonants in the independent analysis was 13, as compared to 7 for Spanish. The inventories did overlap to quite a degree. For example, both languages contained the nasal consonants [m], [n], and three stop consonants. There were also similar numbers of fricatives, liquids and glides. The preferred fricatives, however, did vary by language. The labio-dental [f] was more used than [s] in English, but [s] was highly frequent and more preferred in Spanish. This was true for both onsets and codas. There were also two language specific fricatives, with 'sh' appearing in the English samples and [x] in the Spanish samples.

REFERENCES

Bunta, Ferenc, Ingrid Davidovich, and David Ingram. 2006. The relationship between the phonological complexity of a bilingual child's words and those of the target languages. *International Journal of Bilingualism* 10: 71-88.

Clements, Albertine, and E. Jane Fee. 1994. An intra-twin phonological study: phonologies of a SLI twin and her normally developing brother. *First Language* 14: 213-231,

Ingram, David. 1981. *Procedures for the phonological analysis of children's language*. Baltimore, Md.: University Park Press.

Ingram, D. 1981/82. The emerging phonological system of an Italian-English bilingual child. *Journal of Italian Linguistics* 95-113.

Ingram, David. 1989. *Child language acquisition: Method, description, and explanation*. Cambridge: Cambridge University Press.

Ingram, David. 2002. The measurement of whole word productions. *Journal of Child Language*, 29: 1-21.

Ingram, David. 2007. Cross-linguistic phonological acquisition. In Martin Ball, Michael R. Perkins, Sara Howard, and Nicole Muller (eds.), *Handbook of Clinical Linguistics.* Blackwell. 626-640.

Ingram, David, and Kelly Ingram. 2001. A whole word approach to phonological intervention. *Language, Speech and Hearing Services in Schools*, 32: 271-283.

Johnson, Carolyn E. and Paige Lancaster 1998. The development of more than one phonology: A case study of a Norwegian-English bilingual child. *International Journal of Bilingualism* 2: 265-300.

Keshavarz, M. & Ingram, D. (2002). "The early phonological development of a Farsi-English bilingual child. *International Journal of Bilingualism* 6; 255-269.

Leonard, Laurence, Marilyn Newhoff, and Linda Mesalam. 1980. Individual differences in early child phonology. *Applied Psycholinguistics* 1: 7-30.

Lewis, Barbara and Lee A. Thompson. 1992. A study of developmental speech and language disorders in twins. Journal of Speech and Hearing Research 35: 1086-1094.

Macken, Marcy, and David Barton. 1980a. The acquisition of the voicing contrast in English: a study of voice onset time in word-initial stop consonants. *Journal of Child Language* **7**: 41-74.

Macken, Marcy, and David Barton. 1980b. The acquisition of the voicing contrast in Spanish: a phonological study of word-initial stop consonants. *Journal of Child Language* 7: 433-458.

Matheny, Adam and Charlene Bruggemann. 1972. Articulation proficiency in twins and singletons from families of twins. *Journal of Speech and Hearing Research* 15: 845-851.

McEvoy, Sandra, and Barbara Dodd. 1992. The communication abilities of 2- to 4-year-old twins. *European Journal of Disorders of Communication* 27: 73-87.

MacWhinney, Brian, and Catherine Snow. 1985. The child language data exchange system. *Journal of Child Language* 12:2. 271-295.

Paradis, Johanne. 2001. Do bilingual two-year-olds have separate phonological systems? *The International Journal of Bilingualism* 5: 19-38.

Vogel, Irene. 1975. One system or two: an analysis of a two-year-old Romanian-English bilingual's phonology. *Papers and Reports on Child Language Development* 9: 43-62.

Volterra, Virginia, and Traute Taeschner. 1978. The acquisition and development of language by bilingual children. *Journal of Child Language* 5: 3211-326.

Table 1. The Measurement of Phonological Similarity

General Calculation. All scores are out of 10 possible points. Each point assigned to a difference drops the overall similarity 10%. Final results are given in percentages, so 8 out of 10 points is 80%.

Whole Word Measures:

Target pMLUs, and child pMLUs, are considered the same if they are within +/- .3 of each other. Differences greater than that receive one point for each .3 difference. Proximities are considered the same if they are within +/- .03 of each other. Differences greater than .03 receive 1 point for each .03 difference.

Word Shapes:

Proportions of Monosyllables are considered the same if they are +/- .05 of each other. Differences greater than that receive 1 point for each .05 difference. Preferred syllable shapes are considered the same if they are the same in number. Differences greater than that are given 1 point for each difference.

Independent Analysis: Children are considered the same is their Articulation Scores are the same. If they are different, 1 point is assigned for each 2 point difference. The score is calculated separately for onsets and codas.

Relational Analysis: The score for the relational analysis is done is the same manner as the Independent Analysis, and is restricted to matches.

Table 2. Phonological Analyses for Leo and Simon in English and Spanish

	Leo's English	Simon's English	Leo's Spanish	Simon's Spanish
-				
Whole Word Measures				
pMLU Targets	6.2	6.1	6.3	6.7
PMLU Child	3.9	4.1	4.9	4.8
Proximity	.63	.67	.78	.71
Word Shapes				
Prop. Monosyllables	.52	.54	.22	.22
Preferred Syllables				
CVCV	.27	.19	.47	.36
CV	.21	.19	---	.17
CVC	.20	.29	---	---
VCV	---	---	.16	.22

Table 3. Results of Independent and Relational Analyses

Independent Analyses

	Leo's English	Simon's English	Leo's Spanish	Simon's Spanish
Onsets	m* n	m (n)	m* n*	m* n*
	b* d* g*	b* d* g*	p* t* k*	p* t* k*
	f (s) sh*	f* (s) (sh)	(f) s* x	s* (h)
	l (j)	(w) j	l j*	w (l) j
Codas	n*	n*	n	(n)
	(k)	(t) k		
	(f) s*	s*	s	s*

Relational Analyses

	Leo's English	Simon's English	Leo's Spanish	Simon's Spanish
Onsets	/m,n,b,d,f,sh,(l),(j)/	/m,n,b,d,g,f,s,(w)/	/m,n,p,t,k,f,s,x,j/	/m,n,p,t,k,v,(f)s,l,(j)/
Codas	/n,(f)/	/n,t,k,f/	/n,s/	/n,s/

Table 4. Similarities within languages (Leo's English vs. Simon's English and Leo's Spanish vs. Simon's Spanish); Child with higher score is given in parentheses for measures under 80% similar

Measures	Leo vs. Simon English	Leo vs. Simon Spanish
pMLU Targets	100%	90%
pMLU Child	100%	100%
Proximity	90%	70% (Leo)
Prop. Monosyllables	100%	100%
Preferred Syllables	100%	100%
Articulation Scores Onsets	80%	100%
Articulation Scores Codas	90%	90%
Number of Matches Onsets	90%	100%
Number of Matches Codas	50% (Simon)	100%
	---	---
Overall Similarity	88%	94%

Table 5. Similarities between languages (Leo's English vs. Leo's Spanish, and Simon's English vs. Simon's Spanish); Language with higher score in shown in parentheses for measures under 80% similar.

Measures	Leo	Simon
pMLU Targets	100%	80%
pMLU Child	60% (Spanish)	70% (Spanish)
Proximity	30% (Spanish)	80%
Prop. Monosyllables	50% (English)	40% (English)
Preferred Syllables	80%	90%
Articulation Scores Onsets	100%	70% (Spanish)
Articulation Scores Codas	80%	60% (English)
Number of Matches Onsets	60% (Spanish)	60% (Spanish)
Number of Matches Codas	90% (Simon)	60% (English)
	---	---
Overall Similarity	73%	68%