Research

Early-, Middle-, and Late-Developing Sounds in Monolingual and Bilingual Children: An Exploratory Investigation

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Purpose: To examine the accuracy of early-, middle-, and late-developing (EML) sounds in Spanish-English bilingual children and their monolingual peers.
Method: Twenty-four typically developing children, age 3–4 years, were included in this study: 8 bilingual Spanish-English-speaking children, 8 monolingual Spanish speakers, and 8 monolingual English speakers. Single-word speech samples were obtained to examine (a) differences on the accuracy of EML sounds between Spanish-English bilingual children and monolingual Spanish and monolingual English children and (b) the developmental trend on the accuracy of EML sounds within languages for Spanish-English bilingual children and monolingual Spanish and monolingual English children.
Results: Findings support those of Shriberg (1993) for English-speaking children and suggest possible EML categories for monolingual Spanish-speaking children and bilingual Spanish-English-speaking children.
Conclusions: These exploratory findings indicate the need for longitudinal examination of EML categories with a larger cohort of children to observe similarities and differences between monolingual and bilingual development.

Key Words: phonology, development, bilingual, Spanish

It is widely accepted that universal properties across the languages of the world contribute to the age at which sounds are acquired and in what order they develop (Jakobson, 1941/1968; Locke, 1983). Sounds that favor ease of articulation, or *unmarked* sounds, are typically acquired first, while more complex, or *marked,* sounds are acquired later in development. That is, phonological acquisition in children is continuous, as the acquisition of one sound (or class of sounds) becomes the building block for the next, more complex sound (or class of sounds; Fikkert, 2007). Evidence from child data for this widely accepted view has been found in the phonetic inventories of English-speaking children with phonological disorders (Dinnsen, Chin, Elbert, & Powell, 1990), predominantly Spanish-speaking children (Cataño, Barlow, & Moyna, 2009), and bilingual Spanish-English-speaking children (Fabiano-Smith & Barlow, 2009). It seems that across languages, children acquire their phonologies in a simple-to-complex fashion, at least as it relates to phonetic inventories.

Although there are developmental data available on phonological acquisition for monolingual English-speaking children (Sander, 1972; Smit, 1993) and monolingual Spanish-speaking children (Acevedo, 1993; Anderson & Smith, 1987; Jiménez, 1987), it has largely not been examined for bilingual Spanish-English-speaking children. The current study explores the continuous nature of phonological acquisition in children acquiring two languages to determine (a) how parameters of markedness apply in a system that must incorporate the rules of two languages and relatedly (b) whether acquisition in bilinguals is the same as or different from monolinguals.

Phonological Skills in Monolingual Versus Bilingual Children

Cross-linguistically, children acquire their phonologies in a simple-to-complex fashion (e.g., Locke, 1983). Dinnsen et al. (1990) examined this phenomenon by investigating the implicational laws that govern the acquisition of sounds in 40 monolingual English-speaking children with phonological disorders, age 3;3 to 6;6 (years;months). The authors based their study on the premise that parameters of markedness dictate the order in which sound classes are acquired and that the presence of marked sounds implies the presence

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of unmarked sounds in a child's phonetic inventory. In their study, children's phonetic inventories were organized into five levels of complexity (A through E): Level A indicated a phonetic inventory that included mostly unmarked sounds (e.g., nasals, stops, and glides), whereas Level E indicated a phonetic inventory that included more marked, later-developing sounds (e.g., fricatives, affricates, and liquids). The results of their study found that, in general, English-speaking children acquire unmarked sound classes before marked sound classes, indicating that implicational laws govern order of acquisition. Their findings supported Jakobson (1941/1968) in that classes of speech sounds are acquired in a simple-to-complex fashion during phonological acquisition.

Similar findings have been reported for acquisition in monolingual Spanish-speaking children. Following the methodology of Dinnsen et al. (1990), Cataño et al. (2009) examined 16 predominantly Spanish-speaking children, age 1;6–4;5, in an attempt to determine whether the results of Dinnsen et al.'s (1990) study of English acquisition would apply to the acquisition of sound classes in Spanish. The authors found that Spanish-speaking children followed the same general pattern of acquisition that monolingual English-speaking children did. Unmarked sound classes such as stops, glides, and nasals were acquired before fricatives and affricates, just as in English-speaking children (Dinnsen et al., 1990). However, there were some exceptions, one of which involved the liquid /l/. The liquid /l/ (a marked sound in English) was present at Level A (the least complex level) in the Spanish-speaking children's phonetic inventories. Thus, even though markedness parameters are applied similarly across the world's languages, they are not applied identically.

Although previous studies have shown the role that markedness plays in monolingual English and Spanish acquisition, it is not yet clear how bilingual children acquire phonological structures for two languages that have differing segmental inventories. To determine whether markedness parameters differed across languages and whether those parameters affected sound class acquisition in both the English and Spanish of bilinguals, Fabiano-Smith and Barlow (2009) used the methodology from Dinnsen et al. (1990) and Cataño et al. (2009) to examine 8 typically developing, 3-year-old bilingual Spanish-English-speaking children. The bilingual children were compared with their age-matched, monolingual peers to determine whether bilingual children demonstrated phonetic inventories that were as complex as those of monolingual English- and Spanish-speaking children. They found that the bilingual children did indeed acquire sounds in a simple-to-complex fashion, with similar levels of complexity as compared with monolingual speakers of either language. However, these same children were examined on measures of accuracy (percentage of consonants correct [PCC]; Shriberg, Austin, Lewis, McSweeny, & Wilson, 1997) and were found to demonstrate significantly lower accuracy than their monolingual Spanish-speaking peers (Fabiano-Smith & Goldstein, in press). It seems that phonetic inventory development measures a somewhat different construct than does accuracy. Therefore, it is not known on which measures bilingual children can be expected to differ from their monolingual peers. Because phonetic inventory complexity and broad measures of accuracy yield different findings in bilinguals compared with monolinguals, it is possible that more broad measures (e.g., PCC) might be less precise in gauging the phonological skills of bilingual children than a more narrow measure such as early-, middle-, and late-developing sounds (EML; Shriberg, 1993). That is, the narrow measure of EML sounds might take markedness into account, whereas the broad measure of PCC might not.

PCC

PCC has been utilized in a number of studies examining phonological skills in bilingual children. Gildersleeve-Neumann, Kester, Davis, and Peña (2008) examined the English speech sound skills of typically developing, bilingual (English-Spanish) 3-year-olds. The results indicated that the bilingual children showed a slower rate of acquisition in comparison with their monolingual English-speaking peers on PCC. As previously mentioned, Fabiano-Smith and Goldstein (in press) examined bilingual Spanish-English-speaking 3-year-olds and found that bilingual children demonstrated significantly lower PCC in Spanish when compared with their monolingual Spanish-speaking peers. However, when independent analyses were performed on the productions of the bilingual children in both of these studies, they demonstrated the same rate of acquisition as their monolingual peers at age 3 (Fabiano-Smith & Barlow, 2009; Fabiano-Smith & Goldstein, in press).

Differences on PCC between monolinguals and bilinguals, however, do seem to be sensitive to age. Goldstein, Fabiano, and Washington (2005) examined the speech sound skills of 15 typically developing bilingual Spanish-English-speaking 5-year-olds. The children in this study included 5 predominantly English speakers, 5 predominantly Spanish speakers, and 5 bilingual Spanish-English speakers. Results indicated that there was no significant difference in PCC between bilingual children and speakers of predominantly English or Spanish. Therefore, it seems that bilingual preschoolers demonstrate differences on broad measures of accuracy when compared with their monolingual peers, but by age 5, they demonstrate commensurate accuracy with monolinguals.

Overall, results from these studies suggest that when compared on broad measures, such as PCC, bilingual and monolingual 3-year-olds differ on rate of acquisition. It is possible that PCC is too broad a measure for bilingual-monolingual comparisons, especially in preschool-age children, because it neither indicates the order in which sounds are acquired nor specifies the relative markedness of sounds produced with high or low accuracy. A more narrow analysis, such as accuracy of EML sounds, might be more revealing in determining whether phonological acquisition in bilingual children is similar to or different from monolingual children because it accounts for an aspect of markedness that PCC does not.

Accuracy of EML Sounds

As indicated, examining the accuracy of EML sounds might be more sensitive to the effects of markedness in children's speech sound acquisition than is PCC. For English, data for EML sounds (see Table 1) were taken from Shriberg,

TABLE 1. Early-, middle-, and late-developing (EML) sounds in English.

Stage	Sounds
Early 8	/m, b, j, n, w, d, p, h/
Middle 8	/t, ŋ, k, ɡ, f, v, ʧ, ʤ/
Late 8[a]	/ʃ, ð, s, z, θ, l, ɹ/

Note. Data are from Shriberg et al. (1992) and are discussed in Shriberg (1993).

[a]The sound /ʒ/ was excluded from analysis by Shriberg (1993).

Kwiatkowski, and Gruber (1992) and discussed in Shriberg (1993). To examine consonant mastery, Shriberg (1993) culled data from 64 children age 3–6 years who had speech delay (i.e., phonological disorders). For the 24 consonant phonemes in English, Shriberg sorted each sound by its decreasing percentage of accuracy. He determined which sounds had accuracy greater than 75% and categorized them as early-developing. He then grouped sounds with accuracy between 25% and 75% into the middle-developing category and sounds with less than 25% accuracy into the late-developing category, stating that, "the obvious breaks in this function allow for the division of the 24 consonants into three groups of 8 sounds" (p. 119). Specifically, mean accuracy was 89.5% (*SD* = 7.2) for early-developing sounds, 68.9% (*SD* = 16.0) for middle-developing sounds, and 12.9% (*SD* = 8.2) for late-developing sounds.

Shriberg (1993) validated the EML construct by retrospectively comparing data from Shriberg et al. (1992) with normative studies of English-speaking children (Hoffman, 1982, in Shriberg, 1993; Prather, Hedrick, & Kern, 1975; Sander, 1972; Smit, Hand, Freilinger, Bernthal, & Bird, 1990). Although there were methodological differences between the Shriberg et al. study and the comparison studies (e.g., stimuli, elicitation method, and criteria for mastery), Shriberg concluded that there was "general agreement" (p. 122) between accuracy for EML sounds and the rank order of acquisition as reported in the comparison normative studies. For example, in comparison to Sander (1972), 15 of the 24 consonants were ranked in the appropriate early-, middle-, or late-developing category.

In another study, Shriberg and Kwiatkowski (1994) found significant differences between 64 children 3–6 years old with speech delay and 72 same-aged typically developing children on EML sounds. Also, Shriberg, Gruber, and Kwiatkowski (1994) found stability for the EML construct over time in the longitudinal examination of 10 children with speech delay. These children were followed yearly from ages 3;8–5;4 to 8;11–11;4. Over time, the categories remained distinct, with accuracy for early-developing sounds higher than for middle-developing sounds, which in turn were higher than for late-developing sounds. Thus, EML appears to be a valid construct in that there is a link between consonant mastery and developmental order that holds over time. Moreover, it distinguishes between typically developing children and those with phonological disorders.

Increasingly, the EML construct has been applied to a variety of populations. For example, Flipsen, Hammer, and Yost (2005) examined the relationship of severity of phonological disorder and a range of segmental and whole word measures. Specific to the EML construct, they found that accuracy of late-developing sounds was positively correlated with severity, but accuracy of middle-developing sounds was negatively correlated with severity. In a study examining the effect of lexical treatment on the phonological skills of late talkers, Girolametto, Pearce, and Weitzman (1997) found that children who received treatment exhibited more consonants in their EML inventories than children who did not receive treatment. Roberts et al. (2005) found that children with Down syndrome showed significantly lower accuracy in comparison with mental age–matched typically developing children and those with fragile X syndrome on EML sounds. Moreover, for all three groups of children, accuracy on early-developing sounds was higher than for middle-developing sounds, and accuracy on middle-developing sounds was higher than for late-developing sounds.

Although the EML construct appears to show the expected trend based on markedness assumptions for diverse groups of monolingual English-speaking children, it is unknown if that trend holds for speakers of languages other than English, such as Spanish. Moreover, it is not clear how this construct differs in the constituent languages of bilingual Spanish-English-speaking children compared with their monolingual peers. Examining a construct such as this one for bilingual speakers would shed light on how markedness parameters in bilingual children influence order of acquisition of consonant sounds.

The purpose of this study was to determine the sounds that make up EML categories in Spanish and subsequently examine the accuracy of those categories in Spanish-English bilingual children and their monolingual peers. Given that the current study does not include the number of participants included in previous studies examining EML in English (Shriberg, 1993; Shriberg et al., 1992), this investigation is preliminary and exploratory in nature. To that end, the following research questions are posed:

1. Which sounds constitute EML categories in Spanish?
2. Based on those categories in Spanish and those existing for English, are there differences on the accuracy of EML sounds *between* Spanish-English bilingual children and monolingual Spanish and monolingual English children?
3. Are there differences *within* languages on the construct of EML sounds for Spanish-English bilingual children and monolingual Spanish and monolingual English children?

Based on findings from previous studies, we predict that, as has been found in previous work on markedness and phonological acquisition (Jakobson, 1941/1968), Spanish-speaking children and bilingual Spanish-English-speaking children will acquire the sounds of their languages in a simple-to-complex fashion.

Method

Participants

Twenty-four typically developing children, ages 3;0 to 4;0, were included in the study. The children were categorized into three major groups based on language history: (a) 8 bilingual Spanish-English-speaking children (mean age = 3;6; range = 3;0–4;0), (b) 8 monolingual Spanish speakers (mean age = 3;4; range = 3;2–4;0), and (c) 8 monolingual English speakers (mean age = 3;3; range = 3;0–3;11). Demographic characteristics of study participants by group can be found in Table 2. A Kruskal-Wallis nonparametric test indicated no significant difference between the groups on age, $\chi^2(2, N = 24) = 3.55$, $p = .169$. An extensive parent and/or teacher report (Restrepo, 1998) was used to determine each child's language status (i.e., monolingual or bilingual), bilingual status (i.e., simultaneous or sequential bilingual), and phonological status (i.e., to ensure that all children were typically developing with no speech, language, cognitive, or neurological deficits).

Bilingual participants. The bilingual children were speakers of Puerto Rican and Dominican Spanish. This study took place during May and June, and the children had been enrolled in a bilingual Head Start since the beginning of the school year. All bilingual participants had at least 8 months of exposure to English. In addition, all bilingual participants received at least 20% input in both languages and produced at least 20% output in both languages, according to parent report. This criterion follows from previous work which has shown that children need at least 20% exposure in order to use the target language (Pearson, Fernandez, Lewedeg, & Oller, 1997). Percentage input and output values were determined for both languages through parent report (after Restrepo, 1998). The first author asked parents to describe his or her child's schedule on a typical day. Since both peer and adult interactions influence input and proficiency (Rojas, Bunta, Iglesias, & Goldstein, 2007), the parent interview was conducted in such a way that all linguistic interactions were accounted for. When the parents reported the child's activities, the individual involved and the language typically used during that activity were recorded. The number of hours that the child was exposed to daily in each language, Monday through Friday, was determined (i.e., input). The same method was used to derive the number of hours the child used each language during the school week (i.e., output). Similar questions were asked regarding the child's weekend schedule. Overall percentages were calculated separately by multiplying the number of hours of exposure (input) or use (output) by 100 and then dividing that number by the total number of hours in the week. This outcome served as percentage input and output values.

In addition to determining frequency of input and output, parents rated their children's proficiency in both English and Spanish on a scale from 0 to 4. Zero represented that the child could not speak the indicated language at all, and 4 represented that the child had native-like proficiency in the language (Peña, Bedore, & Rapazzo, 2003; Peña, Bedore, & Zlatic-Giunta, 2002). These criteria were based on Gutierrez-Clellen and Kreiter (2003), who found that parent ratings of proficiency and percentage input in both languages correlated with bilingual children's proficiency (as measured by grammaticality) on narrative tasks. In addition, previous studies have also used these criteria to categorize bilingual children (e.g., Peña et al., 2003). All children included in the current study were rated as either 3 or 4 by their parents in both English and Spanish, indicating native or near native-like competence in the indicated languages. Therefore, regardless of percentage input and output, all bilingual children in the study were rated as native-like or near-native-like speakers of both Spanish and English.

In addition to proficiency ratings, parent report was used to determine the length of exposure to each language. Children included in this study were both simultaneous and sequential bilinguals. Sequential bilingual children had mostly Spanish input and output in the home up to age 3;0, after which English exposure began at preschool. Simultaneous bilingual children received exposure to both languages in the home from birth. Data from both types of bilinguals were included for four reasons. First, all bilingual children had at least 8 months of exposure to both languages. Second, as indicated above, all bilingual children demonstrated native or near-native-like proficiency in both languages, regardless of whether they were simultaneous or sequential bilingual children. Third, research indicates that phonological skills in simultaneous and sequential bilingual children are commensurate, although not identical (Arnold, Curran, Miccio, & Hammer, 2004; Fabiano-Smith & Goldstein, in press). Finally, it has been suggested that bilinguals be classified on multiple factors rather than on only one (Spolsky, 1989; Valdés & Figueroa, 1994). Thus, both bilingual types were aggregated in the current study because all participants had similar levels of input, output, and proficiency.

Monolingual participants. Data from 8 monolingual Spanish speakers were collected in Querétaro, Mexico, and data from the 8 monolingual English speakers were collected in Philadelphia. The children in each monolingual group had no input or output in any language but their native language, and their proficiency rating (obtained through parent report) in their one language was either 3 or 4 to be included in the study.

Data Collection

Single-word samples were collected from each child for analysis. Although the early-middle-late construct has been validated in English on conversational samples, it seems to be valid in productions derived from single-word samples as well (Ingram, 1992; Morrison & Shriberg, 1992). Each bilingual child was recorded in Spanish and English, and each monolingual child was recorded in his or her respective language. Overall, 32 single-word recordings were obtained. The phonology subtest of the Bilingual English Spanish Assessment (Peña, Gutierrez-Clellen, Iglesias, Goldstein, & Bedore, 2009), a phonological assessment designed to gauge children's speech sound productions in both English and Spanish, was used to elicit sounds in single words (see Goldstein & Washington, 2001, for English and Spanish stimuli). The assessment contains 31 separate target items for English and 29 separate target items for Spanish. This assessment has been used previously with bilingual children (e.g., Goldstein et al., 2005; Goldstein & Washington, 2001). Each target item was elicited via a spontaneous label made in reference to a photograph. If a child did not label the photograph spontaneously, the function of the item was provided to the child. If the child still did not label the item, delayed imitation was used because of the negligible

TABLE 2. Demographic characteristics of study participants by group.

	Chronological age (years;months)			% input Spanish		% input English		% output Spanish		% output English		Mean proficiency in Spanish (scale of 0–4)	Mean proficiency in English (scale of 0–4)
Language group	*M*	Range	Gender	*M* (*SD*)	Range	*M* (*SD*)	Range	*M* (*SD*)	Range	*M* (*SD*)	Range		
Bilingual	3;6	3;0–4;0	7 male, 1 female	60 (15)	40–80	41 (15)	20–60	37 (22)	20–75	63 (22)	25–80	3.25	3.5
Monolingual Spanish	3;4	3;2–4;0	5 male, 3 female	100 (0)	100–100	0 (0)	0–0	100 (0)	100–100	0 (0)	0–0	4	0
Monolingual English	3;3	3;0–3;11	5 male, 3 female	0 (0)	0–0	100 (0)	100–100	0 (0)	0–0	100 (0)	100–100	0	4

difference between these forms (Goldstein, Fabiano, & Iglesias, 2003). Each sample was recorded using "The Presenter" from Shure—a wireless lapel microphone, transmitter (Model T1-CL), and receiver (Model T3-CL)—with input into a Dell Latitude 100L using a Sound Blaster Audigy 2-Z5, 24-bit sound card from Creative Labs.

Phonetic Transcription

Data from the single-word samples were narrowly transcribed phonetically using diacritics into the Logical International Phonetics Program (LIPP; Oller & Delgado, 2000) for analysis. Dialectal features of both Spanish and English consonants (e.g., in Spanish [x] for /r/ in "perro"; in English [n] for /ŋ/ in "going") were taken into account and were not scored as errors. Dialect features of Puerto Rican, Dominican, and Mexican Spanish were drawn from a variety of sources (e.g., Alvar, 1998; Cotton & Sharp, 1988; Hammond, 2001; Navarro-Tomás, 1968; Poplack, 1978, 1980) and were taken into account during transcription and not scored as errors. This approach of accounting for dialect features in Spanish has been used in a number of studies (e.g., Goldstein, 2007; Goldstein, Fabiano, & Washington, 2005; Goldstein & Iglesias, 2001; Goldstein & Pollock, 2004). In those studies, the attested features of the dialect are noted in the children's speech, and modifications are made accordingly in LIPP. That is, the target line in the LIPP program is modified such that the children's productions that include known dialect features are not scored as errors in the LIPP analyses. This process ensures that only true errors are counted as such. Moreover, previous research indicates that after accounting for dialect, data from dialect groups can be aggregated. In a group of 12 Spanish-speaking 4- and 5-year-olds, 6 speakers of Puerto Rican Spanish and 6 speakers of Mexican Spanish, Goldstein (2007) found no significant between-groups differences for vowel accuracy, consonant accuracy, sound class accuracy, and percentage of occurrence for phonological patterns. Thus, in this study, all dialect features were accounted for, and data from the dialect groups were aggregated.

Analyses

Reliability of transcription. Reliability of transcription was performed on the children's speech samples among two bilingual Spanish-English-speaking graduate students and the first author of this study, who is an English-Spanish bilingual. Both the first author and the two bilingual graduate students were trained using the International Phonetic Alphabet for narrow transcription. The two student transcribers phonetically transcribed all of the single-word samples. Three weeks after the initial transcription, the graduate student transcribers performed intrajudge reliability by relistening to the recordings and indicating disagreements in their own transcriptions. Next, the first author performed interjudge reliability on the transcriptions produced by the two graduate student transcribers. She listened to the recordings while checking the students' transcription and indicating where disagreements occurred. Since three judges were involved in the reliability process, when a disagreement occurred between two of the judges, the third judge was called in to make a decision. The decision made by the third judge was accepted as the final transcription, and final reliability percentages take into account these final decisions. Intra- and interjudge reliability of narrow transcription was calculated for 100% of the Spanish and English target words for all of the children.

For the monolingual Spanish-speaking children, intra- and interjudge reliability reached 99.16% and 98.74%, respectively. For the monolingual English-speaking children, intra- and interjudge reliability reached 98.7% and 96.94%, respectively. For the Spanish productions of the bilingual children, intra- and interjudge reliability reached 99.14% and 97.48%, respectively. Finally, for the English productions of the bilingual children, intra- and interjudge reliability reached 98.61% and 95.67%, respectively.

Overall consonant accuracy. Using LIPP, overall PCC was calculated for both English and Spanish for all language groups (monolingual English speakers, the English productions of bilinguals, monolingual Spanish speakers, and the Spanish productions of bilinguals). These measures were obtained to determine whether a difference in overall consonant accuracy existed between Spanish-English bilingual children and monolingual Spanish-speaking and monolingual English-speaking children. The Mann–Whitney U test was used to determine whether any differences between monolinguals and bilinguals were significant (across group comparison). The Wilcoxon signed-ranks test was used to compare overall PCC from the English and Spanish productions of the bilingual children (across language comparison).

Accuracy of EML sounds in English. The sounds included in the EML categories for English were taken from Shriberg (1993), because these categories have already been established empirically and validated (see Table 1). Because Shriberg's (1993) data were taken from 3–6-year-old children with phonological delay, data from monolingual English speakers included in the current study were used for analysis in place of Shriberg's (1993) data. The monolingual English-speaking children included in this study were all typically developing and age-matched with the bilingual children in this study. Therefore, data from the monolingual English-speaking children in the current study were plotted using the phonemes making up Shriberg's (1993) EML categories. Shriberg (1993) excluded the phoneme /ʒ/ from analysis, and the current study followed suit. Data from the English productions of bilinguals were plotted in the same manner as the monolingual data for comparison.

Accuracy of EML sounds in Spanish. Because there are no established categories for early-, middle-, and late-developing sounds in Spanish, the current study aimed to establish these categories empirically. Mean accuracy for each of the 18 consonant phonemes of Spanish was taken from the monolingual Spanish speakers in the current study. Spanish data were recorded and plotted, dividing the Spanish phonemes into three groups as Shriberg (1993) did for English. Since the glide /w/ is widely considered to be part of the vowel nucleus in Spanish (Harris, 1983), it was excluded from analysis. In addition, the literature suggests that the voiced stops /b, d, g/ in Spanish are surface forms of the phonemic spirants /β, ð, ɣ/ based on fortition rather than spirantization

(Baković, 1994; Barlow, 2003). Although Harris (1969) considered the stops /b, d, g/ as the underlying form and the spriants /β, ð, ɣ/ as the surface form, current evidence suggests categorizing the spirants as the underlying form because they occur in more phonetic contexts than the voiced stops. This frequency of occurrence provides a child with a greater number of opportunities to produce the spirants, making the spirants more fundamental to the Spanish phonemic inventory than the voiced stops (Barlow, 2003). Therefore, the accuracy measures of the spirants were used in place of the voiced stops in all analyses. The Spanish productions of bilinguals were then organized according to categories established by the monolingual Spanish speakers.

Nonparametric statistical analyses. First, to determine whether a difference existed *between* Spanish-English bilingual children and monolingual Spanish and monolingual English children, the nonparametric alternative to the independent samples *t* test, the Mann–Whitney *U* test with Cohen's *d* as a measure of effect size, was used to compare monolingual and bilingual children on EML sound accuracy. Second, to determine whether there were differences *within* languages on the construct for Spanish-English bilingual children and monolingual Spanish and monolingual English children, the following tests were performed: (a) a nonparametric alternative to the analysis of variance, the Friedman test, was performed to examine whether there was a difference when results from EML sound categories were compared, and (b) the nonparametric alternative to the paired-samples *t* test, the Wilcoxon test, to determine which specific categories (when examined pairwise) were different from one another (e.g., early vs. middle, middle vs. late, and early vs. late). These analyses were performed separately on (a) the productions of monolingual Spanish-speaking children, (b) the Spanish productions of bilingual children, (c) the productions of monolingual English-speaking children, and (d) the English productions of bilingual children. Using the results of these analyses, comparisons were made between bilingual children and monolingual children to observe developmental similarities and differences, as well as between monolingual children from Shriberg (1993) for English and the monolingual Spanish-speaking children to examine early, middle, and late developmental categories.

Results

Bilinguals Versus Monolinguals

English productions. Means and standard deviations for overall accuracy and accuracy of EML sounds for English can be found in Table 3. Accuracy of individual sounds for monolinguals and bilinguals can be found in Figure 1. The results of the Mann–Whitney *U* test comparing overall PCC of monolingual English-speaking children with the English productions of bilinguals indicated that monolingual and bilingual children did not differ significantly from one another on overall consonant accuracy although the effect size was large ($z = -1.73$, $p = .083$, $d = 1.11$). The English productions of monolingual English-speaking children and bilingual children did differ significantly, with a large effect size on the accuracy of early-developing sounds ($z = -2.48$, $p = .013$, $d = 1.65$). However, the two groups did not differ significantly on either middle-developing sounds, for which there was a large effect size ($z = -1.63$, $p = .102$, $d = 1.15$) or late-developing sounds, for which there was a medium effect size ($z = -1.05$, $p = .294$, $d = 0.54$).

Spanish productions. EML sound categories were established empirically using sound accuracy from monolingual Spanish-speaking children and can be found in Table 4. Means and standard deviations for overall accuracy and accuracy of EML sounds for Spanish can be found in Table 5. Comparison of accuracy in EML sound categories between monolinguals and bilinguals can be found in Figure 2.

The results of the Mann–Whitney *U* test comparing overall PCC of monolingual Spanish speakers to the Spanish productions of bilinguals demonstrated that monolingual Spanish-speaking children were significantly more accurate, with a large effect size, on their productions of consonants than their bilingual peers ($z = -1.99$, $p = .046$, $d = 1.32$).

Monolingual Spanish speakers and the Spanish productions of bilingual children were then compared on EML categories established by the monolingual Spanish speakers. The results of the Mann–Whitney *U* test comparing bilingual and monolingual speakers on accuracy of early-, middle-, and late-developing sounds indicated that monolingual Spanish-speaking children and the Spanish productions of bilinguals did not differ significantly on the accuracy of early-developing sounds, with a medium effect size ($z = -.974$, $p = .330$, $d = 0.58$); middle-developing sounds, with a small effect size ($z = -.24$, $p = .809$, $d = 0.08$); or late-developing sounds, with a large effect size ($z = -.887$, $p = .375$, $d = 0.68$).

Spanish Versus English in Bilinguals

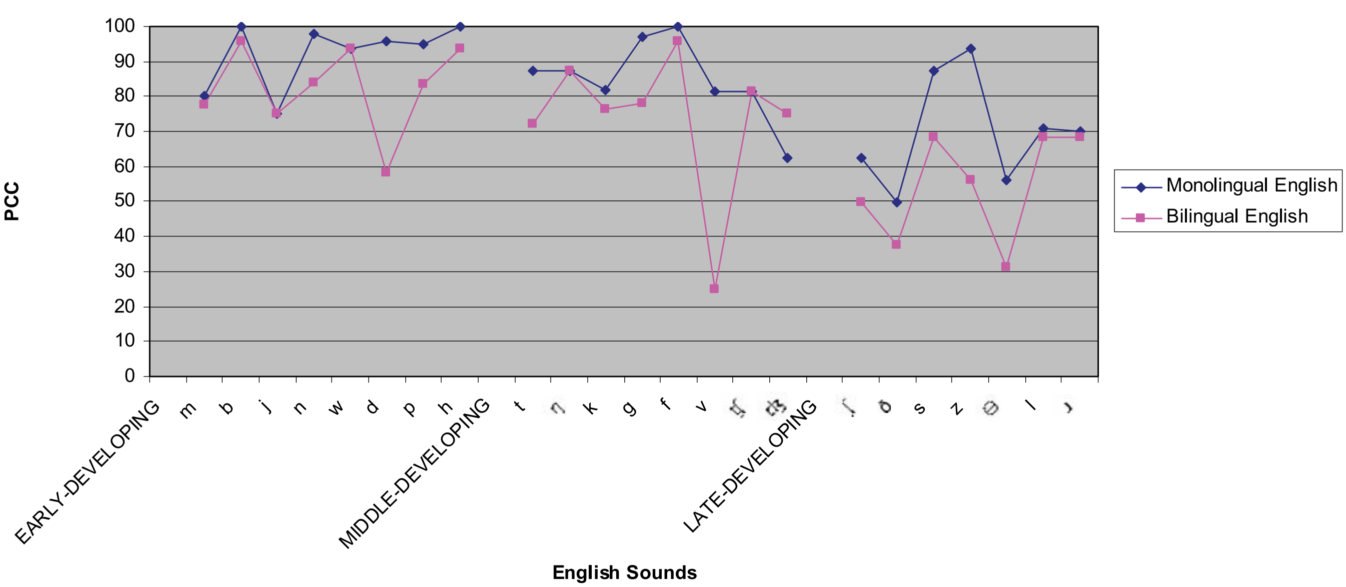
The results of the Wilcoxon signed-ranks test comparing the English and Spanish skills of the bilingual children demonstrated that overall PCC of English did not differ significantly from overall PCC of Spanish ($z = -1.68$, $p = .093$).

English productions. The results of the Friedman test examining accuracy of early-, middle-, and late-developing

TABLE 3. Means and standard deviations for overall percentage of consonants correct (PCC) and PCC in English EML categories established by monolingual children.

	Overall PCC		PCC early		PCC middle		PCC late	
Language group	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Monolinguals	84.10	8.20	93.93	3.97	86.53	7.60	74.10	16.07
Bilinguals	72.31	12.45	82.76	8.65	74.08	13.24	63.91	20.88

FIGURE 1. English early-, middle-, and late-developing (EML) categories: monolingual and bilingual children. PCC = percentage of consonants correct.



sounds in *monolingual* English-speaking children yielded a significant difference on accuracy between EML sounds, $\chi^2(2, N = 8) = 8.58$, $p = .014$. To determine which categories differed from one another on accuracy, the Wilcoxon tests were performed. The results of the Wilcoxon tests yielded a significant difference between early- and middle-developing sounds ($z = -2.19$, $p = .028$), middle- and late-developing sounds ($z = -2.10$, $p = .036$), and early- and late-developing sounds ($z = -2.38$, $p = .017$).

The results of the Friedman test examining accuracy of EML sounds in the English productions of *bilingual* speakers yielded a significant difference between EML sounds, $\chi^2(2, N = 8) = 10.51$, $p = .005$. To determine which developmental categories differed from one another, Wilcoxon tests were performed. The results of the Wilcoxon tests yielded a significant difference in accuracy between early- and middle-developing sounds ($z = -2.52$, $p = .012$) and between early- and late-developing sounds ($z = -2.10$, $p = .036$). However, there was no significant difference in accuracy between middle- and late-developing sounds ($z = -1.36$, $p = .173$).

Spanish productions. The results of the Friedman test examining accuracy of early-, middle-, and late-developing sounds in *monolingual* Spanish-speaking children yielded a significant difference, $\chi^2(2, N = 8) = 8.0$, $p = .018$. To determine which categories were different from one another, Wilcoxon signed-ranks tests were performed comparing each developmental category pairwise. The results of the Wilcoxon tests indicated a significant difference in accuracy between early- and middle-developing sounds ($z = -2.20$, $p = .027$). There was no significant difference between early- and late-developing sounds ($z = -1.82$, $p = .068$) or middle- and late-developing sounds ($z = -1.84$, $p = .066$). The results of the Friedman test examining accuracy of early-, middle-, and late-developing sounds in the Spanish productions of bilingual speakers yielded no significant difference, $\chi^2(2, N = 8) = 4.13$, $p = .127$. To determine if any individual categories were different from one another, the Wilcoxon tests were performed. The results of the Wilcoxon tests indicated no significant difference in accuracy between early- and late-developing sounds ($z = -1.82$, $p = .068$), early- and middle-developing sounds ($z = -.944$, $p = .345$), or middle- and late-developing sounds ($z = -1.46$, $p = .144$).

TABLE 4. EML categories for established, monolingual, Spanish-speaking children.

Category	Sounds
Early 6	/ɲ, t, m, n, k, x/
Middle 6	/s, f, p, ʧ, β, ɣ/
Late 4	/l, ð, r, ɾ/

Discussion

The purpose of this study was to examine the accuracy of EML sounds in Spanish-English bilingual children and their monolingual peers. This study aimed to answer the following research questions:

1. Which sounds constitute EML categories in Spanish?
2. Based on those categories in Spanish and those existing for English, are there differences on the accuracy of EML sounds *between* Spanish-English bilingual children and monolingual Spanish and monolingual English children?
3. Are there differences *within* languages on the construct of EML sounds for Spanish-English bilingual children

TABLE 5. Means and standard deviations for overall PCC and PCC in Spanish EML categories established by monolingual children.

	Overall PCC		PCC early		PCC middle		PCC late	
Language group	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Monolinguals	74.08	5.49	91.80	5.01	79.16	5.26	45.83	15.86
Bilinguals	65.77	6.95	85.19	13.31	78.05	17.61	30.65	26.99

and monolingual Spanish and monolingual English children?

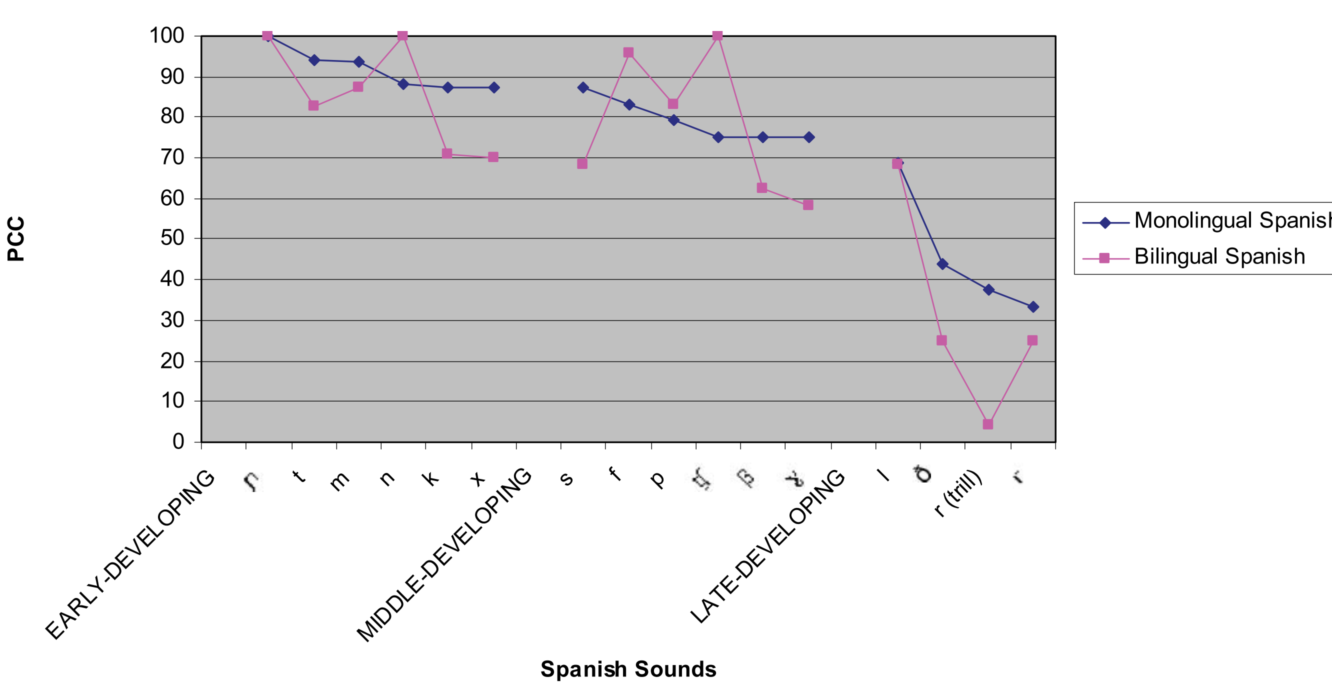
Monolingual Versus Bilingual Comparison

Overall PCC. The results of the children's productions in Spanish indicated that monolingual Spanish-speaking children were significantly more accurate on overall consonant accuracy than bilingual children. However, this was not the case for English. Monolingual and bilingual children did not differ significantly on overall PCC for English, indicating that bilingual children could be exhibiting slower acquisition in one language as compared with Spanish monolinguals, but at the same time, demonstrating commensurate skills with monolinguals in their other language, English (Goldstein et al., 2005; Peña et al., 2003).

EML sounds in English. The results of the monolingual English-speaking children's productions indicated that accuracy between all three sound categories was significantly different from one another, just as Shriberg (1993) found for monolingual, English-speaking children with speech delay. Accuracy within the three categories decreased significantly from early- to middle- to late-developing sounds. These findings support generative theories of phonological acquisition (Jakobson, 1941/1968) that have found accuracy to continually decrease as sound markedness increases. Jakobson (1941/1968) argued that there is a hierarchical manner in which children acquire the sounds of their language—more specifically, that easier-to-produce sounds will be acquired first (i.e., stops, nasals, and glides) and sounds with more complexity will be acquired later (e.g., liquids, fricatives, and affricates). The findings of the current study support this position, as accuracy of production was high for unmarked, or early-developing sounds, and continually decreased for middle- and late-developing sounds.

As mentioned previously, Shriberg (1993) concluded that there was "general agreement" (p. 122) between accuracy for EML sounds and the rank order of acquisition as reported in the comparison normative studies. Sander (1972) found that 15 of the 24 consonants were ranked in the appropriate early, middle, or late category. The findings from the current study also demonstrated that monolingual English-speaking children show a clear separation of EML sound categories, as in previous studies. Of the 24 sounds in Shriberg's

FIGURE 2. Spanish EML categories: monolingual and bilingual children.



categorization of EML sounds, 16 were included in those same categories using data from the current study: six early-developing sounds (/h, f, b, n, g, d, p, z, w/), five middle-developing sounds (/s, ŋ, t, k, v, ʧ, m, j/), and five late-developing sounds (/l, ɹ, ʃ, ʤ, θ, ð/).

EML sounds in Spanish. Overall, accuracy of production in the monolingual Spanish-speaking group decreased from early- to middle- to late-developing sounds, much like the monolingual English-speaking children in the current study and those in Shriberg (1993). Shriberg validated the EML construct by retrospectively comparing data from Shriberg et al. (1992) to normative studies of English-speaking children (Hoffman, 1982, in Shriberg, 1993; Prather et al., 1975; Sander, 1972; Smit et al., 1990). To validate our data for Spanish, we compared our findings with Acevedo's (1993) developmental data on Spanish monolinguals. Acevedo examined 120 Mexican-American Spanish-speaking children, ages 3;0–5;11, on a single-word test and organized her data into 6-month age intervals. To determine the order of phoneme acquisition for Spanish-speaking children, she used the following criterion: A phoneme was mastered if correct production remained at 90% or better over two successive age intervals. Her findings indicated that most phonemes were mastered by 4;0–4;5. There were certain phonemes, however, that were acquired later than most of the Spanish consonants. The sounds /β, x, ɣ, r/ demonstrated variation in age of mastery, and none of these phonemes stabilized earlier than 4;6. Our data showed that monolingual Spanish speakers demonstrated lower accuracy on those particular phonemes when compared with the monolingual Spanish speakers in the current study, especially for /r/. However, although overall accuracy decreased as markedness increased, the Spanish-speaking children did not categorize EML sounds in exactly the same way that the English-speaking children did. Monolingual Spanish speakers showed a significant difference in accuracy between early- and middle-developing sound categories but not between middle- and late-developing sound categories.

The Spanish productions of bilinguals resulted in a different finding. The bilingual children did not demonstrate any significant differences in accuracy across the three categories. It could be possible that bilingual children, at age 3;0, do not delineate EML categories in the same way that monolingual children do, at least for Spanish. It is possible that bilingual children have somewhat different developmental trajectories for each language or that they treat the EML construct differently in each language due to differences in markedness parameters between Spanish and English. This finding mirrors that of the studies examining phonetic inventory complexity. English-speaking children in Dinnsen et al. (1990) and Spanish-speaking children in Cataño et al. (2009) exhibited similar, but not identical, order of acquisition of sound classes. Both English- and Spanish-speaking monolingual children in those studies followed a simple-to-complex trajectory, with some differences likely due to how certain sounds are ranked in terms of markedness in each language (e.g., /l/). Thus, it is possible that one sound can differ on certain aspects of markedness across languages, resulting in markedness parameters being applied somewhat differently cross-linguistically. Even if order of acquisition across those languages is similar overall, certain sounds can show variation in markedness ranking. However, that interpretation will need to be investigated with a larger sample size and its subsequent greater statistical power.

Upon examination of the means and standard deviations for EML categories for Spanish in the current study, bilingual children demonstrated more variation than monolinguals in that accuracy was more uniform across monolingual Spanish-speaking children and varied much more in the bilingual group. In addition, both monolinguals and bilinguals demonstrated a wide range of variation on accuracy in the late-developing category, which includes /r/, just as in Acevedo (1993). It is important to note, however, that accuracy within the three categories largely decreased from early- to middle- to late-developing sounds, even if variation across speakers for individual sounds was observed. It is also important to point out that differences in EML categories found between Spanish monolinguals and the Spanish productions of bilingual children would not have been seen solely through the use of a broad measure of accuracy. Although monolinguals and bilinguals differ on overall PCC, it is unclear on what specific sounds or sound classes they differ without examining the narrow measure of EML. Therefore, using a narrow measure, such as EML, sheds light on how order of acquisition of sounds in bilingual children is similar to, and different from, acquisition in monolinguals. Finally, although there were some differences in *accuracy* within and between monolinguals and bilinguals in Spanish, the overall *pattern* of acquisition proceeded from simple to complex. These findings support Jakobson's (1941/1968) theory of acquisition in which children acquire unmarked phonemes before their more marked counterparts.

Comparison of Bilingual Children's Two Languages

The bilingual children in this study exhibited differences between their two languages on EML categories. In English, the bilingual children showed significant differences in accuracy between EML sounds. Specifically, there were significant differences in accuracy between early- and middle-developing sounds, between middle- and late-developing sounds, and between early- and late-developing sounds. In Spanish, however, there was a significant difference in accuracy between early- and middle-developing sounds but not between either early- and late-developing sounds or between middle- and late-developing sounds.

Upon examination of the findings from the English productions of bilinguals, there was a tendency to collapse the middle- and late-developing categories in that those categories did not differ significantly in accuracy ($z = -1.36$, $p = .173$). In Spanish, there were no significant differences between any of the categories. These findings might be a result of sociolinguistic factors such as amount of input heard by the children and/or amount of output used by the children. However, Goldstein, Lange, Rodriguez, Bunta, and Burrows (2009) found that neither amount of input nor amount of output predicted Spanish-English bilingual children's phonological skills. What did predict their skills were parental estimates of use and proficiency, the same measures used in this study to determine the children's skills in each language. These findings also could be due to the relatively small number of participants in the current study. Including a larger number of participants would allow more advanced statistical analyses, such as factor analysis, that would determine which sounds "naturally" group together. Finally, the dialect of the children might be a factor in the differences between languages. However, in both English and Spanish, the children's dialect features were taken into account, as has been done in previous studies with this population (e.g., Goldstein et al., 2005; Goldstein & Iglesias, 2001), and previous research indicates that once dialect features are taken into account, differences between dialect groups are mitigated (e.g., Goldstein, 2007).

It is not surprising that bilingual children would show differences between languages. This effect has been found in a number of studies examining bilingual children's phonology and other domains of language. Goldstein et al. (2005) found differences in the percentage of occurrence for phonological patterns across languages. For example, cluster reduction and final consonant deletion showed higher percentages of occurrence in English than in Spanish; however, unstressed syllable deletion was exhibited with a higher percentage of occurrence in Spanish than in English. In a group of 47 typically developing Spanish-English bilingual children between 4;5 and 7;0, Peña et al. (2003) found across-language differences in the children's semantic skills. For example, performance on expressive association tasks was higher in English, but performance on receptive association tasks was higher in Spanish. Bilingual children have been found to treat the developmental trajectories of their two languages differently, and the findings of this study concur with those of previous studies.

Limitations of the Current Study

The findings of this study suggest that the more narrow measure of EML categories detects similarities and differences between monolinguals and bilinguals that otherwise are overlooked by broader measures of accuracy. Furthermore, these results are commensurate with previous work finding a relationship between markedness and phonological acquisition. These findings are preliminary, however, and should be interpreted with caution given the cross-sectional nature of the investigation and a relatively limited number of children. Including a larger sample and examining the data longitudinally would allow the use of parametric statistics such as factor analysis or discriminant analysis, which classify cases into categories. Such analyses could better demonstrate how bilingual children acquire and organize the sounds from two languages.

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References

Acevedo, M. A. (1993). Development of Spanish consonants in preschool children. *Journal of Childhood Communication Disorders, 15,* 9–15.

Alvar, M. (1998). *Manual de dialectología Hispánica* [Manual of Hispanic dialectology]. Barcelona, Spain: Ariel.

Anderson, R., & Smith, B. L. (1987). Phonological development of two-year-old monolingual Puerto Rican Spanish-speaking children. *Journal of Child Language, 14*(1), 57–78.

Arnold, E., Curran, C., Miccio, A., & Hammer, C. (2004, November). *Sequential and simultaneous acquisition of Spanish and English consonants*. Poster presented at the Annual Convention of the American Speech-Language-Hearing Association, Philadelphia.

Baković, E. (1994). Strong onsets and Spanish fortition. *MIT Working Papers in Linguistics, 23,* 21–39.

Barlow, J. (2003). The stop-spirant alternation in Spanish: Converging evidence for a fortition account. *Southwest Journal of Linguistics, 22*(1), 51–86.

Cataño, L., Barlow, J. A., & Moyna, M. (2009). Phonetic inventory complexity in the acquisition of Spanish: A retrospective, typological study. *Clinical Linguistics and Phonetics, 23,* 446–472.

Cotton, E., & Sharp, J. (1988). *Spanish in the Americas*. Washington, DC: Georgetown University Press.

Dinnsen, D., Chin, S., Elbert, M., & Powell, T. (1990). Some constraints on functionally disordered phonologies: Phonetic inventories and phonotactics. *Journal of Speech and Hearing Research, 33,* 28–37.

Fabiano-Smith, L., & Barlow, J. (2009). Interaction in bilingual phonological acquisition: Evidence from phonetic inventories. *The International Journal of Bilingual Education and Bilingualism, 13*(1), 81–97. Retrieved from http://dx.doi.org/10.1080/13670050902783528.

Fabiano-Smith, L., & Goldstein, B. (in press). Phonological acquisition in bilingual Spanish-English speaking children. *Journal of Speech, Language, and Hearing Research*.

Fikkert, P. (2007). Acquiring phonology. In P. DeLacy (Ed.), *The Cambridge handbook of phonology* (pp. 537–554). Cambridge, England: Cambridge University Press.

Flipsen, P., Hammer, J., & Yost, K. (2005). Measuring severity of involvement in speech delay: Segmental and whole word measures. *American Journal of Speech-Language Pathology, 14,* 298–312.

Gildersleeve-Neumann, C., Kester, E., Davis, B., & Peña, E. (2008). English speech sound development in preschool-aged children from bilingual Spanish-English environments. *Language, Speech, and Hearing Services in Schools, 39,* 314–328.

Girolametto, L., Pearce, P., & Weitzman, E. (1997). Effects of lexical intervention on the phonology of late talkers. *Journal of Speech, Language, and Hearing Research, 40,* 338–348.

Goldstein, B. (2007). Phonological skills in Puerto Rican- and Mexican-Spanish speaking children with phonological disorders. *Clinical Linguistics and Phonetics, 21,* 93–109.

Goldstein, B., Fabiano, L., & Iglesias, A. (2003, April). *Phonological representation in bilingual Spanish-English speaking children*. Poster presented at the 4th International Symposium on Bilingualism, Tempe, AZ.

Goldstein, B., Fabiano, L., & Washington, P. (2005). Phonological skills in predominantly English, predominantly Spanish, and Spanish-English bilingual children. *Language, Speech, and Hearing Services in Schools, 36,* 201–218.

Goldstein, B., & Iglesias, A. (2001). The effect of dialect on phonological analysis: Evidence from Spanish-speaking children. *American Journal of Speech-Language Pathology, 10,* 394–406.

Goldstein, B., Lange, J., Rodriguez, J., Bunta, F., & Burrows, L. (2009). *Language output and phonological skills in bilingual children*. Manuscript submitted for publication.

Goldstein, B., & Pollock, K. (2004). Vowel production in Spanish-speaking children with phonological disorders: Dialect and sampling issues. *Journal of Multilingual Communication Disorders, 2,* 147–160.

Goldstein, B., & Washington, P. (2001). An initial investigation of phonological patterns in 4-year-old typically developing Spanish-English bilingual children. *Language, Speech, and Hearing Services in Schools, 32,* 153–164.

Gutierrez-Clellen, V. F., & Kreiter, J. (2003). Understanding child bilingual acquisition using parent and teacher reports. *Applied Psycholinguistics, 24,* 267–288.

Hammond, R. (2001). *The sounds of Spanish: Analysis and application (with special reference to American English)*. Somerville, MA: Cascadilla Press.

Harris, J. (1969). *Spanish phonology*. Cambridge, MA: MIT Press.

Harris, J. (1983). *Syllable structure and stress in Spanish: A nonlinear analysis*. Cambridge, MA: MIT Press.

Ingram, D. (1992). Articulation testing versus conversational speech sampling: A response to Morrison & Shriberg (1992). *Journal of Speech and Hearing Research, 37,* 935–937.

Jakobson, R. (1968). *Child language, aphasia, and phonological universals* (A. R. Keiler, Trans.). The Hague: Mouton. (Original work published 1941)

Jiménez, B. (1987). Acquisition of Spanish consonants in children aged 3-5 years, 7 months. *Language, Speech, and Hearing Services in Schools, 18,* 357–363.

Locke, J. (1983). *Phonological acquisition and change*. New York: Academic Press.

Morrison, J. A., & Shriberg, L. D. (1992). Articulation testing versus conversational speech sampling. *Journal of Speech and Hearing Research, 35,* 259–273.

Navarro-Tomás, T. (1968). *El Español en Puerto Rico [Spanish in Puerto Rico]* (R. D. Abraham, Trans.). Coral Gables, FL: University of Miami Press.

Oller, K., & Delgado, R. (2000). Logical International Phonetics Program (Version 2.02) [Computer software]. Miami, FL: Intelligent Hearing Systems.

Pearson, B., Fernandez, S., Lewedeg, V., & Oller, D. K. (1997). The relation of input factors to lexical learning by bilingual infants. *Applied Psycholinguistics, 18,* 41–58.

Peña, E., Bedore, L., & Rappazzo, C. (2003). Comparison of Spanish, English, and bilingual children's performance across semantic tasks. *Language, Speech, and Hearing Services in Schools, 34,* 5–16.

Peña, E. D., Bedore, L. M., & Zlatic-Giunta, R. (2002). Category-generation performance of bilingual children: The influence of condition, category, and language. *Journal of Speech, Language, and Hearing Research, 45,* 938–947.

Peña, E., Gutierrez-Clellen, V., Iglesias, A., Goldstein, B., & Bedore, L. (2009). *Bilingual English Spanish Assessment*. Unpublished.

Poplack, S. (1978). Dialect acquisition among Puerto Rican bilinguals. *Language in Society, 7,* 89–103.

Poplack, S. (1980). Deletion and disambiguation in Puerto Rican Spanish. *Language, 56,* 371–385.

Prather, E., Hedrick, D., & Kern, C. (1975). Articulation development in children aged two to four years. *Journal of Speech and Hearing Disorders, 40,* 179–191.

Restrepo, M. A. (1998). Identifiers of predominantly Spanish-speaking children with language impairment. *Journal of Speech, Language, and Hearing Research, 41,* 1398–1411.

Roberts, J., Long, S., Malkin, C., Barnes, E., Skinner, M., Hennon, E., & Anderson, K. (2005). A comparison of phonological skills of boys with fragile X syndrome and Down syndrome. *Journal of Speech, Language, and Hearing Research, 48,* 980–995.

Rojas, R., Bunta, F., Iglesias, F., & Goldstein, B. (2007, November). *Interlocutor differential effects on ELL children's language output measures*. Seminar presented at the Annual Convention of the American Speech-Language-Hearing Association, Boston.

Sander, E. K. (1972). When are speech sounds learned? *Journal of Speech and Hearing Disorders, 37,* 55–63.

Shriberg, L. (1993). Four new speech and voice-prosody measures for genetics research and other studies in developmental phonological disorders. *Journal of Speech, Language, and Hearing Research, 36,* 105–140.

Shriberg, L. D., Austin, D., Lewis, B. A., McSweeny, J. L., & Wilson, D. L. (1997). The percentage of consonants correct (PCC) metric: Extensions and reliability data. *Journal of Speech, Language, and Hearing Research, 40,* 708–722.

Shriberg, L. D., Gruber, F. A., & Kwiatkowski, J. (1994). Developmental phonological disorders III: Long-term speech-sound normalization. *Journal of Speech and Hearing Research, 37,* 1151–1177.

Shriberg, L. D., & Kwiatkowski, J. (1994). Developmental phonological disorders I: A clinical profile. *Journal of Speech and Hearing Research, 37,* 1100–1126.

Shriberg, L. D., Kwiatkowski, J., & Gruber, F. A. (1992, November). *Short-term and long-term normalization in developmental phonological disorders*. Paper presented at the Annual Convention of the American Speech-Language-Hearing Association, San Antonio, TX.

Smit, A. B. (1993). Phonologic error distributions in the Iowa-Nebraska Articulation Norms Project: Word-initial consonant clusters. *Journal of Speech and Hearing Research, 36,* 931–947.

Smit, A. B., Hand, L., Freilinger, J. J., Bernthal, J. E., & Bird, A. (1990). The Iowa articulation norms project and its Nebraska replication. *Journal of Speech and Hearing Disorders, 55,* 779–798.

Spolsky, B. (1989). *Conditions for second language learning*. Oxford, England: Oxford University Press.

Valdés, G., & Figueroa, R. (1994). *Bilingualism and testing: A special case of bias*. Norwood, NJ: Ablex.

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Early-, Middle-, and Late-Developing Sounds in Monolingual and Bilingual Children: An Exploratory Investigation

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