Clinical Linguistics & Phonetics, March 2012; 26(3): 255–272

informa
healthcare

A Spanish pilot investigation for a crosslinguistic study in protracted phonological development

MARIO E. CHÁVEZ-PEÓN[1], BARBARA MAY BERNHARDT[2], MARCY ADLER-BOCK[3], CARMEN ÁVILA[4], GLORIA CARBALLO[5], DOLORES FRESNEDA[5],CONXITA LLEÓ[6], ELVIRA MENDOZA[5], DENISSE PEREZ[5], & JOSEPH PAUL STEMBERGER[7]

[1]*Programa de Becas Posdoctorales, Coordinación de Humanidades, Instituto de Investigaciones Antropológicas, Universidad Nacional Autónoma de México, Mexico City, Mexico,* [2]*School of Audiology and Speech Sciences, University of British Columbia, Vancouver, BC, Canada,* [3]*Vancouver Coastal Health, Richmond, BC, Canada,* [4]*Departamento de Lengua Española, University of Granada, Granada, Spain,* [5]*Departamento de Personalidad, Evaluación y Tratamiento Psicológico, University of Granada, Granada, Spain,* [6]*Institut für Romanistik, University of Hamburg, Hamburg, Germany,* [7]*Department of Linguistics, University of British Columbia, Vancouver, BC, Canada*

(*Received 16 January 2011; Accepted 25 July 2011*)

Abstract
A crosslinguistic study is underway concerning children's protracted phonological development (i.e. speech sound disorders). The current article reports pilot Spanish data for this study from two 4-year-old boys with protracted phonological development. The purposes of the pilot study were to: (1) develop and evaluate a word list for elicitation that could be used across Spanish dialects and that sufficiently sampled Spanish word lengths, stress patterns, word shapes and phonemes; and (2) to derive hypotheses for the larger study, based on patterns found in these children's speech, and a review of the literature. The two speakers showed some developmental patterns reported for other languages (e.g. constraints on production of liquids and word-initial consonants in unstressed syllables) but also patterns that may reflect Spanish phonological inventories, allophony and frequencies. These data helped consolidate the Spanish word list for elicitation and led to questions for the ongoing study concerning word structure, multisyllabic words, liquids, fricatives and vowel sequences.

Keywords: *crosslinguistic, Spanish, phonological development, phonological disorders*

Introduction

The current article provides preliminary Spanish data for a crosslinguistic study concerning children's protracted phonological development (PPD[1]) in at least 10 languages. For the larger study, Spanish data will be collected in Granada, Spain (Andalusian dialect) and

Correspondence: Barbara May Bernhardt, School of Audiology and Speech Sciences, University of British Columbia, 2177 Wesbrook Mall, Vancouver, V6T 1Z3 BC, Canada. E-mail: may.bernhardt@audiospeech.ubc.ca

ISSN 0269-9206 print/ISSN 1464-5076 online © 2012 Informa UK Ltd.
DOI: 10.3109/02699206.2011.608463

Mexico City. The current article reports pilot data from Mexican and Argentinian-born 4-year-old boys with PPD. The purposes of the current study were to (1) evaluate a word list for elicitation that could apply across Spanish dialects and sufficiently sample Spanish word lengths, stress patterns, word shapes and phonemes; and (2) to derive hypotheses for the larger study, based on patterns found in the children's speech, and a review of the literature. The introduction below provides a background on Spanish phonology – calling attention to the dialect regions for our larger study: Argentinian, Mexican and Andalusian, the development of the word list for elicitation and previous research on Spanish acquisition.

Consonant inventory of Spanish

Because the word list for elicitation was designed to account for both Granada Spanish and Spanish of the Americas (primarily Mexican), we note dialectal differences throughout the following sections. Table I shows the Spanish consonant inventory. By manner, Spanish has stops, nasals, fricatives, affricate(s), liquids and glides; by place, labials, dentoalveolars, palatoalveolars, palatals and velars; and by voicing, both voiced and voiceless obstruents.

Many sound classes show allophonic variation. Voiced stops undergo lenition between vowels both within and between words, fluctuating between fricatives and approximant-like elements (Quilis, 1981; Martínez Celdrán and Fernández, 2007): /b, d, g/→ [β, ð, ɣ]/V_V.

Fricatives and affricates also show variation by word position and across variants. The orthographic coda 's' may be produced as an aspirate [^{h}] in Argentina, Mexico and Granada or may even be deleted in Granada. In Granada, there is also considerable across-speaker variability concerning the use of [s] versus [θ] in words spelled with 'z' before 'a, e or o' and 'c' before 'e' or 'i' (Moya and García, 1995). The fricative /x/ may be pronounced as [h] in Granada, Mexico and Argentina or deleted word finally in Mexico and Granada (Alvar, 2009). In Mexico and Granada, /ʝ/ (orthographically *ll* or *y*) is realized as [dʒ] in initial position or after nasals (e.g. *llanta* /ˈdʒan.ta/ 'tire'; *cónyuge* /ˈkon.dʒu.xe/ 'spouse'; Alarcos, 1974; Quilis, 1981). Elsewhere, there is fluctuation between [ʝ] and [j]. In Argentina, the orthographic *ll* and y are pronounced as [ʒ] (Aleza and Enguita, 2002), with some dialectal variants showing [ʃ]. The medial affricate /tʃ/ may be pronounced as /ʃ/ in northern Mexico and Granada (Moya and García, 1998).

Within sonorants, nasals assimilate to the place of articulation of the following consonant (e.g. [eŋ.ˈfeɾmo] 'sick', [ˈaŋ.kla] 'anchor'). In addition, in Granada, as in much of Spain, the orthographic <n> is often pronounced [ŋ], especially in coda position (Quilis, 1993).

Table I. Spanish consonant inventory.

	Bilabial	Labiodental	Dento-alveolar	Palato-alveolar	Palatal	Velar {Glottal}
Stop	p b		t d			k g
Nasal	m			n	ɲ	
Trill				r		
Tap				ɾ		
Fricative		f	(θ)	s (ʃ) (ʒ)	ʝ	{x/h}
Affricate					ʧ	
Approximant					j	w
Lateral approximant				l	(ʎ)[a]	

Note: [a]This phoneme /ʎ/ is contrastive only in some regions of Spain (North) and the Americas (Bolivia). In the rest of the dialects /ʎ/ is neutralized into /ʝ/ (phenomenon called *yeísmo*).

Concerning liquids, in Granada Spanish /r/-/ɾ/-/l/ may interchange medially and /r/ or /ɾ/ may be deleted syllable finally (Narbona, Cano, and Morillo, 1998; Jiménez Fernández, 1999; Mondéjar and Carrasco, 2001).

Vowels of Spanish

Spanish is generally described as having a five-vowel system /a, e, i, o, u/ (Alarcos, 1974, 1991; Navarro, 1977; Hualde, 2005). In addition, there are falling diphthongs /ai, au, ei, eu, oi, ou/ and rising diphthongs /ia, ie, io, iu, ua, ue, ui, uo/. (Here we follow Harris (1983), who treats /u/ and its derived [w] as rime constituents.) Vowel sequences also occur across syllable boundaries (e.g. /e.a/ as in *chimenea* /tʃi.me.ˈne.a/ 'chimney'; /e.o/ as in *leona* /le.ˈo.na/ 'lion (fem.)'; /i.a/ as in *día* /ˈdi.a/ 'day', etc.).[2]

Syllable and word structures of Spanish

By word length, disyllabic words are the most frequent content words in Spanish, with multisyllabic words also fairly frequent. Monosyllabic content words are infrequent. Stress can be on any syllable in Spanish, although most disyllabic words have trochaic stress (left-prominent, stressed-unstressed or strong-weak, Sw). Words with final consonants form the pattern (w)wS, which could be considered iambic (right-prominent) under a syllabic analysis. However, another account (Lipski, 1997) considers stress to be predominantly trochaic for the language. In this proposal, word-final consonants are moraic (timing units) and therefore affect stress. If stress is determined from the right edge of a word, and the first syllable at the right has a final consonant, then that word has trochaic-moraic stress. This account also would consider stress patterns such as w(w)Sw to be trochaic, with the first two syllables added on to the primary trochaic (Sw) foot (for more discussion on stress, see Harris (1983); Roca (1989)).

Spanish is considered to be a syllable-timed language, with a similar amount of time between syllables and vowels and no vowel reduction in the unstressed syllable (Auer, 1991; Laver, 1994). Spanish has word-initial and -medial consonant sequences (two consonants maximum). Syllable-initial obstruent-liquid clusters include /pl/, /bl/, /tl/,[3] /kl/, /gl/, /fl/, /pɾ/, /bɾ/, /tɾ/, /dɾ/, /kɾ/, /gɾ/ and /fɾ/ (D'introno, del Teso, and Weston, 1995; cf. Harris, 1983). Coda consonants are limited to coronals {d/ð}, {n /ŋ}, /l/, /ɾ/ and /s/ and dorsal /x/; some variants (e.g. Granada Spanish) have fewer than others (see note above on /x/ and /s/). Spanish word-final clusters rarely include two consonants, namely a consonant followed by /s/ (Núñez-Cedeño, 2000). Heterosyllabic consonant sequences occur with sonorants, for example, /mp/, /mb(ɾ)/, /nt/, /nd/, /n{θ/s}/, /ŋk/, /lt/, /ɾt/, /ɾk/, /ɾn/, /ɾð/ and fricatives /{s/h}t/, /{s/h}p/, /{s/h}k/ (Núñez-Cedeño, 2000).

Acquisition of Spanish

A brief discussion of Spanish phonological acquisition follows. Singleton vowels appeared to be acquired by age 2 (Maez, 1985; Goldstein and Pollock, 2000; Kehoe, 2002), but information on diphthongs is limited (Lleó and Prinz, 1996).

Early studies concerning Spanish consonant acquisition include Montes Giraldo (1970, 1971) and Macken (1978, 1979).[4] The former describes productions of Colombian children from early words to age 3 years (two children) and 5 years (two children). Key findings were a high frequency of labial consonants in early words and late acquisition of the tap and trill (age 5). Macken (1978, 1979) describes the early acquisition of Spanish by two California-

based Mexican children, J and Si. By age 1;9, J produced all voiceless stops, nasals /m n/, glides /w j/ and /h/, with fricatives /f s x/ and affricate /tʃ/ emerging. Si's consonant inventory at age 1;7 comprised stops /p t/, nasals /m n/ and glides /w j/. The /k/ emerged at 1;9, /tʃ/ at 1;10, /l/ and /ɲ/ at 1;11, /s/ at 2;0 and /f/ at 2;1.

Concerning manner of articulation, early acquisition of stops and nasals, and later acquisition of fricatives and liquids have been noted (González, 1981; Anderson and Smith, 1987; Goldstein and Cintrón, 2001; Goldstein, 2007). Lleó (2008) points out, however, that there may not be a developmental precedence of stops over fricatives/continuants in Spanish because both manners of articulation tend to be acquired at about the same time. This is likely related to the allophonic variation of voiced stops described above. (See also Eblen (1982) concerning Mexican fricative development.)

The liquid /l/ generally is acquired relatively early compared with the rhotics. Fabiano-Smith and Goldstein (2010a) noted an overall accuracy of 70% for /l/ in their eight monolingual Mexican Spanish-speaking 3–4-year-olds, with Acevedo (1993) showing mastery of /l/ by age 4 in 20 Mexican-American functionally monolingual Spanish-speaking children in Texas. The vibrants /ɾ/ and especially /r/ tend to be acquired rather late across children, that is after age 5, although some children do use these early on (Acevedo, 1993; Carballo and Mendoza, 2000; Arellanes, Meneses, and Herrasti, 2003; Fabiano-Smith and Goldstein, 2010a).

Concerning acquisition of voicing, Fabiano-Smith and Barlow (2009) and Fabiano-Smith and Goldstein (2010a, b) noted 80–95% match across children for acquisition of voiceless stops in their groups of eight Spanish-speaking monolingual and bilinguals between ages 3;0 and 4;0. However, Macken and Barton (1980) noted relatively late acquisition of the voicing contrast in Spanish (not before age 5), possibly because of the prevoiced aspect of voiced stops (see also Macken, 1975). Summarizing the literature on voice contrasts, Kehoe, Lleó, and Rakow (2004) point out that studies show earlier acquisition of long lag-short lag contrasts (English) versus long lead-short lag contrasts for voicing (Spanish). They conducted two studies on the acquisition of Voice Onset Time (VOT), one with English-learning children and the other one with Spanish-learning children. The former produced the English voicing contrast by 2;6, whereas the latter did not distinguish voiceless and voiced stops in Spanish by means of VOT, that is all stop consonants tended to be produced with short lag. They proposed that children acquiring Spanish use the contrast between stops and continuants, instead of VOT, to distinguish voiced (with continuants or spirants as allophones) from voiceless stops (without such allophones). Lleó (2008) points out that a note of caution is necessary, because different authors use different criteria to decide when a certain unit has been acquired and use different phenomena to measure development. Furthermore, the voicing contrast is complicated in Spanish because of the stop-spirant alternation intervocalically for the voiced targets, which can also affect word-initial stops, at least after the feminine articles.

For place of articulation, studies suggest that labials and coronals tend to be acquired early, and velars later (Montes Giraldo, 1970, 1971; Macken, 1975), although for most 3-year-olds in Acevedo (1993) and Fabiano-Smith and Goldstein (2010a), all three places of articulation were present early on.

With respect to word structure, Carreira (1991) notes that open CV (and V) syllables emerge before CVC, complex onsets and codas, and that singleton codas appear before complex onsets. Kehoe and Lleó (2003) describe similar patterns, that is, appearance of open syllables CV and V before closed syllables CVC and VC. Lleó (2003) noted minimal coda use in two Spanish-speaking children in Madrid, up to ages 2;2/2;3, with emergence of falling diphthongs before word-final codas, and glides commonly substituting for coda

consonants. Lleó (2008: 357) states that 'the presence of glides instead of consonants in coda position seems to be a typical property of the Spanish children's productions. . .' (see also Bosch, 2004). Regarding consonant clusters, Goldstein and Iglesias (1996) report accurate Spanish cluster production by age of 5 years. Up until then, cluster reduction is reported to be common. Lleó (2008) notes that the consonant retained is typically the least sonorous (e.g. /pl/ > [p]; Barlow, 2003); exceptions have been reported, however (De Zuluaga, 1979; Macken, 1979; Lleó and Prinz, 1996).

Concerning word length, Lleó (2002, 2006) describes relatively early acquisition of longer words compared with monosyllables; three monolingual Spanish children first produced trochaic disyllables, then both iambic disyllables and trisyllables (under age 2), and finally, monosyllables. Lleó and Demuth (1999) found syllable truncation to be a short-lived pattern in Spanish acquisition, although Lleó and Arias (2006) observed a tendency for children to substitute trochaic for iambic stress (see also Hochberg, 1988; Goldstein and Cintrón, 2001). Astruc, Payne, Post, Prieto, and Vanrell (2010) noted that Spanish- and Catalán-learning children generally produce iambic stress and multisyllabic words by the age of 2, earlier overall than the English-learning children in their study. However, even though there may be a higher preponderance of weak syllables produced (less truncation) in Spanish, the segmental content of those syllables may be reduced (Lleó, 1996; Prieto, Bosch-Baliarda, and Saceda-Ulloa, 2005).

The literature review led to predictions about what we might find in the speech of the two boys in the study:

(1) Word structure:
- Multisyllabic words: Production of at least some multisyllabic words with weak initial stress, since many children appear to produce those relatively early in Spanish
- Consonants in weak syllables: Higher number of deletion or substitution patterns in weak syllables, particularly initial weak syllables

(2) Codas and clusters: Coda deletion or cluster reduction, due to later acquisition of consonant sequences and codas in Spanish (lower frequency of codas; need for liquids and /s/ in many consonant sequences)

(3) Consonant mismatches for:
- Later-developing manner categories: trilled /r/ and possibly /l/, plus some fricatives
- Voicing contrasts
- [Dorsal], at least for /k/ and '/g/'

(4) Vowel match: High vowel match for singletons (because of the limited vowel inventory), with uncertainty concerning vowel sequences due to limited data available in the literature.

Method

Word list for elicitation

A 100-word pilot list was prepared for single-word elicitation, following procedures for word list creation for other languages in the crosslinguistic study. Phonological inventories for Spanish dialects were first identified: consonant and vowel inventories by position, word lengths, stress patterns, word shapes and cross-vowel consonant sequences. Words were then generated by native and proficient second-language speakers. The list was culled to 100 words, so as to sample all phonological targets at least twice in words that would be at last relatively familiar to children in the dialect areas and imageable by photographs.[5]

The description below first outlines word structure frequencies, then consonant frequency (singletons, sequences) and finally vowel sequence frequency.

Word length and stress pattern frequencies in the list generally reflected proportional frequency in Spanish (Navarro, 1946):

(1) Monosyllables: 8 words.
(2) Disyllables: 60 words, with 48/60 Sw stress patterns, and 12/60 with weak-strong stress patterns, wS.
(3) Trisyllables: 20 words, with 18/20 wSw.
(4) Four syllables: 11 words, with 9/11 wwSw and 2/11 wSww.
(5) Five syllables: 1 word (*hipopótamo*), wwSww.

Word shapes in terms of CV sequences showed the following major target patterns (grouped by frequency) (Note that coda use would be generally less in Granada Spanish.):

(1) Disyllabic words:
    - without clusters: (C)V(V)CV(V) (34 words) > (C)VCVC (10) > CV.V (1)
    - with clusters: CCVCV(V)C (5) > > CCVCV (3) > CCVCCV, CVCCV (2 each) > CVVCCVC (1)
(2) Multisyllabic words: CVCVCV (seven words) > CVCCVCV (four words). There were one or two tokens of a variety of other shapes.
(3) Monosyllables: CVC, CCVC (four each).

The word list consonant frequencies are presented in Appendix 1. Most frequently elicited consonants were (most to least): /s/, /l/, /k/, /n/, /ɾ/, /p/, /t/. Least frequently elicited consonants were (most to least) /b/, /g/, /d/ and /ɲ/. These proportions mirror frequencies reported for spoken language (see Guirao and García Jurado, 1990, Spanish of the Americas; Quilis and Esgueva, 1981, Castilian Spanish). For consonant sequences, most word-initial clusters of Spanish were elicited once, although /bl/, /tɾ/ and /fl/ were elicited twice. All cross-vowel place and manner sequences were represented more than once, with some words targeting three places of articulation (e.g. *caballo* /ka'βaʃo/ '*horse*' in Argentinian Spanish, i.e. dorsal–labial–coronal), and some, four manners of articulation (e.g. *elefante* /ele'fan.te/ '*elephant*' with a liquid, fricative, nasal and stop).

The five singleton vowels of Spanish were elicited frequently in stressed and unstressed syllables. In this preliminary list, vowel sequence targets included falling diphthongs /ue/ (seven words), /ua/ (five), /ia/ (two) and /'i.a/ (two) plus /ui/, /ie/, /i.'a/ and /'e.a/ (once each).

For the picture elicitation, free stock photos were downloaded from the web. A group of 10 objects were also used at the beginning of elicitation in order to provide repeated exemplars of low-frequency phonemic targets (*blanco, azul, pez, agua, reloj, baño, tres, nueve, flores* and *fuego*), gain information about within-word variability and provide a warm-up activity for the session.

Participants

The data are from two boys with PPD (age 4;9) who had immigrated to Canada with their families (and who thus were in a bilingual Spanish-English environment). RP1 was from Argentina. He was a functionally monolingual Spanish speaker. Although he had been attending English preschool three half-days per week for a few months, he spoke only minimal English; nonetheless, exposure to English and his developing comprehension may have influenced some aspects of his Spanish. RP2 was from Mexico; he spoke Spanish exclusively

at home and an undetermined amount of English in preschool. No developmental concerns other than speech were reported by the families. Both boys scored within normal limits on a language test for Spanish-speaking children, the Receptive One-Word and Expressive One-Word Picture Vocabulary Tests (Spanish) (Brownell, 2001a, b). RP1 had scaled scores of 109 and 117 (mean of a 100, with SD of 15), respectively, and gave only one English word as a response on the Expressive One-Word Picture Vocabulary Test (*car*). RP5 had 114 on both scales and used Spanish almost exclusively also. Because RP5 appeared to have more English skills than RP1, he also was given the Preschool Language Scale-4 (Zimmerman, Steiner, and Pond, 2002), receiving a Comprehension Scale score of 88 and an Expressive Scale score of 80, that is borderline average for English learners. These scores were notably lower than his scores on the Spanish language test, suggesting higher proficiency in Spanish. Furthermore, some of the items had to be administered in Spanish due to lack of English skills; thus, the PLS-4 scores are an over-estimate of his English language knowledge. Due to time limitations for this pilot study and lack of English vocabulary, the children's English phonological skills were not tested. Further delineation of the boys' relative bilingual status was not done; if future studies were to include bilingual participants, the participants' relative bilingualism would be investigated in greater depth in order to analyse potential transfer between the languages.

Procedures

A speech-language pathologist (SLP) who speaks Spanish as an additional language conducted the elicitations in Spanish with the help of the child's parents. The parents had initially requested an assessment because the children were less intelligible than age-matched Spanish-speaking peers; the SLP concurred after assessment. Later phonological analyses and comparisons with previous normative data also confirmed the designation of PPD (see Results). Audio-recordings were made with an M-Audio Microtrack II tape recorder (M-Audio, Irwindale, CA, USA) and a Sennheiser remote system (transmitter EK 100 G2 and receiver SK 100 G2) with Countryman remote lapel microphones. The elicitation began with the naming of 10 objects (for reasons noted in the discussion of word list creation above) and proceeded to picture-naming. Most items were named spontaneously, but if not, immediate or delayed imitation was used. An audio-recording was also made of the parents' pronunciation of the words, to provide dialect-appropriate adult targets for each child for analysis.

RP1 was transcribed by the first author with the collaboration of three coauthors trained in transcription (English native speakers). Because RP1's data were the first to be transcribed for the overall study in Spanish, each token was transcribed by consensus in a group setting, with the use of acoustic analysis to confirm VOT, frication and formant transition (Praat, Boersma and Weenink, 2009). Reliability was not calculated, but the final token required agreement of all listeners. This process led to creation of a document to be used for the project, outlining transcription conventions (see e.g. Bernhardt and Stemberger (in press)). RP1's mother's recording was transcribed by a native speaker of Mexican Spanish, with consultation with the first author, also a Mexican Spanish speaker. Both were trained transcribers familiar with variants of Spanish, including Argentinian. RP5 (and his father's pronunciations) was transcribed primarily by the two Mexican Spanish speakers with the aid of acoustic analysis, and consensus building from two of the English-speaking coauthors, until 100% agreement was reached for each token. The transcriptions for all words (object-based, picture-based) were entered into the Computerized Articulation and Phonology Evaluation System (CAPES;

Masterson and Bernhardt, 2001) and spreadsheets for analysis. The pronunciation of the parent was considered the adult target, unless the child used another acceptable form for the dialect area. From the CAPES were extracted match and mismatch analyses for word length, shape and stress, consonants and vowels (singletons and sequences). Feature analyses were conducted using the spreadsheets and by hand. The feature system for Spanish was based on Santiago, Pérez, Palma, and Stemberger (2007).

Results

Results are presented in the following order below: (1) global measures; (2) word structure: length, stress, codas, onsets, contiguous consonant and vowel sequences; (3) singleton consonant match and mismatch patterns; (4) cross-vowel consonant sequence results. Within each section, the children's data are discussed both independently, and comparatively.

Global measures

Two global measures were calculated. The first, whole-word match (WWM; see, e.g. Schmitt, Howard, and Schmitt (1983)) indicates the proportion of child's productions that matches the adult target completely. RP1 showed a WWM of 17% and RP5 9.5%. Per cent consonant match (PCM) was also calculated for singletons, that is the proportion of consonants matching adult targets and were 57.6% (RP1) and 51.9% (RP5).

Word structure

Syllables and stress. Word length and stress were relatively well-preserved. For RP1, the exception was truncation of the specific weak initial syllable /eh/, as in *escuela* /eh'kuela/ ['xuera] 'school'.

RP2 showed weak syllable deletion in 5/11 four-syllable words and 1/22 trisyllabic words (*manzana* /man'sana/ ['tʃana] 'apple'). Stress shift occurred twice for stress-initial words, and three times for weak initial syllables: *princesa* 'princess', *cortando* 'cutting' and *pescado* 'fish'.

uvas	/'uβas/	[u'pas]	'grapes'	(RP2)
lámpara	/'lampara/	[am'pa.a]	'lamp'	
princesa	/prin'sesa/	['hintsesa]	'princess'	

Singleton codas and onsets. Comparatively speaking, codas were better preserved than onsets for both boys. Word-final codas were produced 100% of the time, usually as segmental matches ([s], [n], [x], [l], [ɾ̪], [t]).

Word-initial onsets in stress-initial words were also generally preserved. RP1 did show deletion of /b/ and /g/ after the article *el* 'the' (masculine singular) (but not after the article 'la'):

el gato	/el 'gato/	['lato]	'the cat'	(RP1)
el baño	/el 'baɲo/	[el 'aɲo]	'the bath'	

RP2 had comparatively weaker onsets. Four (/29) word-initial onsets deleted (/l/, /r/, /m/), and three were glottal substitutions ([h], [ʰ], [ʔ]):

mesa	/'mesa/	['esa]	'table'	(RP2)
leche	/'letʃe/	['ʰetʃe]	'milk'	

However, onsets were more vulnerable for both boys in word-initial *unstressed* syllables. RP1 showed one consonant deletion, six glottal stop replacements (arguably deletion) and one consonant harmony (/32 targets).

manzana	/man'sana/	[an'sana]	'apple'	(RP1)
guitarra	/gi'tara/	[ʔa'tarˡa]	'guitar'	
zapatos	/sa'patos/	[pa'patos]	'shoes'	

For RP2, 11/36 word-initial onsets deleted in unstressed syllables, for example:

sombrero	/som'brero/	['am'peɾo]	'hat'	(RP2)

Less marked segments appeared (e.g. [k] twice instead of /g/ or /x/, three glottal substitutions [h], [ʰ] or [ʔ]). There were two instances of reduplicative harmony, as in:

juguetes	/{h/x}u'ɣetes/	[ku'ɣetes]	'toys'	(RP2)
conejo	/ko'neho/	[no'neho]	'rabbit'	
zapatos	/sa'patos/	[ha'hatos]	'hat'	

Contiguous consonant sequences (surface-neighbouring segments). Overall, there were few contiguous consonant sequences for either boy, especially word initially. Table II shows word-initial consonant sequence patterns for both speakers.

Word-initial /Cɾ/ or /Cl/ sequences showed cluster reduction (although RP5 did have one approximation in *globo* /gloβo/ [gˡᵒo̯wo] 'balloon'), with different types of realizations patterns within and across words and speakers. RP1 retained C1 (or a close approximation) in 9/15 cases, C2 once, and various patterns for an additional five (consonant harmony, glottal stop replacement, metathesis).

Table II. Word-initial consonant sequence mismatches for RP1 and RP2.

	RP1	RP2
pl	p	p̪
bl	l, ʔ	w
gl	w (CH)	gˡᵒ
fl	f (3)	h (2), ʔ
pɾ	p	h
{b/β}ɾ	d (A)	β
tɾ	t, d, ʔ	t (2)
{d/ð}ɾ	ʔ	ʧ
kɾ	k	ʔ (or kʔ)
gɾ	agɣ (M)	h
fɾ	f	h
nwe	new (2, M)	me, nie
kwa	kwa, wa	k, g
{g/ɣ}wa	ʍwa	ɣw
rwi	di (CH)	oi (A, o)
fwe	ʍwe, xwe	e, ɸe
ʃwe	ʃo:we (M)	

Notes: One token unless otherwise indicated. The sequences with /w/ and /j/ show the vowels because /we/ /je/, etc., are often considered diphthongs following singletons. Braces indicate alternative adult targets. M, metathesis; CH, consonant harmony.

tres	/'tɾes/	{['des]/[tes]/['ʔes]}	'three'	(RP1)
blanco	/'blaŋko/	{['ʔako]/['lako]}	'white'	
gracias	/'gɾacias/	['agɣias]	'thank you'	
brazos	/'bɾasos/	['dasos]	'arms'	

RP5, on the other hand, retained C1 (or a close approximation) in only 5/15 cases, C2 twice and otherwise showed glottal substitutions (7/15) or coalescence (once).

tres	/'tɾes/	['tes]	'three'	(RP2)
blanco	/'blaŋko/	['waŋkǫ̲]	'white'	
gracias	/'gɾasias/	['haθt$^{\theta}$a]	'thank you'	
dragón	/dɾa'ɣon/	[ʧa'tʂon]	'dragon'	

If diphthongs starting with /u/ or /i/ are designated as part of /C-glide/ clusters, both speakers showed several instances thereof (see Table II). Otherwise, they showed similar reduction and substitution patterns as the liquid clusters.

Heterosyllabic word-medial sequences were moderately well-established for RP2 (10/33), especially for nasal-voiced obstruent sequences (*triángulo* /'triaŋgulo/ ['aŋgulo] 'triangle'). However, they were just emerging for RP1; the obstruent deleted in nasal-voiced obstruent sequences, and the nasal usually in voiceless stop contexts before voiceless stops (also on occasion for RP2):

llorando	/ʃo'ɾando/	[ʃo'ɾanːo]	'crying'	(RP1)
sombrero	/som'bɾeɾo/	[so'meɾo]	'sombrero'	
blanco	/'blaŋko/	['ʔako]	'white'	

Contiguous vowel sequences. Considering vowel sequences independently of word-initial consonants, reductions or alternations were observed about 50% of the time for both boys. The /ua/ ([wa]) was the most accurate (5/5 for RP1, 3/5 for RP2, with reduction to [a] if a mismatch). The /ue/ ([we]) showed 3/7 matches for RP1 and 1/6 for RP2. Again, the second vowel (/e/) was most commonly retained (three tokens each), with other variants including long [oː] (RP1), [ie] (RP2) and substitutions with labial consonants [v^{b}e] (RP1), [me] (RP2).

llueve	/'ʃueβe/	['ʃoːwe]	'it rains'	(RP1)
fuego	/'fueɣo/	['ego]	'fire'	(RP2)
nueve	/'nueβe/	['newe]	'nine'	(RP1)
		{['niebe]/[mepe]}		(RP2)

Diphthongs starting with /i/ (/ia/, /ie/) showed 2/3 matches for RP1 and 2/4 for RP2. In both cases the [a] was retained for /ia/, with the /ie/ showing metathesis to [ej] in *nieve* 'snow' for RP2 (i.e. *gracias* /'grasias/ ['haθt$^{\theta}$a] 'thank you'). The diphthong /ui/ in *ruido* 'noise' surfaced as [oi] for RP2 and [i] for RP1. RP1 also showed coronal stop epenthesis (or reduplication) in heterosyllabic vowel sequences ['i.a] and ['e.a] (e.g. *dia* /'di.a/ ['d̪id̪a] 'day').

Singleton consonants and features: RP1

Singleton vowels generally matched the adult targets; hence we focus on consonants here (see Table III).

As noted, RP1 had a singleton PCM of 57.6%, with highest accuracy in codas and lowest accuracy word medially (word-initial = 58.5%; intervocalic = 48.9% and word-final = 92%). Table III shows strongest categories (over 80% match) to be voiceless stops /p, t, k/, coronal stops

Table III. Singleton consonant matches, deletions and substitutions for RP1.

	Word-initial		Intervocalic		Word-final		
Target	Match	Pattern	Match	Pattern	Match	Pattern	Total % match
p	7/7		3/4	t (M)		91	
b	3/5	Del-2	1/1			67	
t	2/3	ʔ	7/8	m (M)		82	
d	2/2					100	
k	7/11	t-3; Del	5/5			80	
g	0/3	ʔ, b, l	1/1			25	
m	3/5	Del-2	1/4	n-2; β-1		44	
n	3/5	Del-2	4/7	Del, ĩ, m (M)	3/3	67	
ɲ			2/3	j		67	
f	2/2		4/4			100	
[β]			3/6	w-3		50	
[ð]			0/1	d		0	
s	4/5	p^h (CH)	9/10	ɣ (M)	16/16		94
{ʃ/dʒ}	2/3	tʃ	3/3			83	
tʃ	0/3	ʃ-3	0/4	ʃ-4		0	
{x/h}	2/2		3/3		2/2	100	
[ɣ]			0/2	w, ð		0	
l	1/3	əl, m (M)	6/12	ɾ-5, t	2/2	53	
ɾ			4/11	$ɾ^l$, ɲ, n; d, l-2	0/2	$ɾ̥$, $ɾ^l$ 31	
r	0/6	d, $ɾ̥$, k, x, ʔ-2	0/4	$ɾ^l$, d, l (2)		0	

Notes: Where numbers are not indicated after patterns, one token is indicated. M, metathesis; CH, consonant harmony; Del, deleted.

and fricatives /t, d, s, ʃ/, labiodental /f/ and glottal [h] (acceptable for /x/). Developing categories (30–75% match) were labial- and dorsal-voiced obstruents /b, g, β/, nasals, and other sonorants /l/ and tap. The affricate /tʃ/, voiced fricatives /ð/ and [ɣ] and trilled /r/ were absent.

Patterns of difference reflected the manner category. The affricate surfaced consistently as the homorganic fricative [ʃ] as in *chimenea* /tʃime'ne.a/ [ʃini'me$ɾ^n$a] 'chimney'. A lack of contrast among palatoalveolars was evident because [tʃ] also appeared for /ʃ/, for example, *llave* /'ʃaβe/ ['tʃaβe] 'key'. The intervocalic voiced fricatives were emerging (possible delay in allophonic development?), with stops or [w] as common substitutions (as seen in previous word structure examples), that is, maintenance of either [−sonorant] if a stop or [+continuant] if a glide).

The intervocalic tap (4/11) showed either lateralized or nasalized substitutions, stop [d] or nasals. Thus, generally [+sonorant] was retained, whereas /l/ often appeared medially as a tap. One of [d, l, $ɾ^n$, $ɾ^l$, ʔ, x] substituted for /r/, that is frequent but not consistent retention of [+sonorant], [Coronal].

guitarra	/gi'tara/	[ʔa'ta$ɾ^l$a]	'guitar'	(RP1)
cara	/'kaɾa/	['tajla]	'face'	
cuchara	/ku'tʃaɾa/	[ku'ʃada]	'spoon'	
reloj	/re'lox/	[ʔa'lox]	'watch' (noun)	
ratón	/ra'ton/	[x̆a'ton]	'mouse'	

Table IV. Singleton consonant matches, deletions and substitutions for RP2.

	Word-initial		Intervocalic		Word-final		
Target	Match	Pattern	Match	Pattern	Match	Pattern	Total % match
p	5/7	ʔ, h	3/4	h			72
b	3/6	p-3	1/2	p			50
t	2/2		9/9				100
d	1/2	dʒ					50
k	6/9	Del, h, n	4/4				77
g	2/3	k	2/2				80
m	3/5	Del-2	2/2				71
n	2/4	Del; m (M)	6/7	h	4/4		80
ɲ			2/3	dʒ			67
f	0/2	Del; ɸ	2/3	h			40
[β]			0/5	b-2; j, p, ɸ			0
[ð]			0/2	Del; t			0
s	1/5	Del-2; ʃ, h	8/12	tʃ, s̪, θt̪θ. t	15/15		75
{dʒ/j}	0/2	Del; ɕ	0/2	j-2			0
tʃ	2/2		3/4	ʃ			83
{x/h}	0/2	Del; k	3/3				75
[ɣ]			1/1				100
l	0/3	Del-2; h	2/13		0/1	t^h	12
ɾ			2/9	Del-3; j, $ɾ^w$	0/1	t	20
r	0/6	Del-3; ɾ, t, ʔ	0/4	Del-2; t, ɾ			0

Notes: Where numbers are not indicated after patterns, one token is indicated. M, metathesis; Del, deleted.

RP2's consonant match and mismatch patterns are shown in Table IV.

He had a lower percentage singleton consonant match than RP1, that is 51.9%, reflecting a weaker word-initial position, but he also showed a high match in coda (word-initial = 45.2%; intervocalic = 51.6%; word-final = 94.1%). Only four consonants had matches higher than 80%: the voiceless coronal /t/ and nasal /n/, plus dorsal obstruents /g/ and /ɣ/. The other stops were nearing 80% accuracy as were the other nasals, and fricatives /s, x/ (although syllable-initial /s/ was weakly established). The /f/, /l/ and tap were emerging, whereas the other voiced fricatives /β, ð, j̠/ were absent as was trilled /r/. As noted earlier, [h], [^{h}] or a weak oral fricative (indeterminate) appeared for a variety of onsets (voiceless obstruents /p/, /f/, /s/, /k/, /l/, or sonorants /n/, /1/), as in:

pes	/pes/	[^{h}es]	'fish'	(RP2)
leche	/ˈletʃe/	[ˈ^{h}etʃe]	'milk'	
elefante	/eleˈfante/	[eˈhante]	'elephant'	

In terms of the liquids, in addition to the aspirate [^{h}] noted above, there were deletions or glide or [t] substitutions, for example:

escuela	/esˈkuela/	[ˈehkej̠a̠]	'school'	(RP2)
azul	/aˈsul/	[a̠aˈʧut^h]	'blue'	

The /r/ and /ɾ/ showed variable patterns. The tap showed 2/10 matches. Otherwise, taps deleted were replaced by a glide word initially or medially, or by [t] word medially and finally.

regalo	/reˈ{ɣ/g}alo/	[eˈgao]	'present'	(RP2)
pájaro	/ˈpa{x/h}aɾo/	[ˈʔa̠xɔɾ̠^{w}o]	'bird'	

burro	/'buro/	['butɋ]	'donkey'
flor	/'floɾ/	['hot^{h}]	'flower'

Concerning the medial voiced obstruents, for the allophonic medial voiced [β], labial stops ([b] or [p]) appeared, or a voiceless fricative, [ɸ] or [f]. The intervocalic [s] showed four mismatches, that is other coronals: [θ] (see *gracias* 'thank you' above) or [tʃ] (*azul* 'blue' above), a retroflexed [ʂ] or a [t]. Overall, place was preserved most of the time word medially for these targets, with manner varying.

nueve	/nueve/	['mepe]	'nine'	(RP2)
		['niebe]		
cabeza	/ka'{b/β}esa/	[ka'feta]	'head'	

Cross-vowel consonant sequences. The final section of the analysis concerns cross-vowel sequences for consonants. A number of patterns appeared suggesting cross-vowel constraints on sequences, particularly in multisyllabic words:

(1) left-to-right harmony/reduplication:

elefante	/ele'fante/	[ela'faːfe]	'elephant'	(RP1)
globo	/'globo/	['wowo]	'balloon'	
zapatos	/sa'patos/	[ha'hatos]	'shoes'	(RP2)

(2) right-to-left harmony/reduplication in three-syllable words with iambic stress:

conejo	/ko'ne{h/x}o/	[no'neho]	'rabbit'	(RP2)
ruido	/ru'iðo/	['dɨdo]	'noise'	

(3) metathesis (with or without deletion)

nariz	/na'ɾis/	[a'nis]	'nose'	(RP1)
lámpara	/'lampaɾa/	['makala]	'lamp'	
chimenea	/tʃime'ne.a/	[ʃini'meɾ^{n}a]	'chimney'	
		[piʃam'hea]		(RP2)

Discussion

Word list revision

After pilot testing, the word list was modified slightly for the ongoing study.[6] Word familiarity in different countries was considered, and more words with diphthongs were added (i.e. rising patterns /ai/, /oi/, /eu/, /au/). The revision changed the frequency counts slightly but the overall frequencies and word selection are very close to the original pilot list.

Phonological development patterns

Global measures. Two global measures (WWM, PCM) support the parent/SLP impressions of PPD and may be useful considerations for the ongoing study. For English (Schmitt et al., 1983), Mandarin (Bernhardt, Zhao, and Lai, 2010) and Arabic (Ayyad, 2011), 4-year-olds are reported to have a WWM of 80%, compared with WWMs below 20% for the two boys. For Texan Spanish-speaking children, Acevedo (1993) noted a PCM (singleton) of 97.4%, compared with PCMs in the 50% range in the current study.

Other analyses. Many patterns observed in the speech of these two pilot participants were predicted to occur based on the literature. The boys showed few or no consonant clusters,

vibrants /r/ and /ɾ/, or the affricate /tʃ/. Furthermore, onset consonants in unstressed (particularly word-initial) syllables were vulnerable, with patterns of deletion, harmony or default glottal [h] or [ʔ] insertion word initially (and sometimes in medial position also). These patterns have been attested for other languages, although default glottal use is a minority pattern (Bernhardt and Stemberger, 1998), found more often in children with PPD than typical development.

In addition, however, the participants showed mastery of form perhaps not as common in English-learning children with PPD, that is, maintenance of unstressed initial syllables, at least in most two- and three-syllable words, surprisingly consistent use of codas, and relative strength in voiceless fricative production. Whether these findings were unique to the two individuals or reflective of higher frequency in Spanish of iambic words and fricatives (because of medial lenition of voiced stops) remains to be determined. Word-final codas are much less frequent in Spanish and were noted to be later acquired in 2-year-olds by Lleó (2003). However, the fact that Spanish has fewer consonant types in coda, and particularly only fricatives and sonorants, may have allowed acquisition of word-final codas in these two 4-year-olds, even as other aspects of phonology showed protracted development. Bernhardt and Stemberger (1998) note that, for some children, vowel-like features [+continuant] and [+sonorant] of the nucleus may help facilitate emergence of [+continuant] fricatives and [+sonorant] nasals in coda in at least some children for English.

The current literature and these data (even though not from strictly monolingual children) provide a basis for questions for the ongoing study. In particular, the structural realization patterns for multisyllabic words, consonant and vowel sequences and singleton onsets and codas in stressed versus unstressed syllables are under-reported elsewhere for children with PPD and thus, a larger study will provide an opportunity to provide more information about these elements. Furthermore, the effect of morphology (articles), the patterns of change for sonorants and fricatives and the development of voicing contrasts across categories will be examined in the larger study. The overarching question is which phenomena will reflect influences of universal, language-specific and child-specific constraints[7] on acquisition. The monolingual data from Granada and Mexico will provide two perspectives on Spanish PPD in different dialect areas.

Acknowledgments

We would like to thank the families for their participation, and one of the transcribers in Mexico, Mariana Reynosa. We gratefully acknowledge the Social Sciences and Humanities Research Council of Canada for funding.

Declaration of interest: The second author (B. May Bernhardt) is co-author of a commercial phonological analysis programme, the *Computerized Articulation and Phonology Evaluation System* (CAPES; Masterson and Bernhardt, 2001), which was used for some of the phonological analyses for this article.

Notes

1. The term 'speech sound disorders' (phonological disorders) is prevalent in the field of speech-language pathology, but a more current, neutral and positive term 'protracted phonological development' is being used for the cross-linguistic study (as in Bernhardt and Stemberger, 1998).
2. In Granada Spanish, lax, open vowels occur if coda /s/ deletes (Alonso, Zamora, and Canellada, 1950; Zubizarreta, 1979; Gerfen, 2002; Alvar, 2009; Lloret and Jiménez, 2009), as in: tres /trɛ/ 'three', or dos /dɔ/ 'two'.

3. In Mexican Spanish.
4. Other studies of consonant development include Acevedo (1993) and Jiménez (1987) for Mexican Spanish and Borzone de Manrique and Rosemberg (2000) for Argentinian Spanish.
5. The word list and the children's data are available from the authors.
6. The final word list is also available from the authors.
7. The term constraint is used in a general sense (see Bernhardt and Stemberger, 1998).

References

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

Alarcos Llorach, E. (1974). *Fonología española.* [Spanish phonology]. Madrid: Gredos.

Alarcos Llorach, E. (1991). *Fonología española (según el método de la Escuela de Praga)*. [Spanish phonology (according to the Prague School methods)]. Madrid: Gredos.

Aleza, M., & Enguita, J. M. (2002). *El español de América: Aproximación sincrónica.* [Spanish of the Americas: synchronic approximation]. Valencia: Tirant lo Blanch.

Alonso, D., Zamora, A., & Canellada, M. J. (1950). Vocales andaluzas. Contribución al estudio de la fonología peninsular. [Andalucian vowels. Contribution to the study of Peninsular phonology]. *NRFH*, *4*(3), 209–230.

Alvar, M. (2009). *Manual de dialectología hispánica. El español de España.* [Manual of Spanish dialectology. Spanish of Spain] (6 ed.). Barcelona: Ariel Lingüística.

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

Arellanes Arellanes, F., Meneses Eternod, S. B., & Herrasti, L. (2003). Las líquidas en el habla de niños de la ciudad de México. [Liquids in the speech of children from Mexico City]. In R. Barriga Villanueva (Ed.), *El habla infantil en cuatro dimensiones.* [Child speech in four dimensions] (*Serie Estudios del Lenguaje, VI*, pp. 15–47). Mexico: El Colegio de México.

Astruc, L., Payne, E., Post, B., Prieto, P., & Vanrell, M. M. (2010). Word prosody in early child Catalan, Spanish and English. In M. Hasegawa-Johnson (Ed.), *Proceedings from the fifth international speech prosody conference, 2010* (pp. 1–4). Champaign-Urbana, IL: University of Illinois.

Auer, P. (1991). 'Stress-timing' vs. 'syllable-timing' from a typological point of view. In B. Palek & P. Janota (Eds.), *Proceedings of the conference linguistics and phonetics: prospects and applications*, Prague, August 27–30, 1990 (pp. 292–305). Prague: Charles University Press.

Ayyad, H. (2011). Phonological development of typically developing Kuwaiti Arabic-speaking preschoolers (Unpublished PhD Dissertation). University of British Columbia.

Barlow, J. A. (2003). Asymmetries in the acquisition of consonant clusters in Spanish. *Canadian Journal of Linguistics*, *48*, 179–210.

Bernhardt, B. H., & Stemberger, J. P. (1998). *Handbook of phonological development: From a nonlinear constraints-based perspective*. San Diego, CA: Academic Press.

Bernhardt, B. M., & Stemberger, J. P. (in press). Transcription of the speech of multilingual children. In B. Goldstein & S. McLeod (Eds.), *Multilingual aspects of speech sound disorders in children.* Bristol: Multilingual Matters.

Bernhardt, B. M., Zhao, J., & Lai, Y. (2010). *Cross-linguistic study of protracted phonological development: Mandarin*. Oslo: ICPLA.

Boersma, P., & Weenink, D. (2009). Praat: doing phonetics by computer (Version 4.3.01) [Computer program]. Accessed 15 April 2009, from: http://www.praat.org/

Borzone de Manrique, A. M., & Rosemberg, C. R. (2000). *Qué aprenden los niños cuando aprenden a hablar? Desarrollo lingüístico y cognitivo en los primeros años.* [What do children learn when they learn to talk? Linguistic and cognitive development in the early years]. Buenos Aires: Aique.

Bosch Galcerán, L. (2004). *Evaluación fonológica del habla infantil.* [Phonological evaluation of child speech]. Barcelona: Masson S.A.

Brownell, R. (2001a). *Expressive one-word picture vocabulary test (Spanish bilingual edition)*. San Antonio, TX: Pearson Assessment.

Brownell, R. (2001b). *Receptive one-word picture vocabulary test (Spanish bilingual edition)*. San Antonio, TX: Pearson Assessment.

Carballo, G., & Mendoza, E. (2000). Acoustic characteristics of trill productions by groups of Spanish children. *Clinical Linguistics & Phonetics*, *14*(8), 587–601.

Carreira, M. (1991). The acquisition of Spanish syllable structure. In D. Wanner & D. A. Kibbee (Eds.), *New analyses in Romance linguistics* (pp. 3–18). Amsterdam: John Benjamins.

De Zuluaga, T. (1979). Procesos en la sistematización de los sonidos del español en niños de corta edad. [Phonological processes in the speech of young children]. *Revista Lenguaje*, *10*, 93–121.

D'introno, F., del Teso, E., & Weston, R. (1995). *Fonética y fonología actual del español*. [Phonetics and phonology of contemporary Spanish]. Madrid: Cátedra.

Eblen, R. (1982). A study of the fricatives by three-year-old children learning Mexican Spanish. *Language and Speech*, *25*, 201–220.

Fabiano-Smith, L., & Barlow, J. A. (2009). Interaction in bilingual phonological acquisition: Evidence from phonetic inventories. *International Journal of Bilingual Education and Bilingualism*, *13*, 81–97.

Fabiano-Smith, L., & Goldstein, B. A. (2010a). Phonological acquisition in bilingual Spanish–English speaking children. *Journal of Speech, Language, and Hearing Research*, *53*, 160–178.

Fabiano-Smith, L., & Goldstein, B. A. (2010b). Early-, middle-, and late-developing sounds in monolingual and bilingual children: An exploratory investigation. *American Journal of Speech-Language Pathology*, *19*, 66–77.

Gerfen, C. (2002). Andalusian codas. *Probus*, *14*, 247–277.

Goldstein, B. (2007). Spanish speech acquisition. In S. McLeod (Ed.), *The international guide to speech acquisition* (pp. 539–553). Clifton Park, NY: Thomson Delmar Learning.

Goldstein, B., & Iglesias, A. (1996). Phonological patterns in normally developing Spanish-speaking 3- and 4-year-olds of Puerto Rican descent. *Language, Speech and Hearing Services in the Schools*, *27*, 82–90.

Goldstein, B. A., & Cintrón, P. (2001). An investigation of phonological skills in Puerto-Rican Spanish-speaking 2-year-olds. *Clinical Linguistics & Phonetics*, *15*, 343–361.

Goldstein, B. A., & Pollock, K. (2000). Vowel errors in Spanish-speaking children with phonological disorders: A retrospective, comparative study. *Clinical Linguistics & Phonetics*, *14*, 217–234.

González, A. (1981). A descriptive study of phonological development in normal speaking Puerto Rican preschoolers (Unpublished PhD Thesis). Pennsylvania State University.

Guirao, M., & García Jurado, M. (1990). Frequency of occurrence of phonemes in American Spanish. *Revue Québécoise de Linguistique*, *19*(*2*), 135–149.

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

Hochberg, J. (1988). First steps in the acquisition of Spanish stress. *Journal of Child Language*, *15*, 273–292.

Hualde, J. I. (2005). *The sounds of Spanish*. Cambridge: Cambridge University Press.

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

Jiménez Fernández, R. (1999). *El andaluz*. [Andalucian]. Madrid: Arco Libros.

Kehoe, M. (2002). Developing vowel systems as a window to bilingual phonology. *International Journal of Bilingualism*, *6*, 315–334.

Kehoe, M., & Lleó, C. (2003). The acquisition of syllable types in monolingual and bilingual German and Spanish children. In B. Beachley, A. Brown, & F. Conlin (Eds.), *Proceedings of the 27th annual Boston university conference on language development* (pp. 402–413). Somerville, MA: Cascadilla Press.

Kehoe, M., Lleó, C., & Rakow, M. (2004). Voice onset time in bilingual German-Spanish children. *Bilingualism: Language and Cognition*, *7*, 71–88.

Laver, J. (1994). *Principles of phonetics*. Cambridge: Cambridge University Press.

Lipski (1997). Spanish word stress. In F. Martínez-Gil & A. Morales Front (Eds.), *Issues in the phonology and morphology of the major Iberian languages* (pp. 559–593). Washington, DC: Georgetown University Press.

Lleó, C. (1996). To spread or not to spread: different styles in the acquisition of Spanish phonology. In B. Bernhardt, J. Gilbert, & D. Ingram (Eds.), *Proceedings of the UBC international conference on phonological acquisition* (pp. 215–228). Somerville, MA: Cascadilla Press.

Lleó, C. (2002). The role of markedness in the acquisition of complex prosodic structures by German-Spanish bilinguals. *International Journal of Bilingualism*, *6*(3), 291–313.

Lleó, C. (2003). Prosodic licensing of coda in the acquisition of Spanish. *Probus*, *15*, 257–281.

Lleó, C. (2006). The acquisition of prosodic word structures in Spanish by monolingual and Spanish-German bilingual children. *Language and Speech*, *49*(2), 205–229.

Lleó, C. (2008). Research on first language acquisition of Spanish phonology. *Studies in Hispanic and Lusophone Linguistics*, *1*(2), 349–382.

Lleó, C., & Arias, J. (2006). Foot, word and phrase constraints in first language acquisition of Spanish stress. In Fernando Martínez-Gil & Sonia Colina (Eds.), *Optimality-theoretic studies in Spanish phonology* (pp. 470–496). Amsterdam: John Benjamins.

Lleó, C., & Demuth, K. (1999). Prosodic constraints on the emergence of grammatical morphemes: Crosslinguistic evidence from Germanic and Romance Languages. In A. Greenhill, H. Littlefield & C. Tano (Eds.), *Proceedings of the 23rd annual Boston university conference on language development* (pp. 407–418). Somerville, MA: Cascadilla Press.

Lleó, C., & Prinz., M. (1996). Consonant clusters in child phonology and the directionality of syllable structure assignment. *Journal of Child Language*, *23*, 31–56.

Lloret, M. R., & Jiménez, J. (2009). Un análisis" óptimo" de la armonía vocálica del andaluz. [An Optimality analysis of vowel harmony in Andalucian Spanish]. *Verba: Anuario Galego de filoloxia, 36,* 293–325.

Macken, M. (1975). The acquisition of intervocalic consonants in Mexican Spanish: A cross sectional study based on imitation data. *Papers and Reports on Child Language Development*, *10*, 29–45.

Macken, M. A. (1978). Permitted complexity in phonological development: One child's acquisition of Spanish consonants. *Lingua*, *44*, 219–253.

Macken, M. A. (1979). Developmental reorganization of phonology: A hierarchy of basic units of acquisition. *Lingua*, *49*, 11–49.

Macken, M. A., & Barton, D. (1980). A longitudinal Study of the acquisition of the voicing contrast in American-English word-initial stops, as measured by Voice Onset Time. *Journal of Child Language*, *7*, 41–74.

Maez, L. (1985). The acquisition of the Spanish sound system by native Spanish-speaking children. In E. García & R. Padilla (Eds.), *Advances in bilingual education research* (pp. 3–26). Tucson, AZ: University of Arizona Press.

Martínez Celdrán, E., & Fernández Planas, A. M. (2007). *Manual de fonética española: Articulaciones y sonidos del español.* Barcelona: Ariel.

Masterson, J., & Bernhardt, B. (2001). *Computerized articulation and phonology evaluation system*. San Antonio, TX: Pearson Assessment.

Mondéjar Cumpián, J., & Carrasco, P. (2001). *Dialectología andaluza: Estudios, historia, fonética y fonología, lexicología, metodología onomasiología y comentario filológico. Anejo 34.* 2 vols. [Andalucian dialectology: studies, history, phonetics and phonology, lexicology, onomasiology and philological commentary]. Málaga: Analecta Malacitana.

Montes Giraldo, J. J. (1970). Dominancia de las labiales en el sistema fonológico del habla infantil. [Dominance of labials in the phonological system of infant speech]. *Thesaurus*, *25*, 487–488.

Montes Giraldo, J. J. (1971). Acerca de la apropiación por el niño del sistema fonológico español. [Concerning children's acquisition of the Spanish phonological system]. *Thesaurus*, *26*, 322–346.

Moya, J. A., & García, E. (1995). *El habla de Granada y sus barrios.* [Speech of Granada and districts]. Granada: Universidad de Granada.

Moya, J. A., & García, E. (1998). *La 'ch' fricativa en Granada: Un sonido del habla masculine.* [La 'ch' fricative in Granada: a masculine speech sound]. In A. Ward (Ed.), *Proceedings of the Actas del XII Congreso de la Asociación Internacional de Hispanistas*, 21–26 August 1995, Birmingham, Vol. 1 (pp. 270–283). Birmingham: University of Birmingham (Medieval y lingüística).

Narbona, A., Cano, R., & Morillo, R. (1998). *El español hablado en Andalucía.* [Spanish spoken in Andalucia]. Barcelona, Spain: Ariel.

Navarro, T. (1946). *Estudios de fonología española.* [Study of Spanish phonology]. New York, NY: Syracuse University Press.

Navarro, T. (1977 [1957]). *Manual de pronunciación española.* [Manual of Spanish pronunciation] (19 ed.). Madrid: CSIC.

Nuñez-Cedeño, R. (2000). Teoría de la organización silábica [Theory of syllable organization]. In J. G. Fernández (Ed.), *Panorama de la fonología española actual* (pp. 455–474). Madrid: Arco Libros.

Prieto, P., Bosch-Baliarda, M., & Saceda-Ulloa, M. (2005). The development of codas in Catalan and Spanish: Frequency effects in specific contexts. *Xth international congress for the study of child language*. Berlin, July 25–29, 2005.

Quilis, A. (1981). *Fonética acústica de la lengua española.* [Acoustic phonetics of Spanish]. Madrid: Gredos.

Quilis, A. (1993). *Tratado de fonología y fonética españolas.* [Spanish phonology and phonetics]. Madrid: Gredos.

Quilis, A., & Esgueva, M. (1980). Frecuencia de fonemas en el espanol hablado. [Frequency of phonemes in spoken Spanish]. *Linguistic a Espanola Actual*, *2*, 1–25.

Roca, I. (1989). The organization of grammatical gender. *Transactions of the Philological Society*, *87*, 1–32.

Santiago, J., Pérez, E., Palma, A., & Stemberger, J. (2007). Syllable, word, and phoneme frequency effects in Spanish phonological speech errors: The David effect on the source of the error. In T. S. Carson, & V. Ferreira, (Eds.), *The state of the art in speech error research: Proceedings of the LSA Institute workshop, MIT working papers in linguistics Vol. 53* (pp. 265–303). Cambridge, MA: MIT Press.

Schmitt, L., Howard, B., & Schmitt, J. H. (1983). Conversational speech sampling in the assessment of articulation proficiency. *Language, Speech and Hearing Services in Schools*, *14*, 210–214.

Zimmerman, I. L., Steiner, V. G., & Pond, R. E. (2002). *Preschool language scale-fourth edition (PLS-4)*. San Antonio, TX: Pearson Assessments.

Zubizarreta, M. L. (1979). Vowel harmony in Andalusian Spanish. In K. Sapir (Ed.), *MIT working papers in linguistics I* (pp. 1–11). Cambridge, MA: MIT Press.

	Word-initial	Word-medial	Word-final	Total
p	7	5		12
b	6			6
t	3	9		12
d	2			2
k	11	6		17
g	4			4
m	5	5		10
n	5	7	3	15
ɲ		3		3
f	4	4		8
[β]		8		8
[ð]		1		1
s	5	12	16	33
{ʃ/dʒ}	3	4		7
tʃ	3	4		7
{x/h}	2	3	2	7
[ɣ]		6		6
l	4	14	2	20
ɾ		12	2	14
r	6	4		1
Total	70	107	25	202