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Research Report

Word structures of Granada Spanish-speaking preschoolers with typical versus protracted phonological development

B. May Bernhardt†, R. Hanson†, D. Perez‡, C. Ávila§, C. Lleó¶, J. P. Stemberger†, G. Carballo§, E. Mendoza§, D. Fresneda§ and M. Chávez-Peón‖

†University of British Columbia, Vancouver, BC, Canada
‡University of Valparaíso, Valparaíso, Chile
§University of Granada, Granada, Spain
¶University of Hamburg, Hamburg, Germany
‖Centro de Investigaciones y Estudios Superiores en Antropología Social, Mexico City, Mexico

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Abstract

Background: Research on children's word structure development is limited. Yet, phonological intervention aims to accelerate the acquisition of both speech–sounds and word structure, such as word length, stress or shapes in CV sequences. Until normative studies and meta-analyses provide in-depth information on this topic, smaller investigations can provide initial benchmarks for clinical purposes.
Aims: To provide preliminary reference data for word structure development in a variety of Spanish with highly restricted coda use: Granada Spanish (similar to many Hispano-American varieties). To be clinically applicable, such data would need to show differences by age, developmental typicality and word structure complexity. Thus, older typically developing (TD) children were expected to show higher accuracy than younger children and those with protracted phonological development (PPD). Complex or phonologically marked forms (e.g. multisyllabic words, clusters) were expected to be late developing.
Methods & Procedures: Participants were 59 children aged 3–5 years in Granada, Spain: 30 TD children, and 29 with PPD and no additional language impairments. Single words were digitally recorded by a native Spanish speaker using a 103-word list and transcribed by native Spanish speakers, with confirmation by a second transcriber team and acoustic analysis. The program Phon 1.5 provided quantitative data.
Outcomes & Results: In accordance with expectations, the TD and older age groups had better-established word structures than the younger children and those with PPD. Complexity was also relevant: more structural mismatches occurred in multisyllabic words, initial unstressed syllables and clusters. Heterosyllabic consonant sequences were more accurate than syllable-initial sequences. The most common structural mismatch pattern overall was consonant deletion, with syllable deletion most common in 3-year-olds and children with PPD.
Conclusions & Implications: The current study provides preliminary reference data for word structure development in a Spanish variety with restricted coda use, both by age and types of word structures. Between ages 3 and 5 years, global measures (whole word match, word shape match) distinguished children with typical versus protracted phonological development. By age 4, children with typical development showed near-mastery of word structures, whereas 4- and 5-year-olds with PPD continued to show syllable deletion and cluster reduction, especially in multisyllabic words. The results underline the relevance of multisyllabic words and words with clusters in Spanish phonological assessment and the utility of word structure data for identification of protracted phonological development.

Keywords: speech–sound disorders, word shape, prominence, stress, word position, consonant clusters, whole word match.

Address correspondence to: B. May Bernhardt, School of Audiology and Speech Sciences, 2177 Wesbrook Mall, Vancouver, BC, Canada V6T 1Z3; e-mail: bernharb@mail.ubc.ca

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What this paper adds?

What is already known on this subject?

Previous research on Northern–Central varieties of European Spanish suggest that multisyllabic words with initial unstressed syllables may be earlier acquired in Spanish than in English, and that word-initial clusters in Spanish are later acquired than other structural elements.

What this study adds?

The current study evaluates word structure development in preschoolers with both typical and protracted phonological development in Granada Spanish, a variety of Spanish with highly restricted codas. Key aspects of word structure are documented: word length, stress, word shapes, singleton consonants and consonant sequences. Effects of word length and relative stress (prominence) are examined in relation to accuracy and mismatch patterns for syllables, singleton consonants and consonant sequences. The data provide preliminary reference data for word structure development for Spanish varieties with restricted coda use in children aged 3–5 years.

Introduction

Phonological assessment and intervention practices have shifted in focus over the past few decades. Speech therapy for 'articulation disorders' initially targeted individual 'speech–sounds' (Powers 1971), then classes of speech–sounds as defined by distinctive features (e.g. McReynolds and Engmann 1975). Phonological process analysis (e.g. Edwards and Bernhardt 1973, Ingram 1976) introduced descriptions of patterns affecting both speech–sounds and word structure (e.g. final consonant deletion, cluster reduction). Nonlinear phonological theories subsequently provided more detailed frameworks for assessment and intervention involving various levels of the phonological system, e.g. word length, stress patterns and word shapes in CV sequences (e.g. Bernhardt and Stoel-Gammon 1994, Chávez-Peón *et al.* 2012). However, research on acquisition of word structure is relatively sparse across languages. More information is needed to support clinical intervention above the level of the segment (phoneme). Meta-analyses of large norm-referenced studies may eventually offer in-depth information on this topic (Cumming 2014), but until such reports appear, smaller investigations can provide initial reference data for clinicians. The current study presents such data for a variety of Spanish with highly restricted coda use: Granada Spanish. Characteristics of (Granada) Spanish (similar to other varieties of Spanish in Andalusia and Hispano-America) concerning word length, stress and word shapes follow below.

Spanish syllable and word structure

Spanish words may contain one to ten syllables. Quilis (1983: 73) reports the following word length frequencies, in descending order: disyllables, 41.9% of words; monosyllables (including closed class lexical items) 27.7%; trisyllabic content words, 20.3%; words of four or more syllables, almost 10% (see appendix A).

There is generally only one prominent (i.e. stressed) syllable per word (Quilis 2009). For disyllabic words, 79.5% have left-prominent (trochaic) stress (Quilis 1983: 75): e.g. *boca*, /ˈbo.ka/, 'mouth' (stressed–unstressed, Su). Left-prominent trisyllabic content words (Suu) are less frequent (2.76%), e.g. *pájaro* /ˈpa.xa.ɾo/ 'bird'. Words with right- or centre-prominent stress are relatively frequent compared with English: uS, e.g. *ratón* /ra.ˈton/ 'mouse'; uSu, e.g. *manzana*, /man.ˈsa.na/ 'apple'; uuSu, e.g. *cocodrilo* /ko.ko.ˈdɾi.lo/ 'crocodile'. In some accounts of Spanish (e.g. Lleó 2002), the initial unstressed syllable of right- or centre-prominent words is considered extrametrical, i.e. outside the word's foot structure.

Spanish has a variety of syllable types (Real Academia Española (RAE) 2011). The most frequent include CV, CVC, V, VC, CCV, CVV, CVVC and CCVC (Justicia *et al.* 1996). Every syllable has a nucleus (a single vowel or diphthong) although onsets (syllable-initial consonants) and codas (syllable-final consonants) are not obligatory. Consonant sequences can occur fully in the onset (tautosyllabic) or across syllable boundaries (heterosyllabic). In varieties like Granada Spanish, codas are often absent, but can occur. For example, CCVC and CCV may alternate: *flor* [floɾ] ~ [flɔ] 'flower'. When coda /s/ is absent, [ʰ] may appear in its place; the preceding vowel is generally produced with greater aperture, e.g. [ɔ] instead of [o], or lowered, as in [ä]. When coda nasals delete, the preceding vowel may be nasalized, although nasal word-medial (WM) codas are less likely to delete than other WM codas. Word-medial (WM) sonorant-stop sequences may alternate with geminate stops, e.g. *tortuga* [toɾˈtuɣa] ~ [toˈtːuɣa] 'turtle'. The geminate preserves the consonant timing units (segmental slots) but the CV sequence changes: CVCCVCV ~ CVC:VCV. Word medially, singleton voiced approximants may also delete,

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e.g. *médico* [ˈmeðiko] ~ [ˈme.i.ko] 'doctor', CVCVCV ~ CV.VCV. As in Northern–Central European Spanish, the first 'vowel' of a word-initial (WI) rising diphthong may be realized as a glide or consonant, e.g. *hielo* [ˈje.lo] ~ [ˈʤe.lo] 'ice', VV ~ CV. A [ɡ] may appear before [u͡e], e.g. *hueso* [ˈu͡e.so] ~ [ˈɡu͡e.so] 'bone', VV ~ CVV (Quilis 2009: 191). Similarly to adults, children acquiring Granada Spanish are likely to produce these elements variably.

Acquisition of Spanish word structure

As background for the study, previous research on Spanish word structure acquisition is discussed below across the varieties of Spanish. Research has concentrated primarily on Northern–Central European Spanish or Hispano-American varieties. Exceptions include Carballo *et al.* (2000), with 416 typically developing (TD) children in Granada (aged 2;6 to 6;6), and Gómez Fernández (1997), with 104 TD children in Seville (aged 1;5 to 5;0). Some papers report on a range of word structure elements, typically in conjunction with consonant development (e.g. Acosta and Ramos 1998, Astruc *et al.* 2010, Borràs-Comes and Prieto 2011, Bosch 2004, Carballo *et al.* 2000, Goldstein and Cintrón 2001, Lleó 2006), while others discuss one topic, e.g. clusters (Barlow 2003, Diez-Itza and Martínez 2004, Gómez Fernández 1997, González 1981). Chávez-Peón *et al.* (2012) described both word structure and segmental aspects of the speech of two 4-year-old boys with protracted phonological development (PPD:[1] one Mexican, one Argentinian) while piloting a single-word elicitation task for the current study.

The current study set out to examine developmental patterns in word structure relative to age, typicality of development and word complexity. Previous findings are thus discussed below in terms of word length, stress and word shape, with reference to children with typical or protracted phonological development in preschool and early school-aged years.

Word length and stress

In terms of word length and stress patterns, Spanish-learning children produce a fairly wide range of forms at relatively early ages. Lleó (2006) reports that three typically developing children learning a Northern–Central variety of Spanish spontaneously produced at least two tokens of common word structures by age 2;2. Left-prominent disyllables (trochees) were earliest and most frequent; however, right- and centre-prominent disyllables and trisyllables (i.e. with unstressed initial syllables) appeared at age 1;6, a month earlier than monosyllables. Two of the children used four-syllable words by age 1;10, and the third by 2;2. Deletion of initial unstressed syllables occurred 30% of the time at age 1;4, and gradually decreased from 1;8. Similarly, in a cross-linguistic study of word structure for 36 TD children aged 2, 4 and 6 years (Spanish, Catalan or English), Astruc *et al.* (2010) observed relatively early acquisition of multisyllabic words in Spanish-speaking children. By age 2, the Spanish children produced words with uSu, uuS and suSuu patterns (u = unstressed; S = stressed; s = secondary stress), with 25% of the children showing no deletion at age 2 except in the word *hipopótamo* 'hippopotamus.' Concurring with these findings, the two 4-year-olds with PPD in Chávez-Peón *et al.* (2012) showed minimal syllable deletion, in spite of having many mismatch ('error') patterns. Bosch (2004) suggests that syllable deletion from age 3 years in Northern–Central Spanish may be one indicator for a child at major risk for PPD.

Word shapes in CV sequences

Simple syllables and word shapes predominate in early acquisition. CV is reported to be the most frequent syllable in early Spanish acquisition (Carreira 1991, Lleó 2002), and left-prominent ˈCVCV a common early word shape.

In terms of more complex structures, consonant sequences (clusters) in Spanish can be tautosyllabic (fully in an onset) or heterosyllabic (a coda followed by an onset). Several studies have reported a high proportion of word-initial (WI) cluster reduction in preschool children, both those with typical development (Carballo *et al.* 2000, Diez-Itza and Martínez 2004, Goméz Fernández 1997, González 1981) and those with PPD (Acosta and Ramos 1998, Chávez-Peón *et al.* 2012). By age 5, the Diez-Itza and Martínez (2004) TD cohort showed a decrease in cluster reduction to 8.8%. Comparing heterosyllabic and tautosyllabic word-medial sequences, Diez-Itza and Martínez (2004) found heterosyllabic sequences to show twice the rate of cluster reduction. In Chávez-Peón *et al.* (2012), however, only one of the two boys demonstrated a higher proportion of deletion in heterosyllabic sequences. Thus, word-medial sequences appear to vary across children in terms of deletion patterns.

Concerning the first part of heterosyllabic sequences, the coda, the literature disagrees as to whether the WM coda is more likely to delete than the word-final coda. Borràs-Comes and Prieto (2011) found a higher frequency of WM coda deletion than WF coda deletion for eight Castilian TD Spanish-speaking children ages 1;11 to 2;5, as did Chávez-Peón *et al.* (2012) for one of their two 4-year-old participants with PPD with a Hispano-American variety of Spanish. However, Lleó (2003) observed an opposite pattern: earlier production of WM codas (ages 1;10 and 2;1) than word-final

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(WF) codas (2;2/2;3) for two TD children acquiring Northern–Central Spanish. In Spanish varieties with restricted coda use, there are fewer opportunities for coda deletion; in words where a coda is variably absent in the adult language, its absence in child speech cannot be treated as a mismatch. This variability was expected to result in higher coda match generally in the current study.

Interaction of stress (prominence) and other phonological elements

Word structure complexity can be compounded, with interactions between the length and stress patterns of a word, and the syllable structure. Few studies report on the interaction of word stress and other structural elements in Spanish. Borràs-Comes and Prieto (2011) found no relationship between stress and WF consonant production in eight TD Castilian Spanish-speaking children. However, for the two 4-year-olds with PPD, Chávez-Peón *et al.* (2012) noted more mismatch patterns in WI unstressed syllables than stressed syllables: more syllable and consonant deletion, glottal stop substitutions and consonant harmony. These patterns concur with single-subject TD data from French (Rose and Dos Santos 2008) and English (Smith 1973), suggesting that WI unstressed syllables are a weak prosodic domain with a greater propensity for developmental mismatches (Bernhardt and Stemberger 1998).

In summary, for Spanish, CV and left-prominent CVCV words appear to be early-acquired, with multisyllabic words earlier-acquired than in languages in which they are less frequent. Consonant sequences, particularly those in onset, are later-acquired. Codas, which are highly restricted in Granada Spanish, may not be challenging for acquisition for that variety. However, elements in initial unstressed syllables may be more likely to show structural mismatch patterns than elements in stressed syllables. Data leading to these general conclusions are limited, however; no studies have specifically investigated all of these variables across the preschool age range in both TD children and those with PPD. The current paper sets out to provide initial reference data for word structure development in Granada Spanish. Anticipated results were as follows.

For participant variables, word structure accuracy was expected to increase from 3 to 5 years, and to be greater for TD than for PPD children across the age range. In terms of word complexity, a number of effects were expected by structure and dialect:

(1) Word length: Shorter words, especially left-prominent disyllables, were expected to show higher structural accuracy than multisyllabic words (Lleó 2006).
(2) Prominence:
    (a) Word structure elements were expected to be more accurate in stressed than unstressed syllables (Chávez-Peón *et al.* 2012).
    (b) An extra-metricality effect: If all initial unstressed syllables are extrametrical (Lleó 2002), then all were expected to be equally likely to delete or reduce, independent of word length.
(3) Syllable structure: Lower accuracy was expected for word shapes with versus without clusters.
(4) Spanish variant: Heterosyllabic sequences (primarily nasal-obstruent sequences) were expected to be more accurate than tautosyllabic onset sequences in Granada Spanish, in contrast with Diez-Itza and Martínez's (2004) report for Northern–Central Spanish, a variant in which heterosyllabic sequences with coda /s/ also occur.

Method

Participants

Fifty-nine monolingual Spanish-speaking participants (aged 3 to 5 years) participated in the study.[2] In accordance with ethical agreements, teachers gave consent forms to parents of children with and without suspected PPD. In order to provide a unitary focus on phonological development, selection criteria limited the sample to children with normal hearing (hearing screening at 25 dB from 250 to 4000 Hz), an unremarkable oral mechanism and language comprehension and production test scores within normal limits. The language comprehension/production tests included *La Prueba de lenguaje oral Navarra—Revisada* (PLON-R; Aguinaga *et al.* 2004) for 3-year-olds, the *Test de Comprensión de Estructuras gramaticales de 2 a 4 años* (Calet *et al.* 2010); the *Peabody Picture Vocabulary Test—Español* (Dunn *et al.* 2006); and the *Test breve de inteligencia de Kaufman* (Kaufman and Kaufman 2009: Spanish adaptation, Cordero and Colonge 2000). Initial group assignment (TD/PPD) was based on (1) the phonology subsection of the PLON-R and (2) a short conversation with the child. The PLON-R phonology subsection contains 21 words for 3-year-olds, 23 for 4-year-olds and 12 for 5-year-olds. The majority of words are disyllabic trochees and the focus is on segmental acquisition by age group. Each child's phonological patterns in the conversational sample were compared with those identified by Bosch (2004) as typical or atypical for the child's age.

Group assignment (TD versus PPD) was confirmed using a global measure, the whole word match (WWM), which evaluated the children's performance on the 103-word elicitation sample for the current study (described below). The whole word match was defined as the proportion of a child's words that matched the adult

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Table 1. Per cent whole word match (WWM) and word shape match (WSM) for Granada Spanish-speaking preschoolers with typical versus protracted phonological development

	Typical development (TD)			Protracted phonological development (PPD)		
Age	Participants (boys; girls)	Mean (SD) % WWM[a]	Mean (SD) % WSM	Participants (boys; girls)	Mean (SD) % WWM[a]	Mean (SD) % WSM
3	10 (2; 8)	57.97 (18)	64.7 (13.1)	7 (4; 3)	21.4 (10)	48.5 (12.2)
4	9 (4; 5)	85.4 (6.5)	92.1 (5.2)	14 (8; 6)	37.5 (13.5)	62.9 (13.9)
5	11 (8; 3)	89.8 (6.5)	95.5 (3.3)	8 (5; 3)	58.6 (SD 3.8)	75.3 (5.3)

Note: [a]Mann–Whitney *U*-tests comparing TD/PPD samples for WWM by age group: $p < 0.001$.

targets; slight phonetic deviations concerning voicing quality, dentalization or vowel quality were ignored, and all pronunciation variants of the Granada dialect were tallied as accurate. Normative data do not exist for Spanish WWM but previous research on English WWM (Schmitt *et al.* 1983) showed this measure to have some utility in establishing criterion reference data in the preschool period. Each child's data were compared with the means and standard deviations for each age and participant group (table 1). One 5-year-old's data were moved from the PPD group to the TD group, because his WWM score fell within the range of the TD group.

The final TD group comprised ten 3-year-olds, nine 4-year-olds and eleven 5-year-olds (16 girls, 14 boys: a higher proportion of girls at ages 3 and 4: 13/19). The PPD sample included seven 3-year-olds, fourteen 4-year-olds and eight 5-year-olds (17 boys, 12 girls). Because the study aimed to provide age-referenced data, group assignment (TD/PPD) was evaluated for each age group. Mann–Whitney *U* tests were performed, because parametric statistics violated assumptions of homogeneity of variance, as often occurs in small behavioural samples (Zumbo and Coulombe 1997). The test statistics supported group assignment: $U = 0.3416$ ($N = 17$), 3.97 ($N = 23$) and 3.633 ($N = 19$) for ages 3, 4 and 5 respectively, with $p < 0.001$ for all groups, and large effect sizes (0.828 for 3-year-olds; 0.86 for both 4- and 5-year-olds).[3]

Procedures

Data were collected by a native speaker of Spanish using a single-word picture-naming task (103 different words[4]). The list is representative of word structure proportions in Spanish (see appendix B): left-prominent disyllables without clusters are most frequent, whereas monosyllables and 4/5-syllable words are least frequent. Spontaneous samples were audio-recorded with a Microtrack II digital recorder and its bundled Microtrack wireless microphone. If the child did not say the word spontaneously, indirect imitation was requested; e.g. for *teléfono* 'telephone', the child was asked whether the item was a *teléfono* or a *flor* 'flower'. If the child still did not name the word, the experimenter requested immediate imitation.

Prior to data collection, the research teams from Granada and North America met to develop conventions for narrow transcription. The North American team is coordinating a cross-linguistic study with 12 languages, including Granada Spanish, and the level of transcription detail was set in accordance with that larger study (Bernhardt and Stemberger 2012). Acceptable adult pronunciation variants were noted for each target word. The Granada and North American teams then independently transcribed the first 12 data sets from the children with PPD. Through further discussion, consensus transcriptions were created for those data sets, and transcription conventions were adjusted accordingly. Native speakers of Granada Spanish transcribed the remainder of the samples. The North American team, experienced transcribers for a variety of languages including Spanish, confirmed transcriptions for every word perceptually, and where ambiguous, with waveform and spectrogram analysis (for determining voicing, formants and formant transitions, segment length, etc.). To calculate agreement, both timing unit presence and segmental content were examined. Timing unit presence indicated that segments appeared where required (substitutions notwithstanding) or, if segments were deleted, that other segments were lengthened, preserving overall syllable timing. For the TD sample, there was 95.6% agreement for timing unit presence and 96% agreement for actual segments, yielding a final summed agreement of 92.1% (253 disagreements in 3204 word tokens). For the children with PPD, 12 samples had already been used for consensus-building. Thus, reliability was computed for the samples of the other 17 children only (1833 words), with 85.6% overall agreement: 92.2% agreement for timing unit presence; 93.6% agreement for actual segments. Disagreements with respect to word structure concerned presence/absence of epenthetic vowels in clusters and segment length. These disagreements were resolved in a final meeting in Granada; for all words, the teams agreed that the acoustic signal contained information that had either been ignored at first, or transcribed with different conventions.

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Table 2. Per cent syllable deletion

		Age 3		Age 4		Age 5	
Word length	Prominence	TD	PPD	TD	PPD	TD	PPD
2 syl	LProm	0.2[a]	0	0.2[a]	0	0	0
	RProm	0	0	0	0	0	0
3 syl	LProm	0	23.8	0	0	9[b]	4.1[a]
	CRProm	3.3	17.2	1.3	4.6	0.4[a]	1.4
4–5 syl	CProm	25.8	42.2	7.7	15.8	1.0[a]	0

Notes: L = left; R = right; C = centre; Prom = prominent (word stress).
[a]One mismatch.
[b]Two/three mismatches from one child in rapid speech.

Analysis

PHON 1.5 (Rose and Hedlund 2012), a phonological analysis program, and spreadsheets provided quantitative measures. For all analyses, adult targets were chosen that matched the child's dialectal pronunciation of a specific word. For example, if a child did not use an optional coda, the adult variant without a coda was assumed to be the child's target. If a vowel or consonant slot was filled (a timing unit match), a word structure was considered accurate; mismatches of segmental content (substitutions) were ignored. Word structure mismatches included: (1) syllable deletion: *bailando* /baiˈlando/ [ˈlando] 'dancing'; (2) CC deletion: *grande* /ˈgrande/ [ˈ__ande] 'big'; (3) consonant deletion (singletons or in consonant sequences): *zapato* /saˈpato/ [saˈ__ato] 'shoe'; (4) diphthong reduction: *dinosaurio* /dinoˈsaurio/ [ˈsaɾo] 'dinosaur'; (5) segment lengthening or shortening: *bloque* /ˈbloke/ [ˈbl:oke] 'block'; *pierna* /ˈpienːa/ > [ˈpiena] 'leg'; (6) C-V interchanges: *Paula* /ˈpaula/ [ˈpaβla]; (7) epenthesis: *flor* /ˈflɔ/ [fɔˈlɔ] 'flower'; (8) migration: *saltando* /salˈtando/ [esˈtando] 'jumping'; (9) coalescence: *cuadro* /kuaˈðɾo/ [ˈpal:o] 'painting'.

Nonparametric statistics were utilized because of the violation of homogeneity of variance for the majority of tests (due to small unequal sample sizes in a developmental population). Where the SPSS (2013) 22.0 output showed 0.000, a p value of < 0.001 is reported.

Results

Results are presented for keyword structure variables, starting with larger phonological units, and moving to more specific word structure characteristics: (1) word length and stress, (2) overall word shape (3) word shapes without consonant sequences and (4) word shapes with consonant sequences (word-initial, word-medial). Participant variables (group, age) and word structure characteristics (prominence/stress, word length, complexity) are discussed in turn within each section, in order to address the questions raised at the end of the introduction about participant differences, and complexity variables, A final summary pulls together the results in terms of those questions.

Word length and stress

In terms of accuracy by group, word length and stress showed relatively high accuracy for both 5-year-old groups and for the TD 4-year-olds. However, multisyllabic words were less accurate for 3-year-olds in both participant groups and for 4-year-olds with PPD.

By mismatch type, both groups showed syllable deletion or addition (epenthesis), and stress shift. Epenthesis was a low frequency pattern, occurring occasionally in multisyllabic words (e.g. *hipopótamo* /ipoˈpotamo/ 'hippopotamus' > [politaˈtampono]) or WI clusters (e.g. *flor* /ˈflɔ/ 'flower' > [fɔˈlɔ]). Stress shift was very rare, e.g. *pantalón* /pantaˈl(on)/ 'pants' > [ˈpatalo].

Deletion of unstressed syllables was the major mismatch pattern affecting word length and stress (table 2). For disyllabic words, there were only two tokens of syllable deletion, one each in left-prominent words in the TD 3- and 4-year-old groups. Multisyllabic words showed more frequent syllable deletion than disyllabic words; for 4/5-syllable words, deletion occurred in 25% of the words for the TD 3-year-olds, and in 42% of the words for the PPD group; trisyllables also showed 17–23% deletion for the latter group. Eleven of 21 words with initial unstressed syllables showed deletion of such syllables in the PPD group only, and two of nine four-syllable words (*primavera* 'spring'; *chocolate*). One 3-year-old and one 4-year-old in the PPD group deleted at least one unstressed syllable in every 4/5-syllable word and in many trisyllabic words (22/24 and 10/23, respectively). In terms of the participant group variable, Mann–Whitney U tests revealed no significant differences between groups in this regard (p values > 0.13).

As expected in terms of syllable deletion across the groups, it was the initial unstressed syllable that typically deleted in centre- or right-prominent words, but other unstressed syllables also deleted, e.g. *hipopótamo*

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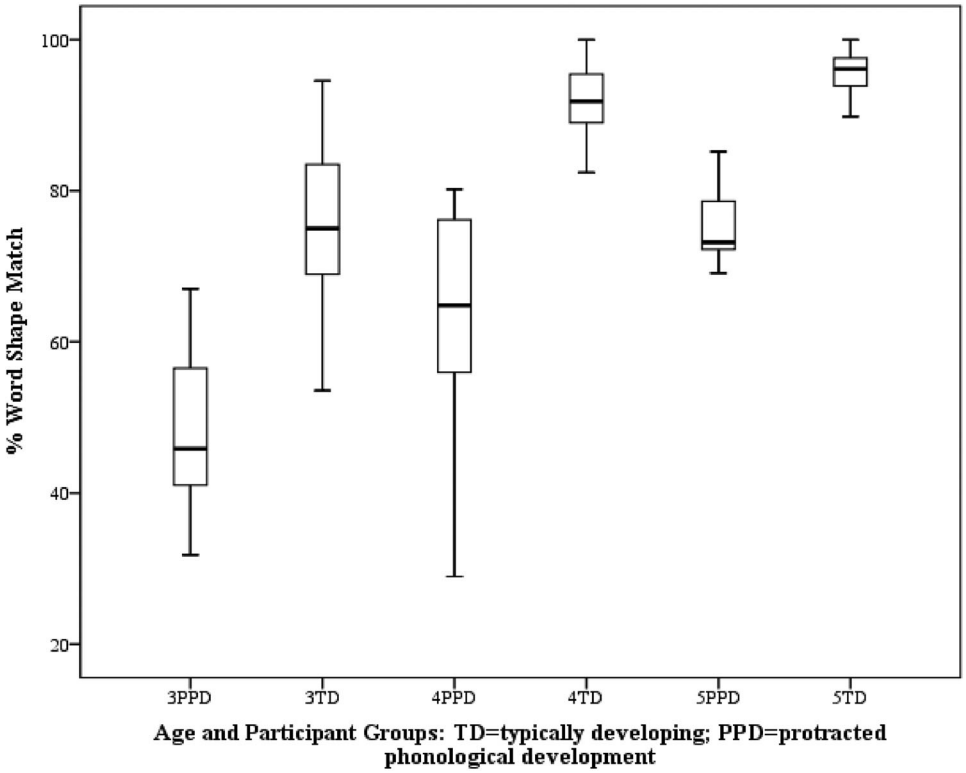

Figure 1. Per cent word shape match box plots by age and participant groups: typically developing (TD); protracted phonological development (PPD). Significant differences between TD and PPD groups at ages 4 and 5 ($U = 3.97$, 3. 635 respectively, $N = 19$, $p < 0.001$).

/ipoˈpotamo/ > [ˈpamʌ̃u] 'hippopotamus'. Syllable deletions generally maintained or resulted in a left-prominent word. Deletion of initial unstressed syllables was most frequent in the 4/5-syllable words *escalera* 'stairs' (17/59 children), *hipopótamo* (16/59) and *elefante* 'elephant' (11/59), and in the trisyllabic word *estanque* 'pond' (10/59). Two words with frequent deletions were often produced as imitations: *estanque* (42/59 children) and *hipopótamo* (26/59).

Word shape match

In addition to length and stress patterns, words can be examined in terms of their CV sequences. Overall word shape match (WSM) data are presented in table 1 above and in figure 1.

In terms of participants, WSM proportion increased from age 3 to 4 to 5: for the TD groups from 64% to 92% to 95%, and for the PPD groups from 48% to 63% to 75%. Figure 1 shows overlapping distributions for the 3-year-old TD versus PPD groups but distinct distributions for the 4- and 5-year-old groups. Mann–Whitney *U*'s were significant for the two older age groups: $p < 0.001$, $ES = 0.83$ (figure 1).

Within TD/PPD groups, there was a significant difference between the 3- and 4-year-old TD groups ($U = 3.677$, $N = 19$, $ES = 0.8435$, $p < 0.001$), but not between the 4- and 5-year-old TD groups ($p = 0.112$), who were both near ceiling. For the PPD groups, a Mann–Whitney *U* was significant only between the 4- and 5-year-olds: $U = 3.823$, $N = 22$, $p = 0.001$, $ES = 0.815$.

Word shape match was further examined in terms of word length and prominence type (figure 2).

Left- and right-prominent words had a slightly higher word shape match overall than centre-prominent words in both TD and PPD groups, with right-prominent words (disyllabic except for *pantalón*) showing a slightly higher match than left-prominent words. The difference between left- and centre-prominent words missed significance, however, following a Bonferroni correction (Mann–Whitney $U = 2.196$, $N = 59$; $p = 0.028$; corrected p value $= 0.0025$). The next two sections outline results for simpler word shapes (no clusters) and then for words with clusters (WI and WM).

Word shapes without consonant clusters

Table 3 provides descriptive details for per cent word shape match by word length, prominence pattern, presence/absence of clusters and age and participant groups.

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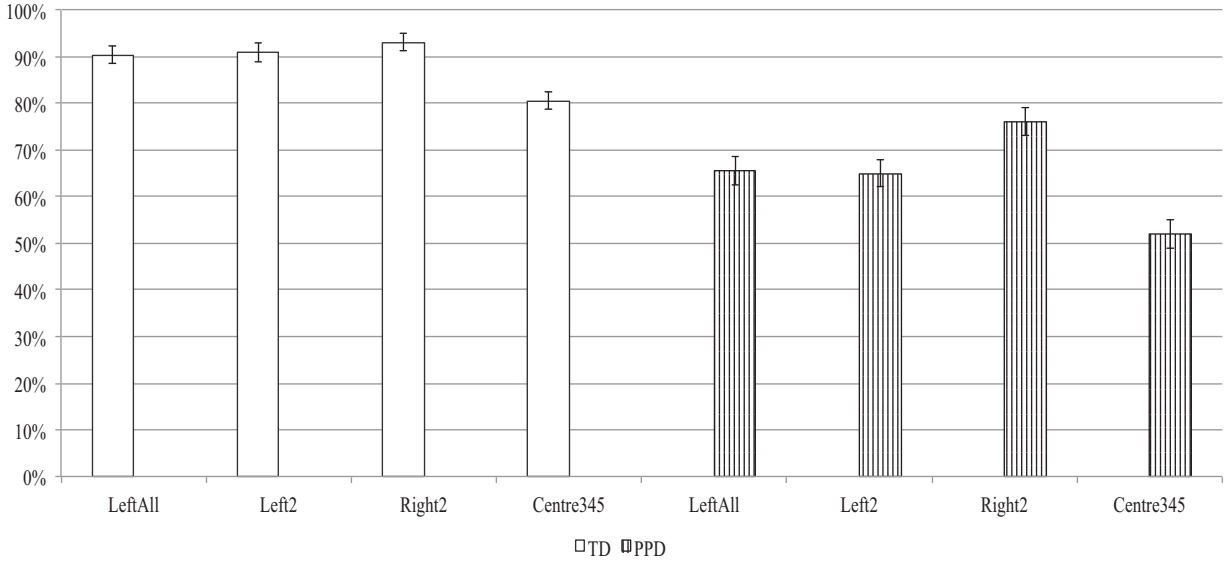

Figure 2. Per cent word shape match by word length and prominence for Granada Spanish-speaking children with typical (TD) versus protracted phonological development (PPD). Left = left-prominent word stress; right = right-prominent; centre = centre-prominent. Numbers following direction labels indicate syllables per word. Error bars = standard error.

Table 3. Per cent word shape match

			Age 3		Age 4		Age 5	
Stress type	Syl #	Word shape	TD	PPD	TD	PPD	PPD	TD
LProm	1	No CC	93.9	89.5	100.0	97.6	100.0	97.9
	With	WI CC	61.3	38.5	94.0	37.0	85.0	33.3
	2–(3)	No CC	91.0	71.8	97.8	80.1	98.6	92.9
	With	WI CC	52.6	14.6	92.9	35.3	93.2	33.0
	With	WMCC	54.3	22.8	85.0	34.6	88.0	48.7
RProm	2	No CC	97.4	64.4	98.4	78.7	98.3	90.4
	With	WI CC	29.4	14.3	85.0	14.3	81.8	37.5
CRProm	3	No CC	84.3	50.7	93.4	73.7	94.6	88.6
	With	WI CC	11.1	0.0	90.0	8.3	90.9	30.0
	With	WMCC	45.4	22.8	88.9	34.4	96.0	76.2
	4–5	No CC	59.3	28.6	83.5	56.9	86.9	87.3
	With	WI CC	0.0	0.0	100.0	15.4	90.9	37.5
	With	WMCC	30.8	18.2	66.7	34.2	81.8	38.7

Note: TD = typically developing; PPD = protracted phonological development; L = left; R = right; C = centre; Prom = prominent (word stress). CC = consonant sequence; WI = word-initial, WM = word-medial. Match denotes presence of C or V timing unit. Words containing both WI and WM consonant sequences were tallied in both categories.

Table 4. Word-initial cluster per cent timing unit match

Group	Age	Overall match	LProm match	CRProm match
TD[a]	3[c]	40.9 (29.1)	61.9 (32.1)	20.0 (32.2)
	4[c]	89.2 (8.7)[b]	89.6 (11.3)[b]	88.9 (6.7)[b]
	5	86.7 (16.9)	91.9 (9.3)	81.8 (27.4)
PPD[b]	3	15.2 (18.6)	25.6 (14.7)	4.8 (12.6)
	4	30.1 (24.7)[b]	43.5 (35.8)[b]	16.7 (25.4)[b]
	5	64.8 (32.5)	62.5 (25.1)	67.0 (39.9)

Notes: Standard deviation is given in parentheses. TD = typically developing; PPD = protracted phonological development; LProm = left-prominent word stress; CRProm = centre- or right-prominent stress.

[a]The TD groups had significantly higher match scores than the PPD groups overall (Mann–Whitney $U = 4.575$, $N = 59$, $p < 0.001$, $ES = 0.596$), in left-prominent words ($U = 4.478$, $p < 0.001$, $ES = 0.583$) and centre- or right prominent words ($U = 3.727$, $p < 0.001$, $ES = 0.4852$).

[b]The TD group had significantly higher scores than the PPD group at age 4 overall ($U = 3.973$, $N = 23$, $p < 0.001$, $ES = 0.798$), in left-prominent words ($U = 3.043$, $p < 0.001$, $ES = 0.625$) and centre-right prominent words ($U = 3.743$, $p < 0.001$, $ES = 0.752$).

[c]The TD 4-year-olds had higher match scores than the TD 3-year-olds for overall match (Mann Whitney $U = 3.073$, $N = 18$, $p < 0.001$, $ES = 0.7768$) and centre-right prominent words ($U = 3.352$, $p < 0.001$, $ES = 0.79$).

The small number of words contributing to each cell precludes statistical analysis; data are presented for reference only.

Word shapes with only singleton consonants had results similar to the overall WSM data. For participants, there were: (1) increases in match data with age for both groups; (2) higher WSM for the TD compared with the PPD groups at ages 3 and 4; and (3) near-equivalent WSM scores between the TD and PPD groups at age 5. By complexity, there was: (1) a 90+% match for word shapes in monosyllables across groups; (2) the lowest overall WSM in multisyllabic words at age 3 for both TD and PPD; (3) a lower WSM in centre-prominent words than in left- or right-prominent words.

Singleton WI and WM onsets matched in over 95% of words across groups and ages, although slightly less in unstressed syllables of centre- or right-prominent words: 81.7% (WI) timing unit match and 78.7% (WM) for the PPD group, and 93% (WI) and 94.1% (WM) for the TD group (non-significant differences). Consonant deletion, and to a lesser extent, syllable deletion, accounted for the small proportion of timing unit mismatches.

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Table 5. Word-initial clusters: per cent mismatch patterns

Pattern	Age 3				Age 4				Age 5			
	LProm		CRProm		LProm		CRProm		LProm		CRProm	
	TD	PPD	TD	PPD	TD	PPD	TD	PPD	TD	PPD	TD	PPD
SylDel	0.7	0	3.7	19.0	0	0	0	2.4	0	0	0	0
CCDel	0	4.7	0	8.3	0	3.6	0	2.4	0	0	0	0
C1Del	6.6	9.6	26.6	17.8	1.4	7.9	7.4	7.2	2.8	4.8	6.1	25.0
C2Del	28.9	61.3	70.0	48.8	2.7	46.4	3.7	57.1	1.7	22.7	12.1	29.2
VEpen	11.3	1.7	1.1	4.7	13.9	6.7	0	2.4	4.1	3.9	0	0
Target #	138	129	27	24	160	207	30	38	172	127	33	24

Note: Per cent of total WI cluster targets. L = left; R = right; C = centre; Prom = prominent (word stress). Syl = syllable; C = consonant; Del = deletion; VEpen = Vowel epenthesis.

WI consonant sequences

In the word list, target WI clusters were present in 15 left-prominent disyllables, 1 right-prominent disyllable (*dragón*) and 2 centre-prominent targets (*princesa*, *primavera*). Table 4 provides information on WI cluster matches by participant variables and word prominence type.

Examining clusters in terms of structural characteristics, a match indicates that both timing units were present, with no epenthesis or consonant lengthening. For participants, a Mann–Whitney test for CC timing-unit match showed significantly higher scores for the TD than for the PPD group across cluster targets, and in words with centre- or right prominent versus left-prominent stress ($p < 0.001$; statistical values in table 4). That difference primarily reflected a significant TD/PPD group difference at age 4 ($p < 0.001$; table 5); the TD 4-year-olds had a significant increase from the TD 3-year-old scores for overall CC match and for centre-right prominent words ($p < 0.001$, table 4). Although the means improved across age in the group with PPD, there was a relatively large standard deviation at ages 4 and 5, decreasing the number of significant changes.

Cluster timing unit mismatch types are presented in table 5.

By participant group, results showed: (1) a higher proportion of deletion in the group with PPD, mirroring the significantly lower CC timing-unit match noted above, (2) full cluster deletion only in the group with PPD (ages 3 and 4); and (3) a higher proportion of vowel epenthesis in the TD group. In centre-right prominent words, the 3-year-olds with PPD showed more initial unstressed syllable deletion, and thus fewer matches where just a consonant was deleted. In terms of position in cluster, C2 (a liquid) deleted significantly more frequently than C1 (an obstruent)[5] (Mann–Whitney $U = 3.709$, $N = 59$, $p < 0.001$, moderate *ES*, 0.483). The small *n* per cell ruled out further statistical measures for participants. In terms of word stress type (prominence), across groups, CC timing units showed significantly less deletion in the stressed syllable of left-prominent words than in the initial unstressed syllable of centre-right prominent words (Wilcoxon's = 4.220, $N = 59$, $p < 0.001$, moderate $ES = 0.549$).

Table 6. Word-medial consonant sequence per cent match for timing units

Group	Age	Heterosyllabic coda. onset[a]	Tautosyllabic onset[a]
TD[b]	3	77.8 (23.6)	30.6 (27.3)
	4[c]	100	77.5 (29.9)[c]
	5	100	81.8 (22.6)
PPD[b]	3	61.9 (22.9)	10.7 (11.8)
	4	81 (28.4)	23.2 (20.7)[c]
	5	91.7 (15.4)	40.6 (26.5)

Notes: Standard deviation is given in parentheses.
[a]Heterosyllabic versus tautosyllabic overall significant: Wilcoxon's = 6.35, $N = 59$, $p < 0.001$, $ES = 0.827$).
[b]TD versus PPD tautosyllabic CC timing unit match across ages: Mann–Whitney $U = 4.244$, $N = 59$, $p < 0.001$, moderate $ES = 0.5576$.
[c]TD versus PPD at age 4, tautosyllabic timing unit match: Mann–Whitney $U = 2.22$, $N = 23$, $p < 0.001$, moderate $ES = 0.4634$.

Word-medial consonant sequences

Turning to WM sequences, words with WM consonant sequences had an overall lower WSM than words with singletons only, but a higher WSM than words with WI clusters (table 3) across participant groups. Table 6 displays CC timing unit match for the two types of WM sequences: heterosyllabic (coda followed by onset) and tautosyllabic (onset). For all groups, the heterosyllabic sequences preserved timing units significantly more than tautosyllabic sequences ($p < 0.001$; detailed statistical values in table 6). The TD groups had a significantly higher overall timing unit match than the groups with PPD for tautosyllabic sequences ($p < 0.001$), although by age group, only for the 4-year-olds ($p < 0.001$). The TD 4- and 5-year-olds showed 100% preservation of timing units in heterosyllabic sequences, with the 5-year-old PPD group nearing 100% but still showing a low match proportion in tautosyllabic sequences (40%). Within-group age-related changes were not significant.

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Table 7. Word-medial heterosyllabic sequences: per cent mismatch patterns

	Age 3		Age 4		Age 5	
	TD	PPD	TD	PPD	TD	PPD
SylDel	1.4	3.1	0	0.5	0	0
C1Del	8.5	21.5	0	14.3	3.6	8.4
C2Del	3.5	.7	0	0.5	0	3.0
C1LengC2Del	0.7	1.5	0	4.1	0	2.3
C1DelC2Leng	0.7	6.2	0	6.1	0.6	3.8

Note: Per cent of total heterosyllabic targets. TD = typically developing; PPD = protracted phonological development; Syl = syllable; C = consonant; Del = deletion; Leng = consonant lengthening.

Table 8. Word-medial tautosyllabic sequences: per cent mismatch patterns

	Age 3		Age 4		Age 5	
	TD	PPD	TD	PPD	TD	PPD
C1Del	44.8	36.8	16.7	40.6	3.3	25.0
C2Del	27.6	47.4	20.0	45.4	13.3	37.5
VEpen	10.3	5.0	3.3	9.1	6.7	4.2

Note: Per cent of total WM tautosyllabic targets. TD = typically developing; PPD = protracted phonological development; C = consonant; Del = deletion. VEpen = vowel epenthesis.

Word-medial sequence mismatch patterns are presented in tables 7 and 8. Patterns appearing less than 2% of the time in only one age and participant group were excluded from the table. The descriptive data show similarities across groups: (1) syllable deletion was rare (heterosyllabic) or absent (tautosyllabic); (2) full CC deletion did not occur; (3) consonant deletion was more common in tautosyllabic sequences (e.g. *cocodrilo* /koko'dɾilo/ [koko'ðilo] 'crocodile'); (4) C1 coda deletion was more common than C2 onset deletion in heterosyllabic sequences. In tautosyllabic sequences, C1 and C2 deletion were equally common at ages 3 and 4 for the TD group, whereas C2 deletion was more common at age 5. For the group with PPD, C2 deletion was more frequent across ages.

Summary

Of interest for the study were both participant variables (age, group) and relative word structure complexity. Examining participant variables, match scores generally increased with age in both the TD and PPD groups. More gradual change was noted for the PPD groups, and more abrupt change between 3 and 4 years of age for the TD groups. Within-group changes by age were significant (Mann–Whitney *U*) for word shape match between the 4- and 5-year-old PPD groups, and for word shape and WI cluster match between the 3- and 4-year-old TD groups. Between groups, the TD children generally had higher word structure match scores than the children with PPD. By age group, the 3-year-olds of the two groups had overlapping distributions at lower match levels, and the 5-year-olds with PPD approached match scores of the TD 5-year-olds for word shapes without clusters and trisyllabic word shapes with WM sequences. Between the two participant groups, differences were significant in terms of: (1) WI and WM tautosyllabic cluster timing unit match across age groups, (2) Word Shape Match at 4 and 5 years of age; and (3) WM tautosyllabic sequences at 4 years of age. At age 5, the children with PPD still showed significant consonant deletion in WI clusters (tables 3 and 4) and lower matches in WM sequences in disyllabic words and words of 4/5 syllables (table 6).

Mismatch patterns occurred with higher frequency in the group with PPD, and included patterns that were rare or absent in the TD sample (tables 2, 5, 7 and 8): syllable deletion, full cluster deletion and conjoint structural mismatch patterns (e.g. C1 deletion plus C2 lengthening). In onset clusters, vowel epenthesis occurred at low frequency at all ages in both cohorts, with a slightly higher frequency in left-prominent words and for the TD groups.

With respect to word structure characteristics, word length, prominence type and syllable complexity often affected the patterns observed. Syllable deletion was more common in longer and centre-prominent words (table 2). However, WSM in disyllables was marginally higher for right-prominent words than left-prominent words (possibly because of the higher proportion of left-prominent words with WI clusters). An initial unstressed syllable matched far more often in uS words than in uSu and uSuu words.

Regarding syllable complexity, word shapes with consonant sequences had overall lower match proportions, with interactions between complexity and prominence. The lowest match levels occurred for WI clusters at age 3 in centre- or right-prominent word shapes, i.e. in unstressed WI syllables. C2 deletion was significantly more common than C1 deletion overall (except for the TD 4-year-olds, who had minimal deletion, table 5).

Overall, WM sequences were more accurate than WI sequences, especially the more highly accurate heterosyllabic sequences (tables 3 and 6). Match levels interacted with prominence and syllabicity, i.e. tautosyllabic onset sequences in stressed syllables were near-equivalent in match levels word initially and medially and lower in accuracy than the limited set of heterosyllabic sequences. The TD sample had a higher WSM in words with WM sequences in left-prominent words at age 3; however, by age 4, there was more equivalence between prominence types as word shape matches exceeded 80% (tables 3 and 6). For the PPD cohort, there was a slight increase in WSM for left- and centre-prominent words with WM clusters by age (tables 3 and 6).

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In terms of mismatches across groups, tautosyllabic sequences had more deletions than heterosyllabic sequences for clusters with similar segments at age 3 (tables 7 and 8); and in heterosyllabic sequences, C1 coda deletion was more common than C2 onset deletion. Vowel epenthesis occurred infrequently across ages and groups in tautosyllabic medial sequences, although slightly more for the TD groups.

Discussion

The current paper evaluated word structure development in Granada Spanish-speaking children from 3 to 5 years of age, both TD and those with PPD. The main purpose of the study was to provide preliminary reference data for clinical application. The data were expected to show increasing match proportions by age, and higher scores for TD children in comparison with children with PPD. In terms of word structure, relative complexity (markedness) or frequency in the language was expected to affect developmental patterns. Greater accuracy was expected for: (1) words with the (more frequent) left-prominent feet, (2) shorter words, especially disyllables, (3) word shapes which contained only singleton consonants, and (4) the more restricted set of heterosyllabic consonant sequences compared with tautosyllabic sequences (because of the optional codas in Granada Spanish). The following discussion highlights key findings and suggests clinical implications and directions for future research.

Participant variables and clinical implications

A key clinical objective of assessment is to identify whether a child has protracted phonological development. The current study, although not normative, does suggest some criteria that may be useful in approaching this objective. Group membership for the study was initially based on a phonological screening. The screening procedures were overall robust, even though the test was normed for a dialect other than Granada Spanish. In the current study, word structure results further corroborated group membership: the TD group generally had higher match scores than the children with PPD. Differences did not always reach significance for every comparison; the not-quite-equal small sample sizes for the groups violated homogeneity of variance, and much larger samples are needed to fully support statistically the robust indicators of PPD. However, two major characteristics differentiated TD from PPD groups: (1) overall word shape match at 4 and 5 years of age, and (2) onset cluster timing unit match (WI, WM) across the age range for this study. These two accuracy measures might be clinically useful indicators of PPD and are relatively easy to calculate.

Mismatch patterns also distinguished between groups. Specific mismatch patterns were present in the PPD data that were either absent or rare in the TD data for these age groups: syllable deletion at 4 and 5 years of age, full cluster deletion, and conjoint patterns (e.g. deletion of one cluster consonant, with compensatory lengthening of the other). These more pervasive syllable-change patterns occur prior to age 3 in typical phonological development (Bernhardt and Stemberger 1998), and thus are not unusual per se. They are also congruent with previous results for Spanish regarding word length and stress development (Acosta and Ramos 1998, Bosch 2004, Diez-Itza and Martínez 2004, Lleó 2002, 2006) and may be useful clinical indicators of PPD if still occurring in children after age 3 years.

Another objective of clinical assessment is to set goals for intervention. Knowledge of developmental paths across time can help in setting achievable goals for treatment. The current study was cross-sectional and had a small number of children per age group; thus, longitudinal trajectories cannot be extrapolated. A further cautionary note is that, as the TD children approached ceiling (100% match), there were small, non-significant age reversals; 4-year-olds had slightly higher match scores than 5-year-olds on four out of 12 measures. Thus, the ranges of scores for TD children at ages 4 and 5, rather than the mean scores, are more relevant for clinical purposes. The data in the tables provide preliminary benchmarks for word shape match, mismatch patterns and cluster development at certain ages, and thus may help with intervention planning for word structure development.

Word structure: theoretical and clinical implications

Further detail regarding possible developmental trajectories comes from the word length, stress and word shape match data, and the interactions between these various levels of the phonological system. Word length and stress/prominence were often associated with accuracy and mismatch patterns; as expected, elements in unstressed syllables, especially the first syllable of centre-prominent words, were more likely to be deleted. The data are consistent with previous studies of multisyllabic words in Spanish (Astruc *et al.* 2010, Chávez-Peón *et al.* 2012, Lleó 2002, 2006) and other languages (e.g. Rose and Dos Santos 2008 for French; Smith 1973 for English) and support the hypothesis that elements in weak prosodic environments, in this case initial unstressed syllables, are more vulnerable than those in stronger environments (Bernhardt and Stemberger 1998). There was one exception concerning prominence, however: right-prominent disyllabic words (uS) (figure 2) did not behave like centre-prominent words (uSu) in that the first syllable of right-prominent

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syllables rarely deleted. The hypothesis that initial unstressed syllables are deleted or reduced because they are extrametrical and thus not part of a foot (e.g. Lleó 2002) predicts parallel effects in uS and uSu words. The high level of match in uS disyllables, equivalent to Su disyllables, suggests rather that uS (e.g. *ratón*) makes up a right-prominent foot, just as Su (e.g. *suave*) makes up a left-prominent foot. This opens up the possibility that the initial unstressed syllable in longer words (uSu, uSuu) is also part of the foot and not extrametrical, but that weak elements delete under conditions of greater complexity (in this case, word length). Further investigation of this theoretical issue is warranted.

In terms of overall word shape and timing unit accuracy, WI and WM singleton timing units tended to be preserved across children, which contrasted with the lower overall WSM in children with PPD and the 3-year-olds. This probably reflects a compounding factor, i.e. a single WI or WM timing unit may be present, but a diphthong or cluster elsewhere in the word may be reduced, lowering accuracy of the overall word shape.

Regarding consonant sequences, WSM was significantly lower in words with WI clusters than words with singleton consonants only, substantiating the developmental relevance of syllable complexity. The most common cluster mismatch pattern affecting structure was consonant deletion, with C2 deleting significantly more often than C1 in WI clusters. Vowel epenthesis in clusters was slightly more common in the TD group than the group with PPD, especially in left-prominent words. Epenthesis allows both consonant timing units to be produced, without solving the basic problem of coordinating two consonants in sequence. Epenthesis was less frequent in words that have initial unstressed syllables (e.g. *princesa* as *[pa-ɾin-ˈse-sa]), probably because epenthesis would create a sequence of two unstressed initial syllables, a less favoured prosodic sequence (Bernhardt and Stemberger 1998).

Word-medial heterosyllabic sequences showed higher timing unit matches than tautosyllabic onset clusters. This was opposite to the results of Diez-Itza and Martínez (2004), and, as expected, is consistent with the Granada dialect. Liquid and obstruent codas in the heterosyllabic sequences are optional in Granada Spanish; thus, the majority of sequences produced were nasal-obstruent, arguably simpler segmentally than the tautosyllabic clusters in Granada Spanish, which have liquids in second position. In the Diez-Itza and Martínez study of Northern–Central Spanish, a larger variety of more complex heterosyllabic sequences were targets and therefore have been more subject to structural and segmental mismatches.

Overall, the TD and PPD groups were not distinguishable in terms of simple structures such as singleton consonants and disyllabic words. Especially at ages 4 and 5, the more complex forms (consonant sequences, multisyllabic words, consonant sequences in initial unstressed syllables), however, distinguished the groups.

Limitations, future research and clinical application

The current study was limited by the small unequal sample sizes at the various ages, and the resulting violation of homogeneity of variance. Further analysis is warranted with the current data concerning development of diphthongs, segments and segment-structure interactions to be addressed in future papers. Normative references will require meta-analyses and large *n* studies, especially to establish cross-dialectal similarities and differences in Spanish word structure development.

The present study uniquely evaluated word structures in a dialect of Spanish with highly restricted codas, providing preliminary benchmark criteria for identification of PPD in Spanish, particularly for such variants. Global measures for WWM and WSM (tables 1 and 3) may serve as possible identification criteria for PPD from ages 3 to 5, for example: a WSM of less than 50% at age 3, 60% at age 4 and 75% at age 5, and a WWM about 20% less than each WSM score by age. Other possible indicators include presence of pervasive phonological patterns (syllable deletion, full cluster deletion, multiple patterns) and low timing unit match for onset clusters, the word structure element causing the most challenges in the group with PPD. By age 4, word structure appears to be well-developed in a variety of Spanish with restricted coda use. But before that age, there are also indicators as noted above, of possible PPD.

For many languages, clinical elicitation materials have often focused on individual speech–sounds; our results suggest that more successful elicitation materials need to sample a much wider range of the phonological system, including words with a variety of complex and marked word structures (multisyllabic words, clusters). Materials for assessment and phonological analysis for goal-setting are available free in electronic form from the first author. The speech–language therapist can provide a customized evaluation of a particular child's phonological system and use these preliminary data as indicators for identification and goal-setting. As more analyses are completed, these will also become part of the materials available. Future studies are encouraged to replicate and expand the results presented here.

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conflicts of interest and are responsible for the content and writing of the paper.

Notes

1. Protracted phonological development (PPD) is used in place of the frequently used terms 'speech–sound/phonological disorders/impairment', and implies a more neutral, positive valence (Bernhardt and Stemberger 1998, Chávez-Peón *et al.* 2012, Dubasik and Ingram 2013). 'Protracted' is not equivalent to 'delayed'.
2. An additional TD child did not complete the speech elicitation task and thus those data were excluded.
3. Effect sizes were calculated using the *r* statistic (Field 2013).
4. The word list, a photo elicitation tool and a scan analysis form are available from the first author, and from 2015 will be available through a website at the University of British Columbia along with an online tutorial on analysis.
5. If a cluster were realized with a single C substitution, the child's typical substitution patterns were used to determine best which consonant was deleted, e.g. *grande* /ˈɡɾande/ [ˈjate] was assumed to involve a C1 deletion because [j] substituted for /ɾ/ but not for /ɡ/ for that child.

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Appendix A: Syllable types: Northern–Central and Granada Spanish

Syllabic elements	Northern–Central	Granada	Examples
Singleton V, C	V		*a* /a/ 'to'
	CV		*mi* /ˈmi/ 'my'
	VC		*as* /ˈas/ 'ace'
	CVC	CV(C)	*azul* /aˈsu(l)/ 'blue'
VV rising[a]	VV		*hiere* {ˈiere/ˈdʒere} 'he wounds'
	CVV		*pie* /ˈpie/ 'foot'
	(C)VV		*hueso* /ˈ(g)ueso/ 'bone'
	(C)VVC	(C)VV(C)	*huésped* /ˈue(s).pe(ð)/ 'guest'
VV falling[a]	VV		VV *hoy* /ˈoi/ 'today'
	CVV		*soy* /ˈsoi/ 'I am'
CC	CCV		*plato* /ˈplato/ 'plate'
			sopla /ˈsopla/ 'blow'
	CCVV		*flauta* /ˈflauta/ 'flute'
	CCVC		*princesa* /prin.ˈ{s/θ}e{s/θ}a/ 'princess'
CC heterosyllabic	VC.C	VC:	*tortuga* /toˈ{rt/t:}uɣa/ 'turtle'
	VCC.C	VC.C	*instaurar* /i{(n)/(s)}.tauˈrar/ 'establish'
	CVCC.C	CVC.C	*constar* /ko{(n/s)}.ˈtar/ 'to state'
CC onset, CC Coda	CCVCC	CCVC	*transportar* /tra{(n/s)}.porˈtar/ 'transport'
CC onset, VV(C)	CCVVC	CCVV	*claustro* /ˈklau(s).tro/ 'cloister'

Continued

Notes: [a]In rapid speech, diphthongs may reduce, e.g.
/ei/ → /e/ or /i/, e.g. *veintidós* /beintiˈðos/ → [b{en/in}tiˈðos]
/au/ → [a], [o] or [u], e.g. *precaución* /prekauˈθion/ → [prekaˈθion]) 'precaution'
/ue/ → [e] or [o], e.g. *luego* /ˈluego/ → [ˈloɣo] 'then'
/ao/ → [o], e.g. zanahoria /{θ/s}anaˈorja/ → [{θ/s}aˈnorja] 'carrot'.

Appendix B: Distribution of word length, stress patterns and word shapes in the word list

Syl #	Stress	#	Syllable structure			
			No CC	#	With CC	#
1	S	7	CV(C)	4	CCV(C)	3
			VV	1		
2	Su	54	ˈCV(V)(C)V(C)	29	ˈCCVCV(V)(C)	11
			ˈV(V)CV(V)(C)	7	ˈCV(V)CCV(C)	5
					ˈCCVCCV	2
	uS	7	(C)V'CVC	6	CCV'CV(C)	1
3	Suu	3	ˈCVCVCV	1	ˈCCVVCCVCV	1
					ˈCVCCVCV	1
	uuS	1			CVCCV'CV(C)	1
	uSu	21	(C)V(V)ˈCVCV	11	(C)V(C)ˈC(V) VC(C)(C)V(C)	9
					CCV'CVCV	1
4	uSuu	1	CV'CVCVCV	1		
	uuSu	8	CVCVCV'CV	1	CCVCV'CVCV	1
			CVCV. ˈ(C)V(V)CV(V)	3	VC(C)VCV(C)CV	2
			CVCV'CV.V	1		
5	uuSuu	1	VCV'CVCVCV	1		

Note: Words elicited twice to increase counts for infrequent elements were: *muñeca* 'doll', *pes(cado)* 'fish', *flor* 'flower', *agua* 'water', *Paula* 'Paula', *zapato* 'shoe', *tres* 'three', *baño* 'bathroom'/*bañera* 'bathtub'. Total words/child: TD = 96–110 (mean = 107); PPD = 103–111 (mean = 108).

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