Prosodic Skills of Spanish-speaking Children with Developmental Language Disorder

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Abstract

Background: Phonological difficulties in children with developmental language disorder (DLD) are well documented. However, abilities regarding prosody, the rhythmic and melodic characteristics of language, have been less widely studied, particularly in the Spanish language. Moreover, the scant research findings that have been reported are contradictory. These considerations justify our new research into the question, focusing on Spanish-speaking children with DLD.

Aims: The aim of this study was to examine a wide range of prosodic skills among Spanish-speaking children with DLD. Another aim was to analyse relationships between prosody and other language measurements.

Methods & Procedures: Prosodic skills were assessed through the Spanish version of the Profiling Elements of Prosody in Speech-Communication (PEPS-C) battery. The performance of 19 children aged 5-11 years with DLD was compared to that of a chronological age-matched control group of 19 typically developing children. Language skills were also assessed.

Outcomes & Results: There were significant differences between the group with DLD and the control group, in terms of skills involving prosody functions and forms: turn-end and chunking signalling, contrastive focus and affect expression and understanding, discriminating and the imitation of prosodic patterns both in words and phrases.

Conclusions & Implications: Spanish-speaking children with DLD present impairments not only when prosody interacts with language but also in the processing of prosody alone. Our study results suggest that prosody is related to lexicon and grammar in children with DLD. The prosodic impairments of Spanish-speaking children with DLD could produce a negative impact on their language functioning and could also relate to their emotional and social difficulties. Consideration should therefore be given to focusing future interventions on prosodic skills in Spanish-speaking children with DLD.

Keywords: prosodic skills, developmental language disorder, specific language impairment, suprasegmental phonology, assessment, Spanish language.

What this paper adds

What is already known on the subject

Although deficits in segmental phonology have been extensively studied in DLD, relatively little research has been conducted into supra-segmental phonology, especially among speakers of Spanish. To our knowledge, only one previous study has analysed the prosodic skills of Spanish-speaking children with DLD (Jordán *et al*., 2019), and this only focused on prosody while reading. No analysis was made of the use of prosody in language comprehension and expression.

What this study adds

This is the first study to analyse competence in a wide range of prosodic skills among Spanish-speaking children with DLD by using the PEPS-C battery. Spanish-speaking children with DLD present impairments in prosody functions and forms, which are related to other language skills.

Clinical implications of this study

Prosodic impairments among Spanish-speaking children with DLD could contribute to explaining both their language difficulties and their socio-emotional problems. The results obtained in this study suggest that Spanish-speaking children with DLD could benefit from interventions focused on prosody.

Prosodic skills of Spanish-speaking children with developmental language disorder

Introduction

Children with developmental language disorder (DLD) (or specific language impairment—SLI)[1] show language atypicalities that cannot be accounted for by physical, neurological, intellectual or sensory disabilities, or by lack of social stimulation (Aguado *et al.* 2015, Leonard 2014). The language skills of children with DLD are usually described as lower than expected from their chronological age (CA) and non-verbal cognitive level, and this leads them to present widespread impairments not only in communication but also in socioemotional functioning (Conti-Ramsden 2013). Difficulties in morpho-syntax represent the hallmark of the disorder but impairments can also be found in other linguistic components such as vocabulary, semantics, phonology and pragmatics (Leonard 2014).

The present study focuses on phonology, in the view that difficulties in this area can affect other linguistic components such as morpho-syntax or semantics. While phonological skills regarding segmental information (i.e. the single sound segments of spoken language) have been widely studied in DLD, less research has been conducted regarding suprasegmental phonology, i.e., prosody, among this population (Marshall *et al.* 2009). Prosody can be defined as the melodic and rhythmic characteristics of speech; through variations in pitch, loudness and length, it conveys important information related to affect, pragmatics and grammar (Peppé 2009). Thus, impairments in prosody understanding and/or expression can cause communicative difficulties and, ultimately, social adaptation problems (Wells *et al.* 1995). Therefore, it is important to have a good understanding of the prosodic skills of children with DLD. Establishing whether such children present prosodic difficulties and, if so, delineating

[1] The recommended term of DLD (Bishop *et al.* 2017), which was recently included in the ICD-11 classification (International Classification of Diseases-11), will be used throughout this manuscript.

the prosodic skills that are affected, would represent an important step towards the design of effective programmes of intervention.

It is also important to consider the role that prosody may play in language development. According to the *prosodic bootstrapping hypothesis*, the processing of prosodic information paves the way for grammar acquisition (Morgan and Demuth 1996). Accordingly, deficits in prosodic processing may contribute to explaining difficulties that children with DLD present in morpho-syntax. In this respect, the *prosodic phrasing hypothesis* proposes that, in DLD, impairments in the processing of low-level auditory features related to prosody may affect the processing of higher-order prosodic characteristics, and this, in turn, would have a negative impact on morpho-syntax during language acquisition (Cumming *et al.* 2015). In contrast, a *dissociation hypothesis* has also been suggested; according to this hypothesis, the morpho-syntax and segmental phonology impairments of children with DLD would be independent of prosody (Snow 1998, 2001).

It is not entirely clear whether children with DLD present impairments in prosodic skills. Inconsistent findings have been reported as to whether the prosodic skills of children with DLD are on a par with those of typically developing (TD) children matched by CA. On the one hand, children with DLD seem to be less sensitive to prosodic cues than TD children of the same CA. Pre-school English-speaking children with DLD perform significantly less well than CA-matched TD peers at matching prosodic contours with their corresponding utterances with segmental information (Fisher *et al.* 2007).The same result has been found for older English-speaking children with DLD (8-12 years) when assessed with tasks tapping sensitivity to lexical stress (Cumming *et al.* 2015, Richards and Goswami 2015) and for Swedish preschoolers with DLD when asked to repeat lexical stress and tonal word accent (Sundström *et al.* 2019). At the word and phrase levels, both preschool and school-age Swedish-speaking children with language impairments also present significantly poorer prosodic performance than CA-matched TD peers (Samuelsson and Nettelbladt 2004).

In addition, German-speaking children with DLD have been found to be less sensitive to prosodic cues that help in the acquisition of grammatical rules (Kauschke *et al.* 2013). There is also evidence that the prosodic skills of children with language impairments significantly correlate with their grammar expression skills (Samuelsson and Nettelbladt 2004, Sundström *et al.* 2019). These results support the view that the prosodic impairments of children with DLD could contribute to explaining their problems in morpho-syntax (Kauschke *et al.* 2013, Richards and Goswami 2019).

Children with DLD have also been found to present impairments in prosodic skills related to pragmatics and affect expression. Swedish-speaking children aged 4-10 years with language disorder present impairments when using prosody at the discourse level (Samuelsson and Nettelbladt 2004). When required to imitate prosodic contours tapping both emphatic accent and emotions, 4 to 6-year-old Dutch-speaking children with DLD perform significantly poorer than CA-matched TD peers (Van der Meulen *et al.* 1997). In addition, 8 to 10-year-old English-speaking children with DLD present deficits – relative to TD peers of the same CA – in understanding affective prosody (Fujiki *et al.* 2008). Importantly, these impairments may contribute to the difficulties children with DLD experience in emotional and social functioning (Fujiki *et al.* 2008).

However, contrasting results have been obtained regarding different prosodic skills and functions. Thus, pre-school English-speaking and school French-speaking children with DLD are both able to imitate rising and falling prosodic contours at the level of CA-matched TD children (Demouy *et al.* 2011, Snow 2001). Just like their CA-matched TD peers, 4-year-old English-speaking children with DLD also use prosodic cues to mark speech boundaries (Snow 1998). From these results, it has been proposed that there may be a dissociation between prosody and morpho-syntax in children with DLD (Snow 1998). Other studies have suggested that, although the general processing of prosody is not impaired in children with DLD, difficulties arise when prosody interacts with other language levels, such as syntax (Caccia and Lorusso 2019, Marshall *et al.* 2009).

Regarding affective prosody, in contrast to Fujiki *et al.* (2008), other research has revealed no difficulties in this respect in children with DLD. Thus, no significant differences have been found between 4 to 6-year-old Dutch-speaking children with DLD and CA-matched TD children for the comprehension of emotional prosody (Van der Meulen *et al.* 1997).

In summary, while some researchers have found prosodic deficits in children with DLD, others have shown that the prosodic skills of these children are at the same level as those of TD children matched by CA and have concluded that prosody does not represent a core impairment in DLD. In accounting for these inconsistent results, we should note that different studies have focused on different prosodic skills, and this leads to a fragmented view of the prosodic profile of children with DLD. A comprehensive assessment of a range of prosodic skills within the same group of children with DLD would help to clarify the extent of possible prosodic impairment in this disorder.

As far as we know, only two studies have followed this approach (Marshall *et al.* 2009, Wells and Peppé 2003). Both made use of the *Profiling Elements of Prosody in Speech-Communication* test (PEPS-C) (Peppé and McCann 2003). This battery, originally designed in English, has since been translated into various languages (Peppé *et al.* 2010) and has been successfully used to assess the prosodic skills of children with autism spectrum disorders (Peppé *et al.* 2007), Williams syndrome (Martínez-Castilla *et al.* 2012), or Down syndrome (Stojanovik 2011). PEPS-C assesses the expression and comprehension of four significant prosodic functions (affect, turn-end, chunking and focus). Furthermore, it distinguishes between the skills needed to understand and express prosodic functions and those used to discriminate and imitate the prosodic forms needed to convey such functions (McCann and Peppé 2003) (a complete description of the PEPC-S test is included in the Method section). Consequently, the battery represents a means of conducting a comprehensive assessment of the prosodic skills of children with language and communication disorders (McCann and Peppé 2003, Peppé 2009).

Using a version of PEPS-C, Wells and Peppé (2003) studied the prosodic skills of eighteen 8-year-old English-speaking children with language difficulties who might also have other disabilities (e.g., visuospatial difficulties, attention deficit hyperactivity disorder, hearing impairment). The group with language impairments performed at the level of a TD group matched by CA on most of the prosodic skills assessed. Nevertheless, significant differences were found. For example, the children with language impairments performed significantly less well than their TD peers in understanding contrastive focus, and in the comprehension and expression of prosodic cues for turn-end signalling. After conducting correlation analyses between prosodic skills and other language measurements, on the whole, no such relationships were found.

Marshall *et al.* (2009) used six of the twelve PEPS-C tasks (Peppé and McCann 2003) to assess the understanding and expression of chunking and focus, and the discrimination and imitation of the prosodic forms involved in these two functions, among different groups of English-speaking children with language impairments. The group diagnosed with DLD (and no other disorders) was composed of 10 children aged between 10 and 14 years. Compared to TD children matched by CA, the group with DLD performed significantly less well in only two tasks: chunking input and focus input. It was then concluded that although children with DLD have problems in understanding some linguistic functions conveyed by prosody (boundary and contrastive focus), they do not show impairments for the discrimination and imitation of prosodic forms. Marshall *et al.* (2009) also studied the possible relationships between prosodic skills and other language measurements in children with language impairments. In a combined group of children with DLD and/or dyslexia, correlations were weak and lacked statistical significance. This led the authors to conclude that the language impairments of these children are not related to their prosodic skills.

Most of the research on the prosodic skills of children with DLD has been conducted on participants who speak a Germanic language but, considering the extant cross-linguistic differences in the ways prosodic functions are used (Peppé *et al.* 2010), different results may be found for other languages. In this work, we focus on the Spanish language. Compared to English, both similarities and cross-linguistic differences are found in the Spanish-speaking individuals' use of prosody (Martínez-Castilla and Peppé 2008a, Peppé *et al.* 2010). Thus, as in English, rising and falling intonation patterns express questions and statements, respectively, and pauses, lengthening and tonal correlates similarly contribute to speech segmentation (Quilis 1981). Stress is conveyed in both languages by greater loudness, higher pitch and longer duration (Quilis 1981, Peppé *et al.* 2010). However, there is no vowel reduction associated to stress in Spanish (Ortega-Llebaria and Prieto 2010) and pre-final contrastive stress is more common in English (Martínez-Castilla and Peppé 2008a). In addition, while the intonation contour used to indicate "liking" is similar in both languages (i.e., rise-fall), cross-linguistic differences are found for the expression of "disliking" (i.e., a falling-rising contour in English vs. a flat melodic contour with a slight fall in Spanish) (Martínez-Castilla and Peppé 2008b).

To our knowledge, only one previous study has assessed the prosodic skills of Spanish-speaking children with DLD. This was Jordán *et al.* (2019), who analysed prosodic reading skills in children aged seven to thirteen years with DLD. These authors found that, with respect to TD peers, the children with DLD made more inappropriate pauses and produced fewer pitch variations in interrogative sentences. This study, however, focused on the use of prosodic cues while reading and did not consider other aspects related to prosodic sensitivity.

In short, strikingly little previous research has been conducted to investigate the prosodic skills of Spanish-speaking children with DLD. Accordingly, the present study sought to fill this gap. By studying a broad range of prosodic skills in Spanish-speaking children with DLD, the study aimed to provide data with which to address the question of whether the prosodic skills of these children are commensurate with those of TD children of the same CA. Finally, this research also aimed to shed further light on the possible relationships between prosody and other language measurements in children with DLD. To achieve these aims, the complete Spanish version of the PEPS-C battery (Martínez-Castilla and Peppé 2008a) was administered to a group of children with DLD and to a control group of TD children matched by CA. Correlations between prosodic and other language skills were also conducted.

Methods

Participants

Thirty-eight Spanish-speaking children participated in the study, 19 had DLD and 19 were CA-matched TD children. Participant's CA ranged 5-11 years. The distribution of CA for the children with DLD and their peers with TD is presented in Table 1. In Spanish, competence on the PEPS-C tasks is reached by 7.5 years (Martínez-Castilla and Peppé 2008a). According to this, two different age groups were considered both in the DLD and the TD groups: younger (5-6 years) and older (7.5-11 years) children.

INSERT TABLE 1 ABOUT HERE.

Following previous research in this field (e.g., Aguado *et al*. 2015, Marshall *et al*. 2009), the following criteria were used to select the participants with DLD:

- A standard score in non-verbal IQ equal to or greater than 85, as measured by the matrices subtest of the *Kaufman Brief Intelligence Test* (K-BIT, Kaufman and Kaufman 2000).
- A score 1.5 SD below the average in the *Grammatical Structures Comprehension Test* (CEG), i.e., a test evaluating receptive grammar in the Spanish language (see below) (Mendoza *et al.* 2005), and the sentence repetition subtest of the *Clinical Evaluation of Language Fundamentals -4* (CELF-4) (Semel *et al.* 2006) or CELF Pre-School (Wiig *et al.* 2009), depending on participants' CA.
- No additional diagnoses of ADHD, autistic spectrum disorder (ASD), hearing impairment dyslexia, or any other neurodevelopmental disorder.
- Diagnosis of DLD or attendance at special schools or units for children with DLD.

Professionals working with the children (psychologists and speech and languages therapists) and parents were asked about children's clinical records. According to them, no participant had any other clinical diagnosis. The participants' descriptive characteristics are shown in Table 2. ANOVA tests with clinical group (DLD vs. TD) and age group (younger vs. older) as between-subject factors were used for testing differences in descriptive variables. As previously said, the DLD and TD groups were matched by CA. Thus, when considering this variable, there was no significant main effect of clinical group ($p = .84$) (the interaction was not significant either, $p = .43$). No significant effects were found for non-verbal cognitive level ($p > .05$). Regarding the linguistic measurements, significance was only found for the main effect of clinical group so that, as expected, the children with DLD performed significantly less well on the CEG test ($F(1, 34) = 50.58$, $p < .001$, $r = .77$) and the sentence repetition subtest of the CELF ($F(1, 34) = 34.82$, $p < .001$, $r = .71$). Participants were also administered with the *Peabody Picture Vocabulary Test* (PPVT-III, Dunn and Dunn 2010) and the K-BIT vocabulary expression test (see below), and the children with DLD also performed significantly less well in these measurements ($F(1, 34) = 21.32$, $p < .001$, $r = .62$; $F(1, 34) = 21.68$, $p < .001$, $r = .62$, respectively).

The participants in this study were recruited from mainstream schools and clinics. Teachers and speech and language therapists identified the children with DLD (who had previously undergone a psycho-pedagogical assessment). To confirm the diagnosis of DLD, the children referred to by professionals were administered the CEG test, the CELF sentence recall subtest and the K-BIT matrices subtest, as previously mentioned. TD children were recruited from the school class' of their peers with DLD or from a class of equivalent academic level. All the children attended schools in the Spanish province of Granada and were in the academic year corresponding to their age. In addition, all came from families with a middle-high socio-cultural level and all had the same regional Spanish accent.

INSERT TABLE 2 ABOUT HERE

Measures

As previously mentioned, non-verbal cognitive level was measured through the K-BIT matrices subtest, which evaluates abstract reasoning by presenting participants with analogies. In this subtest, the Cronbach's alpha reliability coefficient is .86. Apart from the prosodic test (described below), the participants were also administered four other language tests: the CEG test, the CELF sentence repetition subtest, the PPVT-III, and the K-BIT expressive vocabulary subtest. The CEG is specifically designed to assess receptive grammar in Spanish-speaking children (Mendoza *et al.* 2005). Cronbach's alpha reliability coefficient for this test is .91. As in the *Test for the Reception of Grammar* (TROG, Bishop 2003), participants have to choose the picture that matches auditory sentences of varying grammatical difficulty. The CELF sentence recall subtest evaluates morpho-syntax expression by means of sentence repetition. As reported in the manual, Cronbach's alpha coefficient is .82. The PPVT-III is a measurement of receptive vocabulary (Cronbach's alpha reliability coefficient of .91). Finally, the K-BIT expressive vocabulary subtest assesses vocabulary production (Cronbach's alpha reliability coefficient of .94).

Prosodic skills were assessed using the Spanish version of the PEPS-C battery (Martínez-Castilla and Peppé 2008a), which parallels the English test, assessing the same prosodic functions and following the same task structure (Martínez-Castilla and Peppé 2008a). In fact, employing the corresponding version, PEPS-C has been used in samples of both Spanish and English-speaking children with other neurodevelopmental disorders in cross-linguistic studies (Martínez-Castilla *et al.* 2012).

As in the English version, the Spanish PEPS-C is a computerised battery composed of eight function tasks (comprehension and expression of affect, turn-end, chunking and focus) and four form tasks (discrimination and imitation of the forms involved in the aforementioned functions). Each task includes two examples, two practice items (to ensure task understanding) and sixteen experimental items. In the function comprehension tasks (input), participants are presented with two pictures and one auditory item and are asked to choose the picture that matches the auditory stimulus. In the function expression tasks (output), participants are presented with pictures and are asked to express what is shown in each one. In the form discrimination tasks (input), participants hear pairs of prosodic contours without segmental information (by means of laryngograph recordings) and have to say whether the two sounds presented are the same or different. Finally, in the form imitation tasks (output), participants are asked to imitate a set of items that are auditory-presented. In the following, we briefly describe the tasks included in PEPS-C.

Function tasks

-Turn-end tasks: These tasks evaluate the skills needed to understand (turn-end input task) and express (turn-end output task) the distinction between questioning and declarative intonation in single words constituted as conversational turns. In the input task, food items expressed with either a falling or a rising intonation are presented together with pairs of pictures representing a child offering a food item or reading out loud the same food item illustrated in a book. Participants have to identify whether the child has offered (rising intonation) or read out (falling intonation) each food item by choosing the appropriate picture. In the output task, participants have to produce the food words with the right intonation when presented with either type of picture (reading or offering).

- Affect tasks: Participants are evaluated on their understanding (affect input task) and expression (affect output task) of 'like' and 'dislike' intonation. For the input task, participants have to identify whether the child portrayed by the computer likes or dislikes a series of food items according to the sound of the child's voice. This task is performed by choosing the picture illustrating the facial emotion in question. For the output task, by using their voice, participants have to express whether they like or dislike a set of food items that are presented in pictures.

- Chunking tasks: These tasks evaluate participants' understanding (chunking input) and expression (chunking output) of prosody as a means to segment and disambiguate the speech chain. In the input task, participants are presented with pairs of pictures representing lexical items that have the same segmental information but different meanings depending on the prosodic cues (e.g., compound nouns: */pez/ espada/ y limón/* vs. */pez-espada/ y limón/* -/fish/ sword/ and lemon/ vs. /sword-fish/ and lemon/-). They have to choose the picture corresponding to what they hear. In the output task, participants are presented with each picture and have to express what they see.

- Focus tasks: These tasks assess the skills needed to understand (focus input task) and produce (focus output task) prefinal contrastive stress in meaningful contexts. In the input task, participants are told that the child shown by the computer wanted two food items but has been given only one of them. On the basis of what they hear (e.g., *‘‘Quería paella y YOGUR para comer”* vs. *‘‘quería PAELLA y yogur para comer’’* -’’I wanted paella and YOGURT to eat’’ vs. ‘‘I wanted PAELLA and yogurt to eat’’), they have to decide which food item the child wanted but had not received. Participants answer by choosing one of the two pictures of food items. In the output task, participants are told that the child shown by the computer had asked her mother for two food items to eat but that her mother always made a mistake over one of them. Participants are shown pictures of what the child wanted, hear what the mother had understood and are asked to correct the mother. The task is designed so that minimal pairs are produced along different items: e.g., *‘‘ha dicho que quería leche y GALLETAS para comer’’ vs. ‘‘ha dicho que quería LECHE y galletas para comer’’* – “she said he wanted milk and BISCUITS to eat’’ vs. ‘‘she said he wanted MILK and biscuits to eat’’-.

Form tasks

- Short-item discrimination and imitation tasks: These tasks evaluate participants’ ability to perceive and reproduce the prosodic cues involved in the turn-end and affect tasks. In the discrimination task, participants hear laryngograph recordings of the minimal pairs included in the aforementioned function tasks and must decide whether the two stimuli are the same or different. In the imitation task, participants are asked to repeat words exactly as they hear them.

- Long-item discrimination and imitation tasks: These tasks evaluate participants’ ability to perceive and reproduce the prosodic cues involved in the chunking and focus tasks. These tasks are parallel to the short-item discrimination and imitation tasks. In the discrimination task, the laryngograph recordings of minimal pairs correspond to the chunking and focus tasks. In the imitation task, participants repeat phrases instead of individual words.

Procedure

All the children were evaluated by the first three authors according to the following procedure. The CEG test, the CELF sentence recall subtest and the K-BIT matrices subtest were administered in a first session lasting 45 minutes. The PEPS-C, K-BIT vocabulary expression and PPVT-III tests were administered in two further sessions, each lasting 35 minutes. Each child was individually assessed in a quiet, comfortable room within the school.

As required in the procedure for every test, practice items were first administered to ensure that the children understood the tasks. In addition, following the recommended procedure for PEPS-C, the children were also given a vocabulary check to ensure that they were familiar with the pictures and vocabulary items to be presented in each prosody task. PEPS-C was administered using a laptop computer (Sony Vaio, Intel Core i3-330M, ATI RV730). The output tasks were recorded with the PEPS-C software at a sampling frequency of 22.05 KHz.

Informed parental consent was obtained in every case for participation in this study. Approval was obtained from the Ethical Human Research Committee of the University of Granada (Spain). Thus, the study was carried out in accordance with the ethical principles of the Declaration of Helsinki (WMA 2001).

Results

To avoid undue load on the participant's auditory memory, each item on the PEPS-C input tasks contains only two possible responses. To test whether the participants' performances were better than chance, separate one-way *t*-tests were run for each group in each input task. The performance of the younger and the older TD children was better than chance in all the input tasks ($p < .05$). The younger children with DLD performed at chance level on turn-end input ($t(9) = 1.79$; $p = .11$), chunking input ($t(9) = 1.59$; $p = .15$), focus input ($t(9) = 1.86$; $p = .10$), and long-item discrimination ($t(9) = 1.18$; $p = .27$). The older children with DLD performed at chance on turn-end input ($t(8) = 1.94$; $p = .09$) and focus input ($t(8) = 1.37$; $p = .21$).

Inter-rater reliability was then calculated for the PEPS-C output/imitation tasks. To do so, another rater (the fourth author), blind to whether each participant belonged to the DLD or TD group, assessed 26.32% of the output items (corresponding to 10 participants). Inter-rater agreement was analysed by means of Cohen's κ. According to the guidelines provided by Pardo and Ruiz (2002) for interpreting Cohen's κ, agreement was excellent for affect output ($\kappa = .84$; $p < .001$) and turn-end output ($\kappa = 0.76$; $p < .001$), and good for focus output ($\kappa = .60$; $p < .001$), chunking output ($\kappa = .49$; $p < .001$), short-item imitation ($\kappa = .43$; $p < .001$) and long-item imitation ($\kappa = .44$; $p < .001$).

Two-way ANOVA tests with clinical group (DLD vs. TD) and age group (younger vs. older) as between-subject variables were conducted for all the PEPS-C tasks. When a significant interaction effect was found, results were analysed by studying the simple effects, i.e., comparing the levels of one factor within the levels of the other factor (Pardo and Ruiz 2002). To control the error rate, comparisons were done using Bonferroni correction. For the sake of brevity and clarity, only significant results are reported.

There was a main significant effect of group, so that the group with DLD performed significantly less well than the TD group, in seven of the twelve PEPS-C tasks: affect input ($F(1, 34) = 5.16$, $p = .03$, $r = .36$), affect output ($F(1, 34) = 8.03$, $p = .008$, $r = .44$), turn-end output ($F(1, 34) = 12.76$, $p = .001$, $r = .52$), chunking output ($F(1, 34) = 9.48$, $p = .004$, $r = .47$), focus input ($F(1, 34) = 23.90$, $p < .001$, $r = .64$), focus output ($F(1, 34) = 23.66$, $p < .001$, $r = .64$), and long-item imitation ($F(1, 34) = 16.30$, $p < .001$, $r = .59$). Significant differences between the children with DLD and their TD peers were also found in turn-end input ($F(1, 34) = 19.81$, $p < .001$, $r = .61$), chunking input ($F(1, 34) = 6.89$, $p = .013$, $r = .41$), and long-item discrimination ($F(1, 34) = 7.88$, $p = .008$, $r = .43$). In these three tasks, a significant effect of age group was also found, so that the older children outperformed the younger ones (turn-end input: $F(1, 34) = 5.32$, $p < .027$, $r = .61$; chunking input: $F(1, 34) = 10.07$, $p = .003$, $r = .48$; long-item discrimination: $F(1, 34) = 18.45$, $p < .001$, $r = .59$). For the short-item discrimination task, the same age effect was found ($F(1, 34) = 5.95$, $p = .02$, $r = .39$), together with a trend for children with DLD to perform lower than their TD counterparts ($F(1, 34) = 3.62$, $p = .07$, $r = .31$). Finally, in the short-item imitation task, statistical significance was found for the main effects of clinical group ($F(1, 34) = 11.78$, $p = .002$, $r = .51$) and age group ($F(1, 34) = 9.20$, $p = .005$, $r = .46$), and for the interaction of these two variables ($F(1, 34) = 5.42$, $p = .026$, $r = .37$). Bonferroni pairwise comparisons showed that, only for the younger children, those with DLD performed significantly lower than the TD children ($CI_{.95} = -3.61$ (lower) -1.21 (upper), $p < .001$) (and no significant differences were found between the older children with DLD and their TD peers, $p > .05$). In addition, only for the children with DLD, the older group outperformed the younger one ($CI_{.95} = 1.04$ (lower) 3.44 (upper), $p = .001$). Table 3 shows the descriptive statistics obtained for each group in the PEPS-C tasks, together with a summary of the results obtained for the comparisons between the DLD and TD groups.

INSERT TABLE 3 ABOUT HERE

To study the relationships between prosodic skills and other language abilities, Pearson correlations were obtained separately for the DLD group (both younger and older children) and the TD group (see Tables 4 and 5). An array of significant correlations between the PEPS-C tasks and the CEG, CELF sentence repetition, PPVT, and K-BIT vocabulary expression tests was found both for the group with DLD and for the TD groups, but the pattern of correlations differed between them. In the TD group (see Table 4), turn-end, chunking, focus, and the form tasks (mainly in their input version) were significantly correlated with the CEG, PPVT-III, CELF or K-BIT vocabulary expression tests.

INSERT TABLE 4 ABOUT HERE

In the DLD group, the turn-end output, the affect (both input and output), and chunking input tasks showed significant correlations with the CEG (see Table 5). Some of them also significantly correlated with the PPVT-III or the K-BIT vocabulary expression tests. Regarding the form tasks, except for short-item discrimination, the remaining tasks generally showed significant correlations with the language abilities tests.

INSERT TABLE 5 ABOUT HERE

Discussion

The aim of this study was to analyse a wide range of prosodic skills in Spanish-speaking children with DLD, using the PEPS-C test. We also aimed to analyse the relationships between prosody and other language measurements in the same children. To our knowledge, this is the first study to address these issues with Spanish-speaking children.

One of the main findings of our study is that Spanish-speaking children with DLD perform worse than their TD peers matched by CA on prosody tasks. Both the younger and older children with DLD performed significantly less well than their TD counterparts on all the function tasks. The same was found on two of the form tasks (long-item discrimination and imitation). A trend for a lower performance of the groups with DLD was observed on the short-item discrimination form task. Finally, on the short-item imitation task, while no significant differences were found between the older children with DLD and their TD peers, the younger children with DLD performed significantly less well than their TD counterparts. Medium or even large effects were found in all cases.

Prior research has claimed that English-speaking children with DLD present poor basic auditory sensitivity to sound frequency, which would contribute to accounting for their prosodic impairments (Richards and Goswami 2015). The short-item PEPS-C tasks assess the ability to perceive and reproduce the prosodic cues involved in the turn-end and affect tasks which, in the Spanish case, refer to tonal contours, as previously mentioned (Quilis, 1981). Therefore, sound frequency processing difficulties could also explain our findings in the short-item PEPS-C tasks. In turn, the difficulties observed in these form tasks could account for the results found in the turn-end and affect tasks. Thus, the difficulties for processing tonal patterns (without linguistic meaning) would have a negative impact when these patterns need to be used in a meaningful context; namely, for distinguishing between questions and declarative sentences and expressing affect through prosodic means.

It should be noted that, on short-item imitation, significantly lower results were only found for the younger children with DLD, but not for their older peers, and that significantly higher performance was observed in the older DLD group compared to the younger one. Importantly, this shows that the ability to reproduce short intonation contours improves along development, to the extent that there is a moment when the results obtained by children with DLD and TD children are not significantly different. Even though, in our study, both the younger and the older children with DLD performed significantly less well than the TD groups on the turn-end and affect tasks. Therefore, we would suggest that even when difficulties for processing intonation contours are overcome with age, the presence of such difficulties in an earlier developmental moment has a cascading negative impact on the functional use of these prosodic cues.

In children with DLD, poor sensitivity to low-level auditory features has been reported not only for sound frequency but also for duration and rise time, and difficulties in the discrimination of the two latter parameters are also considered to contribute to accounting for their prosodic impairments (Cumming *et al.* 2015; Richards and Goswami 2015). Perception and imitation of prosodic patterns formed by such acoustic cues are assessed in the long-item discrimination and imitation PEPS-C tasks, and these prosodic patterns are also the ones involved in the chunking and the focus tasks. Therefore, we suggest that poor discrimination of sound frequency, duration and rise time could explain the low results of the two groups of children with DLD on the long-item form tasks. In turn, difficulties for the processing of prosodic patterns (as shown in the results of the long-item form tasks) would explain why the children with DLD also performed significantly lower than their TD peers (even at chance) in chunking and focus, i.e., when the prosodic patterns are not presented alone but need to be used in a linguistic context to segment the speech chain or stress relevant information.

Our results in the function tasks with Spanish-speaking children are consistent with prior research focused on English-speaking children with DLD. Thus, the results obtained in turn-end and chunking are similar to those found with English versions of the PEPS-C test (Marshall *et al.* 2009, Well and Peppé 2003). Considering that these two functions are expressed through similar cues in Spanish and English (Martínez-Castilla and Peppé 2008a, Peppé *et al.* 2010), the consistence in results is to be expected. Similarly to the Spanish-speaking children with DLD, their English-speaking counterparts also present difficulties in focus comprehension (Marshall *et al.* 2009, Well and Peppé 2003). However, there are cross-linguistic differences in the way contrastive stress is expressed in English and Spanish (Martínez-Castilla and Peppé 2008a). Therefore, regardless of such differences, both English and Spanish-speaking children with DLD present difficulties in this prosodic function. Our findings in the affect tasks are also consistent with previous studies in which difficulties of English-speaking children with DLD for using emotional prosody have been highlighted (Fujiko *et al.* 2008). We therefore conclude that impairments in prosodic functions are present both in English-speaking and Spanish-speaking children with DLD, even though cross-linguistic differences exist in the way prosodic functions are used.

Difficulties in using prosody alone have also been found in prior studies conducted with children with DLD who speak other Germanic languages. In Dutch, Van der Meulen *et al.* (1997) found that children with DLD perform significantly less well in prosody imitation tasks than their TD peers matched by CA. The same has been found in Swedish-speaking children with DLD (Sundström *et al.* 2019). The study also found that the impairments presented by Swedish-speaking children with DLD when asked to repeat the lexical stress of words are observed for long words (4-5 syllables) but not for short ones (2-3 syllables). This suggests that problems in imitating prosodic cues may be due in part to the added problems of children with DLD in repeating segmental information, since they would need to invest more cognitive resources in decoding. In our work, significant between-group differences were found not only in the long-item imitation task but also in the short-item one (for the younger children). The latter task includes words of 1-3 syllables. We conclude, therefore, that the short-item imitation task impairments observed in the younger participants with DLD in our study cannot be accounted for solely by difficulties in repeating segmental information. The fact that we found impairments both in function and in form PEPS-C tasks leads us to conclude that, unlike what has been suggested in earlier research (Marshall *et al.* 2009), Spanish-speaking children with DLD present prosodic impairments not only when prosody interacts with language but also in the processing of prosody alone, as we have already highlighted.

In our study significant correlations were obtained between prosodic and other language skills in the participants with DLD. Our results, therefore, support the view that prosody, and lexicon and morpho-syntax, are related in children with DLD (e.g., Cumming *et al.* 2015, Richards and Goswami 2019). Another significant finding in our study is that the pattern of correlations differed between the DLD and TD groups, which corroborates earlier results (Sundström *et al.* 2019) and suggests that there are atypicalities in the way prosody relates to language in children with DLD. The significant correlations found in the present study, together with the fact that the Spanish-speaking children showed impairments in the processing of prosody alone, support the *prosodic phrasing hypothesis* (Cumming *et al.* 2015) that prosodic deficits could contribute to accounting for difficulties in language development.

The prosody difficulties of children with DLD reported in this study can have negative consequences for other language and socio-communication skills. Thus, the ability to segmentate the speech chain through prosodic means (assessed in the chunking tasks) is related to children's vocabulary levels (Newman *et al*. 2006). The skills assessed in the turn-end tasks are critical for both oral language comprehension and social interaction (Fujiki *et al.* 2008, Wells *et al.* 1995) and may contribute to accounting for the reading difficulties of children with DLD (Jordán *et al.* 2019). The focus tasks assess the ability to understand and produce contrastive stress, which serves a pragmatic function. When contrastive stress is not appropriately used, misunderstandings take place, imposing problems for social communication, which, in turn, may contribute to the difficulties children with DLD have when interacting with their peers (Conti-Ramsden 2013). Difficulties for the expression and understanding of affect through prosodic means (assessed in the affect tasks) could also contribute to their social problems (Fukijo *et al.* 2008). The children with DLD of this study presented impairments in all these prosodic areas, as already mentioned. Considering the negative impact of such impairments, intervention on prosodic skills should be given high importance in clinical contexts. We have argued that the difficulties of children with DLD to discriminate and produce prosodic forms (i.e., a lower processing-level) may explain their difficulties for using these forms in a meaningful way (i.e., a higher processing-level).

Therefore, we suggest that intervention programs could be first based on the training of prosody patterns discrimination and production, prior to working on the functional use of prosody.

To our knowledge, the present study is the first to evaluate a wide range of prosodic skills in Spanish-speaking children with DLD. However, our research also has some limitations that need to be mentioned. Firstly, the sample size of each of the age groups of children is small. Therefore, future research should increase the number of participants. This would increase the power and representativity of the study. A larger sample would also enable the children with DLD to be grouped according to their most impaired linguistic dimensions and enable us to conduct a more extensive analysis of the relationships between prosody and language. For similar reasons, including another control group of TD children matched by language level would also be of interest. In short, further, more extensive study is needed so that firmer conclusions can be drawn. Future studies could also include the assessment of other important prosodic functions, such as that of lexical stress, which is an area of difficulty reported in children with DLD who speak Germanic languages (e.g., Cumming *et al.* 2015, Richards and Goswami 2015, Sundström *et al.* 2019). Considering the potential explanatory role of a low sensitivity for basic auditory cues in the prosody difficulties of English-speaking children with DLD (Cumming *et al.* 2015, Richards and Goswami 2015), this would be another important area of research in Spanish-speaking children with DLD.

To conclude, this study shows that 5- to 11-year-old Spanish-speaking children with DLD present impairments both in prosodic functions and in prosodic forms. In other words, they present prosodic difficulties not only when prosody interacts with language but also for the processing of prosody alone, and the latter may account for the former. Our results also suggest that prosody is related to lexicon and grammar in children with DLD. The prosodic impairments of Spanish-speaking children with DLD would not only have a negative impact on their language functioning but could also contribute to the emotional and social difficulties they also present. Therefore, further interventions focused on prosodic skills in children with DLD should be considered.

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Table 1. Distribution of CA (in months) for the children with DLD and their peers with TD.

Children with DLD	TD children
55	63
63	66
63	66
66	70
66	73
67	74
68	78
73	78
75	80
79	91
95	94
97	95
98	96
98	97
100	105
119	113
133	131
134	132
136	141

Table 2. Mean and standard deviation (SD) for each group in age, non-verbal cognition and language ability tests.

	Children with DLD				TD children			
	Younger N = 10		Older N = 9		Younger N = 9		Older N = 10	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
CA (months)	67.50	6.84	112.22	18.03	72.00	6.10	109.50	18.63
Non-verbal IQ (K-BIT)	106.50	7.49	93.89	12.51	107.78	14.65	105.10	15.65
CEG Percentile***	14.80	17.60	10.22	7.93	51.67	23.18	64.00	24.70
Sentence repetition CELF Scaled score***	7.70	2.98	6.33	1.87	12.67	2.06	11.30	3.09
Receptive vocabulary IQ (PPVT-III)***	88.50	18.93	75.78	18.29	106.44	7.58	103.90	13.55
Expressive vocabulary (K-BIT) (raw score)***	20.40	4.77	32.00	4.69	28.78	2.68	36.90	4.91

Note. CA = Chronological age; K-BIT = Kaufman Brief Intelligence Test; CEG = Grammatical Structures Comprehension Test; CELF = Clinical Evaluation of Evaluation Language Fundamentals; PPVT-III = Peabody Picture Vocabulary Test. *** $p < .001$.

Table 3. Mean and standard deviation (SD) for each group on the PEPS-C tasks.

	Children with DLD				TD children			
	Younger		Older		Younger		Older	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Turn-end input	9.00***	1.76	11.00***	4.64	13.00	2.45	15.30	1.89
Turn-end output	11.00**	3.74	13.00**	2.50	14.56	1.74	15.30	1.34
Affect input	13.60*	3.20	15.44*	1.33	15.89	0.33	15.80	0.42
Affect output	13.20**	3.68	15.00**	1.32	15.89	0.33	16.00	0.00
Chunking input	9.10*	2.18	11.89*	2.42	11.44	2.01	13.80	3.16
Chunking output	10.00**	3.37	11.67**	2.87	13.00	0.87	13.50	1.65
Focus input	9.60***	2.72	9.89***	4.14	14.00	2.40	14.60	1.84
Focus output	3.60***	2.72	4.67***	2.65	8.33	3.67	10.70	4.27
Short-item discrimination	10.70+	2.16	13.22+	3.15	12.78	2.68	14.30	2.16
Short-item imitation	13.15***	2.03	15.39	0.99	15.56	1.16	15.85	0.24
Long-item discrimination	8.40**	1.07	12.11**	3.14	11.00	2.55	13.70	2.06
Long-item imitation	10.00***	4.06	11.28***	3.24	13.83	2.37	15.05	0.98

Note: Maximum score in each task is 16. Significant differences between the DLD and TD groups are shown. * $p < .05$, ** $p < .01$, *** $p < .001$, $^{+}$ $p < .10$

Table 4. Pearson correlations between prosodic skills and other language abilities in the typically developing children.

	Grammar reception (CEG)	Sentence repetition (CELF)	Vocabulary reception (PPVT-III)	Vocabulary expression (K-BIT)
Turn-end input	0.60**	0.47*	0.59**	0.52*
Turn-end output	0.57*	0.37	0.36	0.26
Affect input	-0.36	-0.34	-0.10	-0.33
Affect output	0.11	0.07	0.05	0.00
Chunking input	0.67**	0.45	0.59**	0.63**
Chunking output	0.14	0.17	0.24	0.16
Focus input	0.58**	0.56*	0.36	0.32
Focus output	0.60**	0.44	0.44	0.44
Short-item discrimination	0.71**	0.71**	0.60**	0.58**
Short-item imitation	0.38	0.39	0.30	0.20
Long-item discrimination	0.59**	0.55*	0.55**	0.61**
Long-item imitation	0.59**	0.54*	0.44	0.40

Note. CEG = Grammatical Structures Comprehension Test*;* CELF = Clinical Evaluation of Evaluation Language Fundamentals; PPVT-III = Peabody Picture Vocabulary Test; K-BIT = Kaufman Brief Intelligence Test; * $p < .05$; ** $p < .01$.

Table 5. Pearson correlations between prosodic skills and other language abilities in the children with developmental language disorder.

	Grammar reception (CEG)	Sentence repetition (CELF)	Vocabulary reception (PPVT-III)	Vocabulary expression (K-BIT)
Turn-end input	0.18	0.23	0.20	0.41
Turn-end output	0.47*	0.37	0.53*	0.58**
Affect input	0.60**	0.41	0.56*	0.51*
Affect output	0.51*	0.35	0.33	0.42
Chunking input	0.52*	0.37	0.42	0.60*
Chunking output	0.37	0.26	0.31	0.40
Focus input	-0.08	0.04	0.15	0.24
Focus output	0.14	0.28	0.15	0.26
Short-item discrimination	0.34	0.34	0.42	0.40
Short-item imitation	0.69**	0.51*	0.66*	0.75*
Long-item discrimination	0.46*	0.71**	0.68**	0.78**
Long-item imitation	0.37	0.65**	0.55*	0.48*

Note. CEG = Grammatical Structures Comprehension Test; CELF = Clinical Evaluation of Evaluation Language Fundamentals; PPVT-III = Peabody Picture Vocabulary Test; K-BIT = Kaufman Brief Intelligence Test; * $p < .05$; ** $p < .01$.