7-2001

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Clinical Forum

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In the United States, there are many individuals who speak languages other than and in addition to English. Spanish, with more than 22 million speakers (approximately 9% of the population), is the language other than English that is most likely to be spoken by individuals in the United States (Grimes, 1996). If, as predicted, the number of Hispanic/Latino individuals in the United States rises to more than 51 million by the year 2025 (an increase to 15.7% of the U.S. population), then there will be approximately 26 million Spanish speakers in the United States by that time, at least 5 million of whom will be under the age of 5 years (U.S. Bureau of the Census, 1995).

Despite the increasing number of individuals in the United States speaking languages other than English, almost all data that exist on phonological development in preschool children come from monolingual speakers, in particular, monolingual English speakers (e.g., see Bernthal & Bankson, 1998 for a review). Although some data also have been collected from monolingual speakers of languages other than

ABSTRACT: **Purpose:** This collaborative study investigated phonological patterns in 12 typically developing 4-year-old bilingual (Spanish-English) children.
Method: A single-word phonological assessment with separate versions for English and Spanish was administered to each child. Analyses consisted of a phonetic inventory; percentage of consonants correct; percentage of consonants correct for voicing, place of articulation, and manner of articulation; and the percentage of occurrence for phonological processes.
Results: The results indicated that there were no significant differences between the two languages on percentage of consonants correct; percentage of consonants correct for voicing, place of articulation, and manner of articulation; or percentage of occurrence for phonological processes. However, the children exhibited different patterns of production across the two languages and showed different patterns compared to monolingual children of either language.
Clinical Implications: The preliminary findings suggest that the phonological system of bilingual (Spanish-English) children is both similar to and different from that of monolingual speakers of either language. Compared to monolingual speakers, bilingual children should be expected to exhibit different types of errors and different substitution patterns for target sounds.

KEY WORDS: children, bilingual, Spanish phonology, phonological patterns

0161–1461/01/3203–0153

English (see Yavas, 1998 for a review), little information exists concerning phonological development in bilingual speakers. It may be the case that phonological acquisition in bilingual speakers is different from that for monolingual speakers. Given that the majority of bilingual speakers in the United States will be speakers of Spanish and English, it is imperative to begin exploring the phonological systems of bilingual (Spanish-English) speakers.

PHONOLOGICAL DEVELOPMENT IN MONOLINGUAL (SPANISH) AND BILINGUAL PRESCHOOLERS

A number of studies have examined phonological acquisition in monolingual, Spanish-speaking children (see Goldstein, 1995 for a detailed review). The results from these studies indicated that, by approximately 4 years of age, typically developing children mastered the majority of sounds in the inventory but still exhibited difficulties with the phonemes /g/, /f/, /s/, /≠/, /r/ (trill), and /ɾ/ (flap) (Acevedo, 1993; De la Fuente, 1985; Eblen, 1982; Gonzalez, 1981; Jimenez, 1987; Mason, Smith, & Hinshaw, 1976). They acquired (a) stops before nasals, (b) nasals before fricatives, and (c) fricatives and affricates before liquids (Macken, 1975, 1978; Macken & Barton, 1980). They also exhibited moderate amounts (percentages of occurrence greater than 10%) of cluster reduction, final consonant deletion, unstressed syllable deletion, tap/trill /r/ deviation, and fronting (Anderson & Smith, 1987; Cabello, 1986; Goldstein & Iglesias, 1996; Gonzalez, 1981). These general findings from monolingual Spanish speakers are comparable to those from monolingual English speakers (Bernthal & Bankson, 1998). Whether these data reflect the skills of bilingual (Spanish-English) children is unknown.

There is some evidence that the phonological system of bilingual speakers develops somewhat differently from that of monolingual speakers of either language. Gildersleeve, Davis, and Stubbe (1996) examined the phonological skills of 29 typically developing 3-year-old bilingual (English-Spanish) children and compared them to the phonological skills of 14 typically developing 3-year-old monolingual English speakers and 6 typically developing 3-year-old monolingual Spanish speakers. All of the bilingual children were tested only in English. Gildersleeve et al. found that the bilingual children showed an overall lower intelligibility rating, made more consonant and vowel errors overall, distorted more sounds, and produced more uncommon error patterns than either monolingual English or monolingual Spanish speakers. Significant differences between younger bilingual children (ages 3:0–3:6 [years:months]) and younger monolingual children were found for number of consonant errors and intelligibility. In addition, the bilingual children had the highest or second highest percentage of occurrence of every phonological pattern (initial consonant deletion, cluster reduction, final consonant deletion, stopping, gliding, and final consonant devoicing). The bilingual children also exhibited error patterns found in both languages (cluster reduction, stopping, and gliding) and evidenced phonological patterns that were not exhibited by either monolingual Spanish speakers (e.g., final consonant devoicing) or monolingual English speakers (e.g., initial consonant deletion).

Gildersleeve-Neumann and Davis (1998) examined the phonological skills of 27 typically developing 3-year-old bilingual (English-Spanish) children and compared them to the phonological skills of 14 typically developing 3-year-old monolingual English speakers and 6 typically developing 3-year-old monolingual Spanish speakers. All of the bilingual children were tested only in English. The bilingual children demonstrated more phonological processes and exhibited, on average, a higher percentage of occurrence on 6 of the 10 phonological processes analyzed (cluster reduction, backing, final consonant deletion, final devoicing, initial voicing, and stopping) than either the monolingual English or the monolingual Spanish speakers. Gildersleeve-Neumann and Davis concluded that bilingual speakers demonstrated different developmental patterns than their monolingual peers and exhibited more errors initially than monolingual speakers. However, these differences decreased over time.

The data collected by Gildersleeve et al. (1996) and Gildersleeve-Neumann and Davis (1998) need to be supplemented for a variety of reasons. First, the children in those studies were all 3-year-olds. Given that phonological development is not complete at that point, there is a need to examine the phonological systems of 4-year-old children as well. Second, the bilingual children's phonological skills were assessed only in English. Thus, there is a need to describe both the English and the Spanish phonological skills of bilingual children. Finally, both studies have yet to be published. In fact, many of the studies completed on Spanish speakers in general and bilingual (Spanish-English) speakers in particular are unpublished and not readily available.

This collaborative project was intended to fulfill two main purposes. First, we wanted to demonstrate how a research scientist (first author) can collaborate with a clinical scientist (second author, a certified and bilingual speech-language pathologist) to complete original research. Second, we wanted to add information to the growing database on Spanish phonological development by collecting initial data in typically developing bilingual (Spanish-English) children and comparing those data to data on typically developing monolingual children in both languages.

METHOD

To undertake this study, the two authors met to determine the method for the study and subsequently discussed the study with and received permission from facilities where children would be tested. Both collaborators were involved in all aspects of the research project. The second author took responsibility for making the majority of contacts with the facilities, assessing the children, and reviewing the manuscript, and the first author was responsible primarily for completing the data analyses and writing the paper.

Participants

A total of 12 typically developing 4-year-old bilingual (Spanish-English) Latino children enrolled in preschool classes participated in this study. Children were enrolled full-time in one of three urban preschools in the Camden (NJ) School District that were served by the second author. The children ranged in age from 4:0 to 4:11 (*M* = 4:7). The need for the children to meet the inclusion criteria (described below) resulted in an imbalance in the number of boys and girls. Of the 12 children in the study, 10 were girls and two were boys. Of the 12 participants, nine children used Puerto Rican Spanish, two spoke Dominican Spanish, and one used Nicaraguan Spanish (see Appendix A for information on Spanish phonology).

The children's use of both Spanish and English was determined by parent and teacher report. That is, these children received input in and spoke both languages at school and at home. The children's bilingual status was based on the notion that "there is knowledge present (to whatever degree) in *more than one* language" (Valdés & Figueroa, 1994, p. 7, emphasis original). Although the actual percentage of the day spent using each language was not calculated, all 12 children were reported to be developing both languages simultaneously according to the Valdés and Figueroa definition.

All of the children in the study were typically developing according to their parents and teachers. There also was no parental concern about speech, language, or cognitive development. Given the lack of standardized assessment tools for children who speak Spanish (either monolingual or bilingual), parent and teacher report often are used to demonstrate typical speech and language development (e.g., Gutierrez-Clellen & Heinrichs-Ramos, 1993). None of the children in the study had been diagnosed with a communication disorder, and thus none had received previous intervention for a communication disorder. Moreover, according to teacher report, each child exhibited normal functioning in the classroom (e.g., able to follow classroom routines and directions). In addition, each child had passed a hearing screening administered by an ASHA-certified audiologist at the child's school and passed an oral-peripheral mechanism screening (St. Louis & Ruscello, 1981) administered by the second author.

PROCEDURES

The Phonological Measure of Bilingual Latino/a Children, a single-word phonological assessment developed by the first author and designed to characterize productive phonology of bilingual (Spanish-English) children, was used to assess the children. The Spanish version of the assessment is composed of 28 words, and the English version of the assessment is composed of 26 words (the word lists are found in Appendix B). The assessment targets all singleton consonants and vowels in Spanish and English at least once. Syllable initial clusters (e.g., /*pl*ato/) and abutting consonant pairs (e.g., /elef*ant*e/) also are targeted. In addition, there are at least 10 opportunities for each phonological process to occur, with the exception of unstressed syllable deletion (six opportunities) and deaffrication (three opportunities) in English and final consonant deletion (eight opportunities) and deaffrication (one opportunity) in Spanish.

Both the Spanish and English versions of the assessment were administered to all children by the second author. To elicit the target words, represented by photographs of the items, the examiner prompted a response by asking, "Qué es esto?" ("What is this?"). If the child did not respond with the target word, the examiner either described the function of the stimulus ("it is used for...") or used a fill-in-the-blank sentence in order to elicit the target word (e.g., for the target word "doctor," the sentence is "When I was sick, I saw the..."). If the child still did not name the picture, the examiner used delayed imitation to elicit a production. The examiner phonetically transcribed the children's productions at the time the children produced the words. All samples were recorded on a Marantz Model PMD222 portable cassette recorder (Aurora, IL) with children wearing an AKG Acoustics Head Microphone (San Leandro, CA).

Transcription agreement was performed on both the English and the Spanish samples independently. Inter-judge agreement (computed between the first and second authors on all data) for English was 97.9% and for Spanish was 91.9%. Intra-judge agreement was completed by the first author transcribing the samples 1 week apart. Intra-judge agreement was 99.2% for English and 98.5% for Spanish.

Data Analysis

The data were analyzed using the Logical International Phonetic Programs (Oller & Delgado, 2000). The data in Spanish and English were subjected to independent analyses (not comparing the children's productions to the adult target) and relational analyses (comparing the children's productions to the adult target). The independent analysis consisted of determining the children's phonetic inventory (the segments produced by the children whether or not they matched the intended target sound). For consonants, relational analyses were composed of percentage of consonants correct–revised (PCC–R, Shriberg, Austin, Lewis, McSweeney, & Wilson, 1997); PCC for voicing, place of articulation, manner of articulation; and the percentage of occurrence of phonological processes. Vowel analyses consisted of examining percentage of vowels correct (PVC, Shriberg et al., 1997), and the number and types of error patterns. A series of five *t* tests using a Bonferroni procedure (Winer, Brown, & Michels, 1991) with a corrected alpha level of .01 was used to determine significance of the results between languages, with language (Spanish or English) as the independent variable and the dependent variables including PCC; percentage correct for voicing, place of articulation, and manner of articulation; and percentage of occurrence for phonological processes.

It should be noted that all data were analyzed taking into account all dialect features of the children's productions in English and in Spanish (following Goldstein &

Iglesias, 1996). That is, features of the dialect used by the children were not scored as errors. For example, in Puerto Rican Spanish, the flap /ɾ/ in syllable-final position is often replaced by /l/ (/martijo/ ("hammer") → [maltijo]). A child's production of that pattern would not be scored as an error. In addition, the data were examined for attested patterns of both Spanish-influenced English (SIE) and English-influenced Spanish (EIS) (Kayser, 1993; Perez, 1994; Roseberry-McKibbin, 1995). Although these patterns clearly are *not* errors, bilingual children do tend to use these patterns in their speech (e.g., Goldstein & Iglesias, 1999; Perez, 1994), and it is important clinically to be able to differentiate true error patterns from features of SIE and EIS.

RESULTS

Independent Analysis

Of the 12 children, only two produced all consonants in both languages. Two other children produced all of the English segments but not all of the Spanish ones. Furthermore, two different children produced all of the Spanish segments but not all of the English ones.

Across both languages, the interdental sounds were the ones most likely not to be produced. In English, both the voiced and the voiceless interdental fricatives were not produced by six children. One other child did not produce the voiceless interdental fricative only, and yet another child did not produce [dʒ]. In Spanish, the voiced interdental fricative [ð] was excluded from the phonetic inventory of six children, five of whom were the same children who did not produce interdentals in English. Two other sounds, [β] and [ɤ], were also excluded from the phonetic repertoires of children in Spanish; [β] and [ɤ] were not produced by two children. All 12 children produced all vowels in both languages.

Relational Analyses

Six relational analyses were completed: PCC, PCC for voicing, PCC for place of articulation, PCC for manner of articulation, percentage of occurrence of phonological processes, and PVC. This section also includes the analysis for patterns of SIE and EIS.

Table 1 lists the results, by subject, of PCC in both English and Spanish. Across all children, PCC was 94.1% in English and 90.3% in Spanish. PCC ranged from 88.9% to 98.6% in English and from 82.1% to 97.6% in Spanish. Paired two-sample *t* tests showed no significant difference between PCC scores in English and Spanish.

PCC by sound class is represented in Table 2. Percentages are provided for voicing, place of articulation, and manner of articulation. Paired two-sample *t* tests showed no significant difference between the two languages for voicing, place of articulation, or manner of articulation. The children exhibited very few voicing errors, with percentages correct in English and Spanish of 97.5% and 96.0%, respectively.

Table 1. Percentage of consonants correct in English and Spanish for the 12 children.

	Gender	*Age*	*English*	*Spanish*
Child 1	F	4:0	95.8	97.6
Child 2	F	4:4	93.1	95.2
Child 3	F	4:5	88.9	88.1
Child 4	F	4:5	94.4	94.0
Child 5	M	4:8	94.4	82.1
Child 6	F	4:8	91.7	90.5
Child 7	F	4:9	88.9	92.3
Child 8	F	4:10	95.8	91.5
Child 9	F	4:10	91.7	94.0
Child 10	F	4:10	98.6	92.9
Child 11	F	4:11	95.8	89.3
Child 12	M	4:11	95.8	84.5
All Participants		*M* = 4:7	94.1 (3.7)[a]	90.3 (3.9)

[a] Standard deviation.

Table 2. Percentage of consonants correct by sound class in English and Spanish for the 12 children.

Target	*English*	*Spanish*
Voicing	97.5	96.0
Place of articulation	94.4	95.5
Bilabial	89.6	95.2
Labiodental	100.0	100.0
Interdental	25.0	97.2
Alveolar	95.2	87.7
Palatal	100.0	94.8
Alveo-palatal	88.9	100.0
Velar	97.0	93.8
Manner of articulation	96.2	90.6
Stops	96.7	93.3
Nasals	99.2	100.0
Fricatives	83.9	97.5[a]
Spirants	n/a	76.8
Affricates	88.9	100.0
Liquids	94.9	95.0
Flap	n/a	71.8
Trill	n/a	77.3
Glide	100.0	90.0

[a] Production of spirants ([β], [ð], and [ɣ]) not included here.

Overall, PCC for place of articulation was high—94.4% in English and 95.5% in Spanish. All places of articulation, with the exception of interdental sounds in English, either exceeded or approached mastery (greater than or equal to 90% correct) (Smit, Hand, Freilinger, Bernthal, & Bird, 1990). In English, the interdental sounds ([θ] and [ð]) showed a PCC of 25%. This result was not surprising given that interdental sounds were most likely to be omitted from the children's phonetic inventories.

Overall, PCC for manner of articulation was higher in English (96.2%) than in Spanish (90.6%). In English, the only two sound classes with accuracy rates less than 90% were fricatives and affricates—83.9% and 88.9%, respectively. In Spanish, only the flap and the trill were produced with accuracy rates less than 90%—71.8% and 77.3%, respectively. PCC for the three spirants, [β], [ð], and [ɣ] (76.8%), was computed separately from the other fricatives because they are fricative allophones of the stop consonants /b/, /d/, and /g/, respectively. Mean PCC for spirants indicated that the children, overall, did not possess adult-like use of the allophonic rule that changes stops into spirants.

Percentages of occurrence and standard deviations are provided for both syllabic and substitution phonological processes in English and in Spanish (Table 3). Paired two-sample *t* tests showed no significant difference between the percentage of occurrence for phonological processes between the two languages. The results indicated that the children exhibited three different types of syllabic processes: cluster reduction, final consonant deletion, and unstressed syllable deletion. The two most commonly occurring syllabic processes in both languages were final consonant deletion and cluster reduction. Final consonant deletion was most common in English (percentage of occurrence = 4.2%), and cluster reduction was most common in Spanish (8.3%). Some of the children also created clusters from singletons. There were two occurrences of "cluster creation" in English: /wægən/ → [wægwən]; /plet/ → [plest]. There were seven total occurrences of "cluster creation" in Spanish: /gitara/ (guitar) → [gitadɾa] (2 occurrences); /gitara/ → [gitjaxa]; /gitara/ → [hikalda]; /rompekabesas/ (puzzle) → [rompɾekabesas]; /rompekabesas/ → [rompeskabesas]; /djente/ (tooth) → [djentje]. These cluster creations (at least in Spanish) may be lexically driven because these error types occurred in only three different words, two of which were relatively long and complex, and the words may have been unfamiliar to the children. Of the seven occurrences of "cluster creation," one exemplar of each word was elicited through imitation. Also, these imitated occurrences of "cluster creation" were exhibited by three different children.

Table 3. Percentage of occurrence and standard deviation *(SD)* for phonological processes in English and Spanish for the 12 children.

	English percentage (SD)	*Spanish percentage* (SD)
Syllabic processes		
Cluster reduction	3.2 (4.4)	8.3 (8.1)
Final consonant deletion	4.2 (8.6)	2.1 (4.9)
Syllable deletion	0.0 (0.0)	0.4 (1.0)
Cluster creation[a]	2	7
Substitution processes		
Liquid simplification	1.3 (3.0)	16.9 (5.8)
Stopping	6.9 (4.2)	3.0 (4.4)
Fronting	1.4 (2.0)	0.4 (1.0)
Backing	2.2 (1.6)	2.8 (1.3)
Final devoicing	2.1 (7.2)	0.0 (0.0)
Final voicing	0.0 (0.0)	2.1 (7.2)
Assimilation	0.3 (1.2)	0.6 (1.1)
Spirantization	0.0 (0.0)	0.8 (1.3)
Distortions[a]		
Dentalization of /s, z/	6	3
Lateralization of /s/	3	0

[a] Number of occurrences.

The children exhibited eight types of substitution processes. In English, no substitution processes showed a percentage of occurrence greater than 10%; the most commonly occurring substitution process was stopping (6.9%). In Spanish, one substitution process showed a percentage of occurrence greater than 10%: liquid simplification (16.9%). In Spanish, three segments were analyzed for liquid simplification, [l], [ɾ], and [r]. The overwhelming majority of errors were on [ɾ] and [r] and not on [l]. Percentage correct for [l] was 95.8%, compared with only 71.8% for [ɾ] and 77.3% for [r]. There were only two types of errors for the flap. Either it was deleted (17 of 31 errors—54.8%), or it was substituted by [l] (14 of 31 errors—45.2%). There were a number of different substitution patterns, but no deletions, for the trill. Of the 18 total errors on the trill, [l] was used as a substitute six times (33% of the total number of errors), [ɾ] was used five times (27.8%), and [j] was used two times (11.1%). The following substitutes were evidenced one time each (5.6% of the total number of errors): [s], [t], [tj], [dɾ], and [ld]. Other substitution processes exhibited included fronting, backing, voicing errors, assimilation, and spirantization. In both languages, the children also showed some distortions, dentalization of /s/ and /z/ (six occurrences) and lateralization of /s/ (three occurrences) in English, and dentalization of /s/ in Spanish (three occurrences).

The number of vowel errors, PVC, and types of vowel errors also were examined. Across all 12 children, there were only four vowel errors in English (PVC = 98.3%) and three vowel errors in Spanish (PVC = 99.5%). In English, one child made two errors (/ɚ/ → [ə]; /ɚ/ → ϕ), and one other child made the other two errors (/æ/ → [a]; /ɚ/ → [ə]). In Spanish, three different children exhibited vowel errors (/o/ → [e]; /a/ → ϕ; /e/ → [ie]).

The possible influence patterns of Spanish on the production of English and vice versa are presented in Table 4. Again, it should be emphasized that these patterns were *not* error patterns but are presented to show the influence of one language on the other. Four different patterns of Spanish-influenced English were exhibited by the children: three occurrences of stopping (/ʃʌvəl/ "shovel" → [ʃʌbəl]), two occurrences of final consonant deletion (/klaʊn/ "clown" → [klaʊ]), one occurrence of flapping of prevocalic *r* (/tɹen/ "train" → [tɾen]), and one occurrence of affrication (/ʃʌvəl/ → [tʃʌvəl]). Two different patterns of English-influenced Spanish were exhibited by the children: three occurrences of flap retroflexing (/floɾ/ "flower" → [floɹ], and one occurrence of trill retroflexing (/aros/ "rice" → [aɹos]).

In summary, the results indicated that there were no significant differences between the two languages on PCC; PCC for voicing, place of articulation, or manner of articulation; or percentage of occurrence for phonological processes. The participants showed relatively high PCC in

Table 4. Patterns of Spanish-influenced English and English-influenced Spanish.

Feature	*Number of children*	*Example*
Use of Spanish features during English production		
/v/ → [b]	3	/ʃʌvəl/ (shovel) → [ʃʌbəl]
/n/ → ø	2	/klaʊn/ (clown) → [klaʊ]
[ɹ] → /ɾ/	1	/tɹen/ (train) → [tɾen]
/ʃ/ → [tʃ]	1	/ʃʌvəl/ → [tʃʌvəl]
Use of English features during Spanish production		
/r/ (trill) → [ɹ]	3	/aros/ (rice) → [aɹos] (2 occurrences) /raðjo/ → [ɹaðjo] (1 occurrence)
/ɾ/ → [ɹ]	1	/floɾ/ (flower) → [floɹ]

both languages and accuracy rates for all places of articulation, with the exception of interdental sounds in English. Two manner classes in English, fricatives and affricates, and one class in Spanish, liquids, showed accuracy rates of less than 90%. Twelve different phonological processes were exhibited by the children. In Spanish, one phonological process, liquid simplification, showed a percentage of occurrence greater than 10%; in English, no process showed a percentage of occurrence greater than 10%.

DISCUSSION

The purpose of this study was to collect initial data on phonological patterns in typically developing bilingual (English-Spanish) children and compare those data to data on monolingual children in both languages. The results from the current study revealed that these 12 bilingual children showed a high PCC, almost no vowel errors, and relatively few voicing errors. Sound classes not mastered (greater than or equal to 90% correct) included fricatives (most notably, the interdental sounds) and affricates in English and the flap and trill in Spanish. Most commonly occurring phonological processes included stopping and final consonant deletion in English and liquid simplification and cluster reduction in Spanish. This profile was generally similar to typically developing, monolingual English-speaking children (e.g., Smit, 1993a, 1993b) and to typically developing, monolingual Spanish-speaking children (e.g., Acevedo, 1993; Goldstein & Iglesias, 1996; Macken & Barton, 1980).

In the next two sections, the results from the current study are compared to the mean PCC, mean percentage correct for manner of articulation sound classes, and percentage of occurrence for phonological processes from studies examining monolingual English and monolingual Spanish speakers. These analyses were used as bases of comparison because data were readily available for monolingual English-speaking children and monolingual Spanish-speaking children.

Comparison to English Speakers

Data comparing the results from the current study to existing data on monolingual English-speaking children are presented in Table 5. The data for PCC for the monolingual children were culled from 47 English-speaking 4-year-olds (Austin & Shriberg, 1997). Data for percentage correct for manner of articulation sound classes were culled from 186, typically developing 4-year-olds (Smit et al., 1990). Percentages of occurrence for phonological processes were gathered from 20 typically developing 4-year-olds (Haelsig & Madison, 1986) and 72 typically developing 3- to 6-year-olds (Shriberg, Kwiatkowski, Best, Hengst, & Terselic-Weber, 1986).

Overall, mean PCC was higher for the bilingual children (94.1%) than for the monolingual children (80.2%). The disparity in results between the two groups may be a function of the data collection procedure used in each of the studies. The data from the bilingual children in this study were collected using a single-word assessment; the data from the monolingual children were gathered through language samples. The increased length and complexity of the language sample may have yielded a lower PCC for the monolingual children than did the single word task for the bilingual children. In a recent study, Morrison and Shriberg (1992) found a significant difference for PCC between single word and conversational samples. Even though there may be differences in the outcome between the two elicitation procedures, Andrews and Fey (1986) suggested that the use

Table 5. Comparison of bilingual children's results with those of monolingual English speakers.

	Current study		
	Bilingual	*Monolingual*	*Monolingual*
Percentage of consonants correct	94.1%	–[a]	80.2%[b]
Manner of articulation			
Stops	96.7	–[a]	96.8[c]
Nasals	99.2	–[a]	91.8
Fricatives	83.9	–[a]	74.2
Affricates	88.9	–[a]	79.4
Liquids	94.9	–[a]	65.2
Glides	100.0	–[a]	93.4
Phonological processes			
Cluster reduction	3.2	12.5[d]	10.0[e]
Final consonant del.	4.2	8.1	2.0
Unstressed syllable del.	0.0	27.5	3.0
Stopping	6.9	8.6	15.0
Liquid simplification	1.3	17.5	8.0
Fronting	1.4	3.1	1.0
Backing	2.2	–[a]	–[a]
Final devoicing	2.1	0.6	–[a]

[a] Not reported.
[b] Austin & Shriberg (1997).
[c] Manner of articulation data culled from Smit et al. (1990).
[d] Haelsig & Madison (1986).
[e] Phonological process data from Shriberg et al. (1986).

of single-word productions is warranted when speech-language pathologists want to ensure that all sounds in all contexts are targeted and all target words can be glossed.

Percentage correct for manner of articulation was similar between bilingual and monolingual children for three sound classes—stops, nasals, and glides—with percentages for all three classes greater than 90% correct. Percentage correct for fricatives and affricates was somewhat higher for bilingual children than for monolingual children, and percentage correct for liquids was quite higher. The unexpected discrepancies may be a function of the preponderance of girls in this study compared to an almost equal number of girls and boys in the Smit et al. (1990) study**.** Smit et al. found that 4-year-old girls exhibited significantly higher total scores than did 4-year-old boys. In addition, Kenney, Prather, Mooney, and Jeruzal (1984) and Kenney and Prather (1986) found that girls produced significantly fewer errors than did boys on consonants from the fricative, affricate, and liquid sound classes. Thus, it may be the case that the over-representation of girls in this study may have resulted in far fewer errors on consonants in these sound classes.

Despite the use of different methods and different numbers of participants between the comparison studies, the results indicated that the percentage of occurrence for many, but not all, phonological processes was similar. Both bilingual and monolingual children exhibited similar percentages of occurrence for final consonant deletion, fronting, stopping, and final consonant devoicing. The percentages were more discrepant for cluster reduction, unstressed syllable deletion, and liquid simplification. The definition of "cluster" may have accounted for the difference between bilingual and monolingual children in percentage of occurrence for cluster reduction.

The two studies of monolingual children considered both syllable onset and syllable final clusters in their determination of cluster reduction; only syllable onset clusters were used to measure cluster reduction in bilingual children. The difference for unstressed syllable deletion may have resulted from the relative lack of words containing more than two syllables for bilingual children. The children in the Haelsig and Madison (1986) study had four opportunities to produce words with more than two syllables as compared to only one word in English in the current study. However, it is interesting to note that, although there were nine opportunities to produce words with more than two syllables in the Spanish part of the test, the rate of syllable deletion was almost identical in English (0%) and Spanish (0.4%). The difference in results for liquid simplification may have resulted from the ages of the children in the two comparison studies. The children in the Shriberg et al. (1986) study included 3-year-olds. The participants in the Haelsig and Madison (1986) study included a group of 10 children aged 4:0–4:5 (years:months, mean age = 4:1). The inclusion of monolingual children with average younger ages than the bilingual children may have served to increase the percentage of occurrence for liquid simplification overall.

Comparison to Spanish Speakers

Data comparing the results of this study to existing data on the Spanish phonological skills of monolingual Spanish-speaking children (Goldstein & Iglesias, 1996) are presented in Table 6. To compare types of error patterns, data from Goldstein (1988) are used. Data from both comparison studies are from 4-year-old children assessed using a single word format.

Overall, mean PCC was lower for the bilingual children (90.3%) than for the monolingual children (96.0%). However, it is interesting to note that the mean for both groups was greater than 90%, indicating quite accurate production of consonants in general. It certainly would be expected that 4-year-olds would exhibit accurate production of sounds overall.

As indicated by the mean percentage correct for manner of articulation sound classes, not all classes of sounds were produced with equal accuracy. Mean percentage correct was comparable between bilingual and monolingual children for stops, nasals, fricatives, affricates, liquids, and glides. Three sound classes—spirants, flap, and trill—showed marked differences between the two groups of speakers. For the difference in results for spirants, it is probable that many of the bilingual children had not acquired the allophonic rule that governed production of the spirants. In another group of monolingual Spanish speakers, Goldstein and Iglesias (1992) showed that [ð] was the only spirant not mastered (i.e., produced with 90% accuracy). Thus, it appeared that the monolingual children, not having to acquire two codes, mastered this rule earlier in development than their bilingual peers.

Bilingual children also showed lower mean percentage correct for both the flap (71.8%) and the trill (77.3%) than did monolingual children (85.8% and 92.7%, respectively).

Table 6. Comparison of bilingual children's results with those of monolingual Spanish speakers.

	Current study	*Goldstein & Iglesias (1996)*
	Bilingual	*Monolingual*
Percentage of consonants correct	90.3%	96.0%
Manner of articulation		
Stops	93.3	89.7
Nasals	100.0	98.9
Fricatives	97.5	94.9
Spirants	76.8	92.4
Affricates	100.0	90.0
Liquids	95.0	91.7
Flap	71.8	85.8
Trill	77.3	92.7
Glides	90.0	99.5
Phonological processes		
Cluster reduction	8.3	5.6
Final consonant deletion	2.1	8.6
Unstressed syllable deletion	0.4	2.4
Stopping	3.0	0.6
Liquid simplification	16.9	2.2
Fronting	0.4	0.2
Backing	2.8	2.5
Final devoicing	2.1	0.0

This discrepancy also was witnessed in the use of liquid simplification, in which the percentage of occurrence was 16.9% for bilingual children and 2.2% for monolingual children. Language status of the children may have played a role in the disparate results. Between the two languages, bilingual children must master three *r*-like sounds: /ɹ/ in English and /ɾ/ and /r/ in Spanish. It is generally acknowledged that *r*-like sounds are later developing by monolingual speakers in both English (e.g., Smit et al., 1990) and Spanish (e.g., Acevedo, 1993). The production of the English /ɹ/ by the bilingual children in this study was highly accurate (percentage correct = 94%). The children were not nearly as successful producing /ɾ/ and /r/ in Spanish (percentage correct = 72% and 77%, respectively). It may be that this group of children was more implicitly focused on mastering the English /ɹ/ than the other two sounds in Spanish. Thus, it may be the case that, for later-developing sounds, bilingual children must master them in one language before mastering them in the other, resulting in an order of acquisition of /ɹ/ then /ɾ/ and /r/.

It also was interesting to note that the error patterns used for /ɾ/ and /r/ were different for the bilingual children in this study than those used by monolingual Spanish-speaking children (Goldstein, 1988). In the current group of bilingual children, the flap was either deleted (17 of 31 errors—54.8%) or substituted by [l] (14 of 31 errors—45.2%). In monolingual children, only 6.3% of the total number of errors were deletion errors, and only 18.8% were substitutions of [l] for /ɾ/ (Goldstein, 1988). In the current group of bilingual children, there also were a number of different error patterns for the trill, all of which involved a substitution. Of the 18 total errors on the trill, [l] was used as a substitute six times (33.3% of the total number of errors), [ɾ] was used five times (27.8%), [j] was used two times (11.1%), and [s], [t], [tj], [dɾ], and [ld] were used as substitutes one time each (5.5%). In monolingual Spanish-speaking children, the flap was used most commonly as a substitute for the trill (45% of the total number of errors). Only 10% of the total number of errors involved [l] being used as a substitute, and only one time (5% of the total number of errors) was [j] used as a substitute.

It is not surprising that bilingual children would tend to use [l] as the most common substitute for the flap and trill because it ([l]) is highly accurate (percentage correct = 95.8%) and is closer in articulatory terms to the flap and trill than any other potential substitutes (i.e., all are sonorants). Bilingual children would not likely choose the English prevocalic [ɹ] as a substitute (there were only three occurrences in which [ɹ] substituted for the trill) because of their desire to keep the two languages separate as much as possible (Watson, 1991). In contrast to the low accuracy of the flap and trill in bilingual children, monolingual children produced both the flap and the trill with high accuracy, 95% and 93% correct, respectively (Goldstein, 1988). Monolingual children then also should use as a substitute a highly accurate sound that was closer in articulatory terms to the targets than any other potential substitutes. Thus, the trill should substitute for the flap, and the flap should substitute for the trill, which was the pattern of substitutions found in the present investigation. In monolingual children, the trill most often substituted for the flap (in 68.8% of the total number of errors), and the flap most often substituted for the trill (in 45% of the total number of errors).

The results indicated that bilingual children manifested higher percentages of occurrence for six of the eight phonological processes targeted in both studies, although for many phonological processes, the percentage of occurrence difference between the groups was rather small. The percentage difference between bilingual and monolingual children is less than 3% for six of eight phonological processes. The percentage of occurrence for liquid simplification (discussed in detail above) was 16.9% for bilingual children and 2.2% for monolingual children. The percentage of occurrence for final consonant deletion was 2.1% for bilingual children and 8.6% for monolingual children. The discrepancy may have resulted from the number of final consonant opportunities for the children in both studies. The monolingual children had almost twice as many opportunities (23 opportunities per child) to produce final consonants as did bilingual children (12 opportunities per child). This difference may have yielded more errors overall in the group of monolingual children.

CLINICAL IMPLICATIONS

The results from this study indicate that the phonological systems of bilingual children are more similar than dissimilar to monolingual speakers of either language. However, there are specific differences that must be taken into account. The phonological patterns described above indicate that bilingual Spanish-/English-speaking children may exhibit both different types of errors and different substitution patterns for target sounds than monolingual children. Given that the monolingual and bilingual Spanish-speaking population of the United States is increasing, speech-language pathologists must be vigilant in their choice of comparison databases. When attempting to diagnose phonological disorders in (predominantly) monolingual Spanish speakers, databases including monolingual Spanish speakers must be used. However, if speech-language pathologists are trying to diagnose phonological disorders in bilingual Spanish-English speakers, then databases including bilingual speakers are required. The results from the current study will be useful for comparison to other typically developing 4-year-olds who are receiving input in both English and Spanish at school and at home. In addition, speech-language pathologists likely will not be able to judge the quality of a bilingual child's phonological system merely by using one approach to phonological assessment. For example, obtaining results only from a phonological process assessment will not demonstrate a complete picture of a bilingual child's phonological system and will not serve to highlight the differences between monolingual and bilingual speakers. Along with examining phonological processes, speech-language pathologists also must look at the nature and quantity of specific substitution types and also percentage correct for individual segments.

There are a few limitations to the current study that should be addressed in the future. Additional studies involving bilingual speakers must be completed in order to increase the number of participants and to include 3-year-olds, thus enlarging the comparison database. Also, the majority of the bilingual children in this study used one dialect of Spanish: Puerto Rican Spanish. The effect of dialect needs to be studied systematically using similar methods and data analyses. Given this caveat, however, speech-language pathologists should still remember to take dialect into account when analyzing children's phonological productions. That is, productions known to be dialect features (e.g., word-final /s/ deletion in Puerto Rican Spanish speakers) should not be considered errors. Also, the majority of participants in the current study were females. An attempt should be made to include an equal number of males and females. Finally, studies including bilingual children diagnosed with phonological disorders need to be completed in order to make appropriate differential diagnoses.

Postscript: The Collaboration Process

Both authors agreed that the collaboration was a success and that each author benefitted from this experience. Through the collaboration, we accomplished the two goals of (a) collecting data on phonological patterns in bilingual children and (b) demonstrating how a clinical scientist and research scientist can plan and carry out a research project. Although we could conduct research independently in the future, we are already planning our next project together.

ACKNOWLEDGMENTS

This study was supported in part by National Institutes of Deafness & Other Communication Disorders Contract N01-DC-8-2100. The authors wish to thank the parents and children of the Camden City School District; Dr. John Boyle and staff at the Early Childhood Development Center; and Dr. Gloria Mitchell, Ms. Louise Lawson, Ms. Migdalia Polo, and the teachers of RESPOND. We also wish to thank Amy Parache for her help in data entry, Kim Oller and Rafael Delgado for their assistance in configuring the Logical International Phonetics Program, and Aquiles Iglesias for his insightful comments on an earlier draft of the manuscript. Finally, thanks to Elaine Silliman, Kenn Apel, and three anonymous reviewers for their constructive feedback.

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Received August 29, 2000
Accepted March 24, 2001
DOI:10.1044/0161-1461 (2001/014)

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APPENDIX A. CHARACTERISTICS OF SPANISH PHONOLOGY

Spanish Phonology

There are 18 consonant phonemes typically described for Spanish (Cotton & Sharp, 1988). These phonemes include the voiceless unaspirated stops, /p/, /t/, and /k/; the voiced stops, /b/, /d/, and /g/; the voiceless fricatives, /f/, /s/, and /x/; the affricate, /tʃ/; the glides, /w/, and /j/; the lateral, /l/; the flap /ɾ/ and trill /r/; and the nasals, /m/, /n/, and /≠/. The three voiced stops /b/, /d/, and /g/ are produced as the spirant allophones [β], [ð], and [ɤ], respectively. The spirant allophones occur intervocalically both within and across word boundaries (e.g., /dedo/ (finger) → [deðo] and /la boka/ (the mouth) → [la βoka]) (Vaquero, 1996). There are five monophthong vowels in Spanish, /i/, /e/, /u/, /o/, and /a/. Vowels in Spanish have relatively the same tongue height and tongue placement as their counterparts in English, with the exception of /a/, which in Spanish is usually described as a low, central vowel (Cotton & Sharp, 1988).

The consonant features of Puerto Rican, Dominican, and Nicaraguan Spanish (Canfield, 1981; Cotton & Sharp, 1988; Navarro-Tomás, 1968; Poplack, 1980; Terrell, 1981) are aggregated in Table 1. The vowel phonemes in these dialects are the five monophthong vowels, /i/, /e/, /u/, /o/, and /a/. It should be noted that not every speaker will make use of every feature and that every feature will not be exhibited by all speakers of the dialect.

Table 1. Consonant features of Puerto Rican, Dominican, and Nicaraguan Spanish.

Pattern	*Example*	*English*	*Spanish dialect*
Stops			
/d/ → ø	/dedo/ → [deo]	"finger"	PR, D, N
/k/ → ø	/doktoɾ/ → [dotoɾ]	"doctor"	D, N
Nasals			
/n/ → [ŋ]	/xamon/ → [xamoŋ]	"ham"	PR, D, N
/n/ → ø	/xamon/ → [xamo]/[xamõ]	"ham"	PR
Fricatives			
/f/ → ɸ	/kafe/ → [kaɸe]	"coffee"	PR, D, N
/s/ → ø	/dos/ → [do]	"two"	PR, D, N
/s/ → ʰ	/dos/ → [doʰ]	"two"	PR, D, N
/x/ → [h]	/xamon/ → [hamon]	"ham"	PR, D
Liquids			
/ɾ/ (flap) → ø	/koɾtaɾ/ → [kotaɾ]	"to cut"	PR, D
/ɾ/ (flap) → [l]	/koɾtaɾ/ → [koltaɾ]	"to cut"	PR, D
/r/ (trill) → [R]/[x]	/pero/ → [peRo/pexo]	"dog"	PR, D
Glides			
/j/ → [dʒ]/[ʒ]	/jo/ → [dʒo/ʒo]	"I"	PR, D, N
/w/ → [gw]	/weso/ → [gweso]	"bone"	PR, D
Affricate			
/tʃ/ → [ʃ]	/mutʃo/ → [muʃo]	"a lot"	D

Note. PR = Puerto Rican, D = Dominican, N = Nicaraguan, ø = deleted, ʰ = aspirated.

APPENDIX B. WORD LISTS

English	*Spanish*	*English translation*
book	señor	man
thumb	radio	radio
ant	leche	milk
toast	tren	train
hand	gris	grey
cars	clavo	nail
pants	bloque	block
doctor	bruja	witch
church	plato	plate
ring	cruz	cross
feather	frío	cold
shovel	flor	flower
bridge	galleta	cracker
present	elefante	elephant
frog	bicicleta	bicycle
stop	rompecabezas	puzzle
plate	arroz	rice
train	perro	dog
grape	guitarra	guitar
clown	rodilla	knee
queen	bigote	mustache
school	aguja	needle
glass	agua	water
lollipop	mano	hand
nose	cama	bed
wagon	amarillo	yellow
	árbol	tree
	dientes	teeth