Reading prosody development in Spanish children

Marta Álvarez-Cañizo · Paz Suárez-Coalla · Fernando Cuetos

Published online: 9 August 2017
© Springer Science+Business Media B.V. 2017

Abstract Reading prosody is considered one of the essential markers of reading fluency, alongside accuracy and speed. The aim of our study was to investigate how development of reading prosody in Spanish children varies with sentence type and length. We compared primary school children from the third and fifth grades with an adult sample. Participants were recorded reading aloud a narrative text including short and long declarative, exclamatory and interrogative sentences. Recordings were analysed using Praat software to measure several prosodic features (i.e., pauses, duration, pitch and intensity). We found that third-grade children had not yet developed an adult-like prosody: they made more pauses, had a flatter melodic contour and had difficulty anticipating sentence structure. Fifth-graders displayed some features of adult prosody. Both length and type of sentence influenced the expressiveness of reading in the three groups. We conclude that reading expressiveness is closely related to reading experience and develops in a similar way to decoding and reading speed.

Keywords Reading prosody · Spanish children · Sentence length · Type of sentence

Introduction

Reading prosody or expressiveness is considered one of the markers of reading fluency, alongside speed (automaticity) and accuracy (Kuhn, Schwanenflugel, & Meisinger, 2010; Kuhn & Stahl, 2003; National Reading Panel, 2000; Rasinski,
Dowhower (1991) described six prosodic features related to expressive reading: intrusive pauses, phrase length, alignment of phrasing with syntactic structure, lengthening of the final phrase, terminal intonation contours and stress; all of them may be considered suprasegmental features. A similar set of variables was proposed by Schwanenflugel, Hamilton, Wisenbaker, Kuhn, and Stahl (2004): length of inter- and intra-sentence pauses, variation in inter-sentence pauses, final pitch declination and sentence pitch. Schwanenflugel and Benjamin (2012) suggested that the main prosodic variables were pausing, vowel duration and sentence pitch. Pauses are indicated by spectrographic silence and include hesitations and stammering during oral reading (Schwanenflugel & Benjamin, 2012). Vowel duration is used as a measure of final-phrase-lengthening as the final vowel of a sentence is typically longer than a non-final vowel (Dowhower, 1987, 1991; Klatt, 1975, 1976; Wightman, Shattuck-Hufnagel, Ostendorf, & Price, 1992). With regard to pitch, declarative and interrogative sentences each have a characteristic melodic contour that focuses on the pitch of the initial and final parts of the sentence (Benjamin & Schwanenflugel, 2010; Miller & Schwanenflugel, 2006; Schwanenflugel & Benjamin, 2012).

There are some scales for measuring prosody as an aspect of reading fluency, for example as the National Assessment of Educational Progress Scale (Pinnell et al., 1995), the Allington scale (Allington, 1983), the various versions of the Multidimensional Fluency Scale designed by Rasinski et al. (Rasinski, Rikli, & Johnston, 2009; Rasinski, 2004; Zutell & Rasinski, 1991) and the Oral Reading Fluency Scale from the Dynamic Indicators of Basic Early Literacy Skills (DIBELS-ORF; Kame’enui et al., 2006). The Comprehensive Oral Reading Fluency Scale (Benjamin et al., 2013) is a more recent instrument and consists of two subscales: automaticity and expression. All these scales are subjective in nature, but may be useful for schools as they are quick to administer and score. However, computer programs such as Praat (Boersma & Weenink, 2015) enable spectrographic analysis of oral reading and allow changes in pitch, amplitude and other voice features to be studied. This kind of analysis is based on objective parameters and thus provides a more rigorous assessment of the subject’s prosody.

It has often been assumed that appropriate use of prosody is transferred from spontaneous speech to oral reading (Dowhower, 1991; Schwanenflugel, Westmoreland, & Benjamin, 2015). Prosody is one of the first features of language children perceive: one study found that babies aged between three and ten months of age showed sensitivity to prosodic features both in their responses to speech and in spontaneous babbling (Crystal, 1986). The use and comprehension of prosody continues to develop during the primary school years (Myers & Myers, 1983). The development of expressive and receptive prosody in primary school children correlates with the development of other language skills, i.e., grammatical understanding and production (Wells, Peppé, & Goulandris, 2004). It has been shown, however, that speech and reading differ with respect to some prosodic features (Blaauw, 1994, 1995; Howell & Kadi-Hanifi, 1991). Blaauw (1994) found that pauses and syllable lengthening before a boundary were related to syntactic structure in reading, but not in speech. Speech also seemed to consist of simpler syntactic structures and involve more grammatical errors than reading. Clearly
when children are reading they need to interpret the writer’s intention in the syntactic phrases, and when they are telling a story they need to construct sentences from scratch.

Adult prosody emerges once a child’s word- and text-level decoding has become automatic (Miller & Schwanenflugel, 2006), so one of the important questions that needs answering relates to the moment children achieve a mature prosodic style. Schwanenflugel et al. (2004) investigated the relationship between decoding skills and reading prosody in second- and third-grade children. They found that differences in pausing and phrase-ending pitch were related to decoding skills. Good decoders made short pauses between sentences and ended declarative sentences with an adult-like fall in pitch whereas poor decoders made longer pauses and used a fairly level pitch at the end of sentences. Longitudinal research by Miller and Schwanenflugel (2008) in which children were followed from first to third grade produced similar results. The best readers, or decoders, made fewer intrusive pauses and had an adult pitch contour. However, it was not just decoding skills that affected prosody; the type of text and its features also influenced reading expressiveness. When second-grade children had to read a difficult (above their grade level) text aloud they made more pauses between words, but their pitch contour was not affected (Benjamin & Schwanenflugel, 2010). However, most studies of children’s reading prosody investigated the relationship between prosody and reading comprehension and linked mature prosody with better comprehension skills (Miller & Schwanenflugel, 2006, 2008). Miller and Schwanenflugel (2006) found that third-grade children who displayed an adult prosody (few, short pauses, pitch declinations in declarative sentences and pitch rises in interrogative sentences) tended to have better reading comprehension skills than peers with a less adult prosody. Rasinski, Rikli, and Johnston (2009) evaluated reading prosody and silent reading comprehension in third-, fifth- and seventh-grade children using the Multi-Dimensional Fluency Scale (Zutell & Rasinski, 1991) and the Stanford Achievement Test respectively. They showed that in all three grades evaluated, expressive reading was associated with a high level of silent reading comprehension. Studies of reading in other languages, such as Portuguese (Lopes, Silva, Spear-Swerling, & Zibulski, 2014) and Dutch (Veenendaal, Groen, & Verhoeven, 2014), found similar relationships between reading prosody and reading comprehension.

Spanish has a transparent orthography, which means that once children have learnt the grapheme-phoneme relationships it is easy for them to automate the decoding process; this means that Spanish children show about 95% accuracy in reading words after one year of learning to read, whereas in children learning to read opaque languages word-reading accuracy is about 35% at the same stage (Seymour, Aro, & Erskine, 2003). Spanish children’s decoding skills develop at an earlier stage, which makes the study of their reading prosody particularly interesting. To date most studies of Spanish prosody have been based on oral speech and tell us about the typical melodic contour of sentences. It is known that the intonation of declarative sentences is similar in Spanish and English, being characterised by a rise in pitch at the beginning of the sentence, followed by a decline (Martínez Celdrán, 2011; Navarro Tomás, 1944). In Spanish the intonation of absolute interrogative sentences is similar to that of declarative sentences, differing only at the end:
questions end with a rise in pitch (Cantero, De Araújo, Liu, Wu, & Zanatta, 2001; Martínez Celdrán, 2011; Navarro Tomás, 1944). Exclamatory sentences have a descending melodic contour, starting at a high pitch and being suspended (Canellada & Madsen, 1987).

There have been a few studies of Spanish reading prosody. González-Trujillo, Calet, Defior and Gutiérrez-Palma (2014) developed a Spanish Reading Fluency Scale based on the Multidimensional Fluency Scale that can be used to assess reading speed and accuracy and some prosodic features. There have also been some studies investigating suprasegmental phonology (i.e., lexical stress sensitivity, metrical stress sensitivity and productive non-linguistic rhythm) as part of prosody in skilled-readers (Calet, Gutiérrez-Palma, Simpson, González-Trujillo, & Defior, 2015) and dyslexic children (Jiménez-Fernández, Gutiérrez-Palma, & Defior, 2015; Shelton, Gerfen, & Gutiérrez Palma, 2012). Data from skilled child-readers showed that the development of prosody skills is not linear and that there is a relationship between prosody and reading development (Calet et al., 2015). Assessment of suprasegmental phonology in dyslexic children showed that they had not developed a stress awareness (Jiménez-Fernández et al., 2015; Shelton et al., 2012), despite of stress is very sensitive in Spanish (Shelton et al., 2012). There are also some spectrographic studies of Spanish children’s reading. Suárez-Coalla et al. (2016) studied reading prosody in dyslexic children and adults. In children they found differences between the dyslexic and control groups; the dyslexic group made more pauses and had a rather flat pitch contour, possibly due to their lack of automaticity in reading. There is also a spectrographic study of skilled Spanish readers that found an association between reading prosody and reading comprehension (Álvarez-Cañizo, Suárez-Coalla, & Cuetos, 2015) based measurements of pauses, pitch, duration and intensity. Children with better reading comprehension showed more of the features of adult prosody, making fewer inappropriate pauses and using an appropriate melodic contour in declarative, exclamatory and, particularly, interrogative sentences.

There are, however, no spectrographic studies tracking the development of prosody in Spanish children throughout the primary school years. In this study we investigated reading prosody and the influence of sentence length and type using objective parameters, comparing data from children in two primary school grades, third and fifth, and adults. The third and fifth grades are commonly used in studies with children because both are important grades in the learning to read process (Cunningham & Stanovich, 1990; Kyte & Johnson, 2006). Third grade is important because it is when children start to acquire the reading skills needed for fluency, whereas by fifth-grade children have developed these skills. We have seen that some studies connect children or adults from opaque languages with low reading skills (i.e., accuracy or speed) with a poor reading prosody (Binder et al., 2013; Miller & Schwanenflugel, 2008; Schwanenflugel et al., 2004). However, as Spanish is very transparent and children develop good decoding skills at a much earlier stage in the learning-to-read process than children from opaque languages, it seems that also a mature prosody could be achieved sooner, disappearing the differences with the adults sample in an early school grade. We also wanted to know if the type and length of sentences affected children’s reading prosody. One of the idiosyncratic features of Spanish is that orthographic
marks are placed at both beginnings of interrogative and exclamatory sentences (¿?; ¡!). Schwanenflugel, Westmoreland, and Benjamin (2015) have shown that children are sensitive to linguistic marks, changing their pitch and intensity when they come across exclamation marks, question marks, stress and other punctuation marks. This suggests that Spanish children may adjust their prosody to the type of sentence, as they will know what type of sentence they are reading as soon as they start to read it. We therefore prepared a text that included declarative, interrogative and exclamatory sentences. We analysed the prosodic features most commonly reported in the literature, namely pauses, duration, intensity and pitch changes.

Method

Participants

Forty children, 20 from third grade ($M_{age} = 8.7$ years, $SD = 0.31$), and 20 from fifth grade ($M_{age} = 10.6$ years, $SD = 0.2$) participated in this study. All were from a publicly funded primary school and had Spanish as their first language. Participants were selected based on their scores in the word- and pseudoword-reading subtests of PROLEC-R (Cuetos, Rodrı´guez, Ruano, & Arribas, 2007); only children whose scores were within the normal range for their age were included (see Table 1), so all of them were typical readers with a reading level according to their age. PROLEC-R is a standardised battery for the assessment of reading in Spanish children aged between 6 and 12 years. In addition 23 university students ($M_{age} = 20.7$ years, $SD = 3.6$) also participated; they constituted the reference group. None of the participants had developmental, behavioural or cognitive problems and, to avoid geographical differences in prosody, they were all from the same geographical area.

Materials

We used a narrative text consisting of 347 words divided into three paragraphs and entitled “Por qué algunos árboles conservan sus hojas en invierno [Why do some trees retain their leaves in winter?]” was used. The text included short (nine-
syllable) and long (nineteen-syllable) declarative sentences (i.e., “El pájaro fue a un roble [The bird went to an oak]”, “Los árboles me darán cobijo durante todo el invierno [The trees will shelter me all winter]”), interrogative sentences (i.e., “¿Puedo tirar todas las hojas? [Can I throw all the leaves?]”, “¿Podrémé quedarme a dormir aquí durante todo el invierno? [Can I sleep here all winter?]”)), and exclamatory sentences (i.e., “¡Qué amable eres abeto! [How kind of you fir]”, “¡Qué feliz estoy de tener tantos compañeros que me ayudan! [How happy I am to have so many friends who are willing to help me!]”). We did not vary the syntactic structure between short and long sentences. We tested the readability of the text with different parameters using FLESH and INFLESZ programs, in order to ensure the text was appropriate for both grades and adults. INFLESZ provides two scores: the Flesch-Szigriszt score (Szigriszt-Pazos, 1993; i.e., an index of the difficulty of comprehension of a document; range 0–100, where 100 indicates an extremely simple document, 0 a very complex document) and the Flesch Fernández Huerta score (Spanish adaptation made by Fernández-Huerta, 1959). The FLESH program also provides two scores: Flesch-Kincaid Grade Level (i.e., index of the years of education, following the American educational system, required to understand the text) and Flesch Reading Ease Score, similar to Flesh-Szigriszt score. The readability parameters for our experimental text were the following: Flesh-Szigriszt score = 78.44, Flesh Fernández-Huerta score = 82.70, Flesh-Kincaid Grade Level = 9.20 and Flesh Reading Ease Score = 53.34. However, only one of these scores is adapted to Spanish, the Flesh Fernández-Huerta score, which indicates the text is easy to understand; therefore, the other readability scores have to be taken with care, as they are constructed to assess American English documents and scholar grades.

**Procedure**

The task involved reading the text aloud, individually. The text was presented on paper in double-spaced, 12-point, Calibri font and none of the target sentences was split across two lines. Children read in a quiet room at their school and adults in a quiet room in the Basic Psychology Laboratory.

Readings were recorded using an H4n voice recorder and an Ht2-P Audix headset dynamic microphone. Audio recordings were processed offline using Praat software (Boersma & Weenink, 2015). Praat is a free computer software package for the scientific analysis of speech in phonetics. It allows us to divide the whole text into smaller units, such as sentences, words, syllables or phonemes, and then extract information about pitch, intensity or duration. We analysed prosodic parameters in the target sentences cited above and in one complete paragraph. We automated the Praat analysis process in Praat using a combination of published scripts, such as the procedure for extracting pitch information in two passes (Atria, 2014), and a script for creating pictures (Elvira García & Roseano, 2014), and specially written scripts. The data obtained from Praat were subjected to statistical analyses using R (R Core Team, 2016). The parameters analysed were those generally used in research in this field:
- Pauses: number and duration (ms) of the pauses in the extracted paragraph
  - Before a full stop.
  - Before a comma.
  - Between words i.e., pauses made in the absence of a grammatical mark indicating a break.
  - Within words i.e., pauses made inside a word.

- Duration:
  - Sentence (ms): duration of a sentence.
  - Syllables (ms): durations of the first and last syllables; duration of the intermediate syllables.

- Pitch variables:
  - Initial rise (St): the difference in pitch between the first trough and the first peak in the pitch contour of the sentence; declarative and interrogative sentences only.
  - Final rise (St): the difference in pitch between the last trough and the end of an interrogative sentence.
  - Slope (St/s): the difference in pitch between the first peak and the end of the sentence, divided by the time between the first peak and the end of the sentence.
  - Syllables (St): the mean pitch of the first, last and intermediate syllables.

- Intensity variables:
  - Syllables (dB): the mean intensity of the first, last and intermediate syllables.

**Results**

First, we summed the number of mistakes—mispronunciations, regressions, word omissions or word insertions—made by each group. Third-grade children made more mistakes per target sentence \( (M = 2, SD = 0.33) \) than fifth-grade children \( (M = 1, SD = 0.2) \) or adults \( (M = 0.39, SD = 0.49) \).
Pauses

Only pauses exceeding 100 ms were included in the analysis. The total number of pauses was greater in third-grade children ($M = 2.23; SD = 2.39$) than in fifth-grade children ($M = 1.65; SD = 1.65$) or adults ($M = 1.42; SD = 1.42$). Pause durations were also longer in third-graders ($M = 527.83; SD = 330.99$) than in fifth-graders ($M = 451.10; SD = 271.10$) or adults ($M = 305.54; SD = 202.10$). Table 2 presents detailed information about pauses, organised by group. We used ANOVAs to compare the number and duration of different types of pause in the three groups. The independent variables were group (third-grade; fifth-grade; adult) and type of pause (before full stop; before comma; between words; within word) and the dependent variables were the number and duration of the pauses. There were interactions between group and type of pause with respect to both number of pauses ($F(2240) = 9.985, p < .001$) and pause duration ($F(6159) = 2.961, p = .009$). Post hoc Tukey analyses were used to investigate group differences further. We found that adults made fewer between-word pauses than third-graders ($p < .001$) and fifth-graders ($p = .006$). Pauses before full stops were shorter in adults than in third-graders ($p < .001$) and fifth-graders ($p = .007$). Pauses before commas were also shorter in adults than in third-graders ($p = .013$) and pauses between words were marginally shorter in adults than in third-grade children ($p = .055$).

Group comparisons of other prosodic parameters were made using a mixed-effects modelling design, as the study used a repeated measures design (i.e., the same items were presented to multiple participants). These analyses required estimates of both fixed effects, i.e., replicable effects of theoretical interest (prosodic parameters i.e., duration, pitch variables and intensity variables) and random effects, i.e., unexplained, random variation between participants (Baayen, 2008; Baayen, Davidson, & Bates, 2008). We used the Tukey adjustment in post hoc analyses of main effects and interactions.

|                      | Third grade children | Fifth grade children | Adults         |
|----------------------|----------------------|----------------------|----------------|
|                      | Mean number $M$      | Mean duration $M$    |                |
|                      | (SD)                 | (SD)                 |                |
| Before full stop     | 2.9 (0.4)            | 755.8 (448.1)*       | 3 (0)          |
|                      |                      | 692.9 (269.2)*       | 3 (0)          |
|                      |                      | 493.8 (120.4)        |                |
| Before comma         | 0.9 (0.5)            | 343.7 (249.1)*       | 0.55 (0.5)     |
|                      |                      | 164.6 (187.8)        | 0.87 (0.6)     |
|                      |                      |                      | 219.3 (167.8)  |
| Between words        | 4.9 (2.3)            | 347.5 (136.5)*       | 2.9 (1.9)*     |
|                      |                      | 297.2 (130.3)        | 1.83 (1.2)     |
|                      |                      |                      | 203 (139.8)    |
| Within words         | 0.3 (0.9)            | 47.8 (123.3)         | 0.15 (0.5)     |
|                      |                      | 18.05 (55.6)         | 0 (0)          |
|                      |                      |                      |                |

* Significant difference ($p < .05$) relative to adult group
  · Near-significant difference ($p < .05$) relative to adult group
Sentence duration

Analysis of sentence duration suggested that the best model, with the lowest AIC, was: \( ms \sim \text{group} * \text{sentence} * \text{length} + (\text{group} + \text{sentence} + 1|\text{subject}) \). There were main effects of group \((p < .001)\): third-graders took longer to read the sentences than fifth-graders and adults, sentence \((p = .003)\): declarative sentences were read more slowly than the other sentence types, and length \((p < .001)\): short sentences took less time to read than long ones. There were also interactions between group and sentence length \((p < .001)\): the length effect was bigger in third-graders than in the other groups, between sentence and length \((p < .001)\): there were significant differences among the type of sentences only in long sentences, and between group and sentence \((p < .001)\): the third-graders took longer to read declarative sentence than exclamatory or interrogative sentences, whereas adults and fifth-grade groups took similar lengths of time to read all sentence types (see Table 3).

Initial pitch rise

We analysed the initial rise in pitch in declarative and interrogative sentences. The final model was: \( \text{St} \sim \text{group} * \text{sentence} * \text{length} + (\text{sentence} + \text{length} + 1|\text{subject}) \). There was a sentence effect \((p < .001)\): the initial rise in pitch was bigger in interrogative sentences than in declarative sentences. There were also interactions between sentence and length \((p = .002)\): the length effect was only observed in interrogative sentences, and between group and sentence \((p < .001)\): the sentence effect was only found in third- and fifth-grade children (see Table 4).

|                | Estimate | SE  | T value | Pr (>|t|) |
|----------------|----------|-----|---------|----------|
| Adults         |          |     |         |          |
| Declarative-exclamatory | –0.053   | 0.113 | –0.469  | >.998    |
| Declarative-interrogative | –0.059   | 0.106 | –0.550  | >.998    |
| Exclamatory-interrogative | –0.006   | 0.076 | –0.073  | =1.000   |
| Short-Long     | –1.209   | 0.061 | –19.708 | <.001*   |
| Third grade    |          |     |         |          |
| Declarative-exclamatory | 0.571    | 0.125 | 4.579   | <.001*   |
| Declarative-interrogative | 0.715    | 0.118 | 6.070   | <.001*   |
| Exclamatory-interrogative | 0.143    | 0.081 | 194.96  | =0.712   |
| Short-Long     | –2.209   | 0.068 | –32.604 | <.001*   |
| Fifth grade    |          |     |         |          |
| Declarative-exclamatory | 0.068    | 0.124 | 0.545   | =.998    |
| Declarative-interrogative | 0.027    | 0.117 | 0.228   | =1.000   |
| Exclamatory-interrogative | –0.041   | 0.083 | –0.041  | =.999    |
| Short-Long     | –1.550   | 0.068 | –22.914 | <.001*   |

Table 3 Post hoc analysis of the group by sentence interaction with respect to sentence duration
Analyses of the final rise in pitch in interrogative sentences (final model: St ~ group * length + (1|subject)) showed no effect of group or sentence length, although the group difference approached significance ($p = .057$): whilst the change in pitch was similar in fifth-graders and adults, third-graders had a lower final pitch than adults (Table 5).

### Final pitch rise in interrogative sentences

Analyses of the final rise in pitch in interrogative sentences (final model: St ~ group * length + (1|subject)) showed no effect of group or sentence length, although the group difference approached significance ($p = .057$): whilst the change in pitch was similar in fifth-graders and adults, third-graders had a lower final pitch than adults (Table 5).

### Pitch slope

Analyses of pitch slope resulted in the following final model: St ~ group * sentence * length + (sentence + 1|subject). There were effects of group ($p < .0001$): adults had a steeper pitch slope than fifth- and third-grade children, sentence ($p = .001$): because of the prosodic characteristics of sentences, exclamatory sentences had a shallower pitch slope than declarative and interrogative sentences, and length ($p < .0001$): short sentences had a steeper pitch slope. There were also interactions between sentence and length ($p < .001$): the length effect was

### Table 4: Post hoc analysis of the group by sentence interaction in the initial pitch rise in declarative and interrogative sentences

| Group          | Interaction          | Estimate | SE   | T value | Pr (>|t|) |
|----------------|----------------------|----------|------|---------|----------|
| Adults         | Declarative – interrogative | -0.337   | 0.599| -0.563  | =.993    |
| Third grade    | Declarative – interrogative | -3.431   | 0.652| -5.266  | <.001*   |
| Fifth grade    | Declarative – interrogative | -2.338   | 0.659| -3.549  | =.009*   |

### Table 5: Post hoc analysis of the marginal effect of group on final pitch rise in interrogative sentences

| Group          | Estimate | SE   | T value | Pr (>|t|) |
|----------------|----------|------|---------|----------|
| Adults – third grade | 4.641    | 2.246| 2.067   | =.043*   |
| Adults – fifth grade  | 0.462    | 2.250| 0.205   | =.838    |

### Table 6: Post hoc analysis of the group by sentence interaction with respect to pitch slope

| Type   | Group          | Estimate | SE   | T value | Pr (>|t|) |
|--------|----------------|----------|------|---------|----------|
| Declarative   | Adults - third grade | 10.985   | 1.907| 5.761   | <.001*   |
|            | Adults - fifth grade | 3.133    | 1.930| 1.930   | =.788    |
|            | Third grade - fifth grade | -7.851  | 2.003| -3.191  | =.007*   |
| Exclamatory | Adults - third grade | 7.446    | 2.392| 3.114   | =.065    |
|            | Adults - fifth grade | 7.433    | 2.401| 3.096   | =.068    |
|            | Third grade - fifth grade | -0.0134 | 2.483| -0.005  | =1.000   |
| Interrogative| Adults - third grade | 9.717    | 2.036| 4.772   | <.001*   |
|            | Adults - fifth grade | 5.452    | 2.060| 2.646   | =.190    |
|            | Third grade - fifth grade | -4.265  | 2.141| -1.992  | =.555    |
only observed in declarative and interrogative sentences, and between group and sentence \((p = .049)\): fifth-grade children and adults had similar pitch slopes, whereas third-graders had different pitch slopes from adults in declarative and interrogative sentences (see Table 6).

**Syllable analysis**

Finally, we analysed variation in the duration, pitch and intensity of syllables. We compared the data from first syllables, last syllables and intermediate syllables. Analysis of syllable duration data produced a best model: \(ms \sim \text{group} * \text{position} + (\text{length} + \text{position} + 1|\text{subject}) + (\text{group} + 1|\text{item})\). We found effects of group \((p < .0001)\) and position \((p < .0001)\). There was also a group by position interaction \((p = .0001)\), reflecting the lack of lengthening of the final syllable relative to the initial syllable in third-grade children (see Table 7).

Second, we analysed the pitch of the syllables, producing the following final model: \(St \sim \text{group} * \text{sentence} * \text{length} + (\text{sentence} + 1|\text{subject}) + (\text{sentence} + 1|\text{item})\). We only considered effects and interactions involving position as our interest was limited to changes in pitch across syllables. There was a group by position interaction \((p < .0001)\) reflecting a reduction in the size of the position effect in third-grade children. There were also three-way group by sentence by position interaction \((p < .001): only adults showed a decrease in pitch in the final syllable of declarative sentences, and a group by length by position interaction \((p = .012): the position effect was only observed in short sentences read by adults.

Third, we carried out analyses of syllable intensity; the best model was: \(\text{dB} \sim \text{group} * \text{sentence} * \text{length} * \text{position} + (\text{group} + \text{sentence} + \text{length} + 1|\text{subject}) + (\text{sentence} + 1|\text{item})\). We found main effects of group \((p < .001): syllable intensity was greater in adults than in the other groups, and position \((p < .001): intensity was lower in the final syllable. There were also interactions between group and position \((p < .001): only adults and fifth-graders showed a difference in intensity between the first and the last syllables of sentences, and between sentence and position \((p = .007): declarative sentences were differently

---

**Table 7** Post hoc analysis of the group by syllable position interaction with respect to syllable duration

| Group            | Syllable Type                  | Estimate | SE  | T value | Pr (> |f|)   |
|------------------|--------------------------------|----------|-----|---------|---------|
| Adults           | Initial-intermediate syllables | 0.031    | 0.006 | 4.811   | <.001*  |
|                  | Initial-final syllable         | -0.021   | 0.009 | -2.223  | =.395   |
| Third grade      | Intermediate -final syllable   | -0.052   | 0.007 | -7.708  | <.001*  |
|                  | Initial-intermediate syllables | 0.057    | 0.008 | 7.019   | <.001*  |
|                  | Initial-final syllable         | 0.026    | 0.011 | 2.319   | =.333   |
| Fifth grade      | Intermediate -final syllable   | -0.031   | 0.008 | -3.981  | =.003*  |
|                  | Initial-intermediate syllables | 0.037    | 0.006 | 5.753   | <.001*  |
|                  | Initial-final syllable         | -0.019   | 0.009 | -2.067  | <.001*  |
|                  | Intermediate -final syllable   | -0.056   | 0.007 | -8.230  | <.001*  |
Fig. 1  Examples of the pitch contour of declarative, exclamatory and interrogative sentences in third-grade children (a), fifth-grade children (b) and adults (c)
affected by the position effect. There were also three-way interactions between group, sentence and length ($p = .003$): in third-graders the length effect was greater in exclamatory and interrogative sentences than in declarative sentences, and between group, sentence and position ($p = .003$): in third-grade children the position effect was smaller in declarative and interrogative sentences than in exclamatory sentences, and between group, length and position ($p = .032$): third-grade children did not show a position effect when reading long sentences (Fig. 1).

Discussion

The aim of this study was to compare the reading prosody of third- and fifth-grade children and adults, looking at the effects of sentence type and length. To do this we prepared a narrative text including short and long declarative, exclamatory and interrogative sentences for the three groups to read aloud. We analysed several prosodic parameters. In general terms the children’s groups did not display mature prosody; however some features of fifth-grade children’s prosody were similar to adult prosody, whereas the third-grade children’s prosody was strikingly different.

The main differences between children’s and adults’ pauses were in the mean duration of pauses before full stops and between words, which were longer in children than adults. Third-grade children also made more inappropriate pauses and made longer pauses before commas. There is evidence that readers with good prosody use punctuation as a guide to pause and for how long, whilst non-fluent readers often make long pauses or pause too frequently and at inappropriate times (Benjamin et al., 2013; Clay & Imlach, 1971; Miller & Schwanenflugel, 2006). Children’s more frequent pausing could be due to their lack of reading experience. It seems that, although the reading skills previously measured (i.e., accuracy and speed in reading words and pseudowords) were appropriate for both grades, they were not yet as developed as adults reading skills, and it made them pause more often.

We manipulated sentence length in order to see if it affected expressiveness in the same way as complexity and syntactic structure do (Benjamin & Schwanenflugel, 2010; Miller & Schwanenflugel, 2006). We observed a length effect in our sample: there were differences in the pitch slope of short and long sentences, with long sentences having a flatter pitch contour at the end. The sentence length effect was bigger in third-graders’ sentence duration and children had flatter pitch and intensity contours in long sentences than in short sentences. This could be because children could not anticipate the end of the sentences and were therefore unable to adjust their expressiveness in accordance with the length and structure of the sentence.

We also manipulated sentence type, as Spanish has orthographic marks at both ends of exclamatory and interrogative sentences. This means that the reader has a cue to the type of sentence (declarative, exclamatory or interrogative) at its start. In the case of declarative sentences we did not find group differences in the rise in pitch at the beginning of the sentence. This may be because declarative sentences are the type of sentence children encounter most often when reading and hence they
learn to read them with appropriate prosody at a very early stage. However, the pitch slope was shallower in third-grade children, reflecting the fact that their melodic contour was flatter in these sentences, lacking the terminal decrease in pitch shown by adults and older children. This result corroborates the findings of other studies that have investigated the decline in pitch at the end of sentences as a marker of adult prosody (Benjamin et al., 2013; Clay & Imlach, 1971; Dowhower, 1987; Schwanenflugel et al., 2004). When reading interrogative sentences fifth-graders had a similar pitch contour to adults, with a final rise. In contrast third-grade children did not show this final rise; instead they left a suspended pitch, once again displaying a flat melodic contour at the end of the sentence. This pattern has been observed in other languages, for example in English only those skilled readers showed a rise in pitch at the end of yes–no questions (Schwanenflugel & Benjamin, 2012). Exclamatory sentences were read similarly by both children’s groups, as in adults pitch decreased across the sentence. Besides, children and especially third graders made fewer changes in the pitch considering the syllable position. This means that their melodic contour was also flat at the end of exclamatory sentences. It seems that children started to read them using appropriate expressive modulation, but the less experienced readers (third-graders) were unable to maintain appropriate expressive modulation. This could be due to lack of reading experience, as fifth-grade children showed a pitch contour similar to that of adults. Both children’s groups had a flat melodic contour at the end of exclamatory sentences, reflecting a reduction in final pitch fall relative to adults. This may be because this type of sentence appears relatively infrequently in the texts children of this age usually read, and so they had not yet developed the appropriate prosody. In spite of the fact that Spanish has also initial exclamatory and question marks (¡), we did not find a sooner adult-like prosody development in these kind of sentences in our study than those found in English studies (Schwanenflugel & Benjamin, 2012, Miller & Schwanenflugel, 2006).

Sentence duration was longer in children than adults, again it seems likely that their lack of reading experience means that they need more time for decoding. We also found that unlike adults and fifth-graders, third-grade children did not lengthen the final syllable of sentences. This lengthening of the final syllable of a phrase is one of the essential prosodic features of fluent reading (Dowhower, 1991) and is observed in good, expressive readers (Smith, 2004). Until now, however, it was not clear how this prosodic feature develops, in particular whether it develops naturally or is taught (Schwanenflugel & Benjamin, 2012). We can add some new information relevant to this; the third-grade children in our sample had not yet developed this final-syllable lengthening. We suggest that final-syllable lengthening develops in parallel with other features of fluent reading features, such as expressive intonation, as children’s reading experience increases.

Our results seem to indicate that reading prosody development takes place similarly in transparent and opaque languages, as we have also found that third-grade children have not reached a mature prosody (Schwanenflugel et al., 2004). We have seen that, after one year of learning-to-read process, children have a 95% of accuracy when reading words (Seymour et al., 2003). However, it seems that good decoding skills are not enough for third-graders to achieve an adult prosody, being
also necessary a wider reading experience. Therefore, we could think that a language with transparent orthography, despite being easy to read with accuracy, does not make easier the development of reading prosody comparing with opaque languages.

In summary, this study provides new evidence about the development of reading prosody in Spanish primary school children. This study confirms that reading prosody develops is linked to the accumulation of reading experience. Children with less reading experience (third-graders) did not display an adult prosody, whereas children with more experience of reading (fifth-graders) did display some of the features of adult prosody. It seems that more speed and accuracy in reading leaves attention resources to be free for prosodic reading. Besides, the initial marks in exclamatory and interrogative sentences did not facilitate an adult-like prosody development in comparison with other languages, which do not have them. Moreover, our study analysed exclamatory sentences, which are a type of sentences not so studied in other languages, usually focused only in declarative and interrogative sentences. Our study is of relevance to teachers who are interested in evaluating their students’ reading development, as it provides new information about expressiveness in reading, which is a little-studied aspect of skilled reading. On the basis of our findings we recommend that teachers place more emphasis on teaching expressive reading. Our findings suggest that advanced readers would display a reading prosody very similar to that of adults. The next step in this research is to investigate prosody in children in other school grades, in order to determine exactly when children achieve the expressive skills required for fluent reading.

Acknowledgements This study was funded by Grant PSI2015-64174-P from the Spanish Government and supported by the predoctoral grant BP14-038 from the Foundation for the Promotion of Applied Scientific Research and Technology in Asturias (FICYT).

References

Allington, R. L. (1983). Fluency: The neglected reading goal. *The reading teacher, 36*(6), 556–561.

Álvarez-Cañizo, M., Suárez-Coalla, P., & Cuetos, F. (2015). The role of reading fluency in children’s text comprehension. *Frontiers in psychology, 6*, 1810. doi:10.3389/fpsyg.2015.01810/full.

Atria, J. J. (2014). Generate pitch object using utterance-specific thresholds: Using Hirst and Delooze’s s two-pass method [Praat script]. Retrieved from: https://github.com/jjatria/plugin_jjatools.

Baayen, R. H. (2008). *Analyzing linguistic data: A practical introduction to statistics*. Cambridge: Cambridge University Press.

Baayen, R. H., Davidson, D. J., & Bates, D. M. (2008). Mixed-effects modeling with crossed random effects for subjects and items. *Journal of Memory and Language, 59*, 390–412. doi:10.1016/j.jml.2007.12.005.

Benjamin, R. G., & Schwanenflugel, P. J. (2010). Text complexity and oral reading prosody in young readers. *Reading Research Quarterly, 45*(4), 388–404. doi:10.1598/RRQ.45.4.2.

Benjamin, R. G., Schwanenflugel, P. J., Meisinger, E. B., Groff, C., Kuhn, M. R., & Steiner, L. (2013). A spectrographically grounded scale for evaluating reading expressiveness. *Reading Research Quarterly, 48*(2), 105–133. doi:10.1002/rrq.43.

Binder, K. S., Tighe, E., Jiang, Y., Kafkanski, K., Qi, C., & Ardoin, S. P. (2013). Reading expressively and understanding thoroughly: An examination of prosody in adults with low literacy skills. *Reading and Writing, 26*(5), 665–680. doi:10.1007/s11145-012-9382-7.
Blaauw, E. (1994). The contribution of prosodic boundary markers to the perceptual difference between read and spontaneous speech. *Speech Communication, 14*(4), 359–375.

Blaauw, E. (1995). *On the perceptual classification of spontaneous and read speech* (Doctoral dissertation). University of Utrecht.

Boersma, P., & Weenink, D. (2015). Praat: Doing phonetics by computer (Version 5.4.12) [Computer software]. Available from [http://www.praat.org/](http://www.praat.org/).

Calet, N., Gutiérrez-Palma, N., Simpson, I. C., González-Trujillo, M. C., & Defior, S. (2015). Suprasegmental phonology development and reading acquisition: A longitudinal study. *Scientific Studies of Reading, 19*(1), 51–71. doi:10.1080/10888438.2014.976342.

Canellada, M. J., & Madsen, J. K. (1987). *Pronunciación del español: lengua hablada y literaria* [Spanish pronunciation: spoken and literay language]. Madrid: Editorial Catalia.

Cantero, F. J., De Araújo, M. A., Liu, Y.-H., Wu, Y.-K., & Zanatta, A. (2001). *Patrones melódicos de la entonación interrogativa del español en habla espontánea* [Melodic patterns of the Spanish interrogative intonation in spontaneous speech]. Paper presented at the meeting of the II Congreso de Fonética Experimental, Sevilla (Spain).

Clay, M. M., & Imlach, R. H. (1971). Juncture, pitch, and stress as reading behavior variables. *Journal of Verbal Learning and Verbal Behavior, 10*(2), 133–139. doi:10.1016/S0022-5371(71)80004-X.

Crystal, D. (1986). *Prosodic development*. In P. Fletcher & M. Garman (Eds.), *Language acquisition* (pp. 33–48). Cambridge: Cambridge University Press.

Dowhower, S. L. (1987). Effects of repeated reading on second-grade transitional readers’ fluency and comprehension. *Reading Research Quarterly, 22*(4), 389–406.

Dowhower, S. L. (1991). Speaking of prosody: Fluency’s unattended bedfellow. *Theory Into Practice, 30*(3), 165–175.

Elvira García, W., & Roseano, P. (2014). *Create pictures with tiers v.4.1* (Praat script). Retrieved from: [http://stel.ub.edu/labfon/en/praat-scripts](http://stel.ub.edu/labfon/en/praat-scripts).

Kame'enui, E. J., Fuchs, L., Francis, D. J., Good, R. I., O’Connor, R. E., Simmons, D. C., et al. (2006). The adequacy of tools for assessing reading competence: A framework and review. *Educational Researcher, 35*(4), 3–11. doi:10.3102/0013189X035004003.

Klatt, D. H. (1975). Vowel lengthening is syntactically determined in a connected discourse. *Journal of Phonetics, 3*(3), 129–140.

Klatt, D. H. (1976). Linguistic uses of segmental duration in English: Acoustic and perceptual evidence. *The Journal of the Acoustical Society of America, 59*(5), 1208–1221.

Kuhn, M. R., Schwanenflugel, P. J., & Meisinger, E. B. (2010). Aligning theory and assessment of reading fluency: Automaticity, prosody, and definitions of fluency. *Reading Research Quarterly, 45*, 230–251. doi:10.1598/RRQ.45.2.4.

Kuhn, M. R., & Stahl, S. (2003). Fluency: A review of developmental and remedial practices. *The Journal of Educational Psychology, 95*, 3–21. doi:10.1037/0022-0663.95.1.3.

Lopes, J., Silva, M. M., Spear-Swerling, L., & Zibulski, J. (2014). Evolução da prosódia e compreensão da leitura: Um estudo longitudinal do 2º ano ao final do 3º ano de escolaridade [Prosody growth and...
reading comprehension: A longitudinal study from 2nd through the end of 3rd grade. *Journal of Psychodidactics*. doi:10.1387/RevPsicodidact.11196.

Martínez Celdrán, E. (2011). La línea melódica de la entonación declarativa e interrogativa absoluta en el español de España [The melodic curve from declarative and absolute interrogative intonation in the Spanish from Spain]. In A. Hidalgo, Y. Cogosto, & M. Quilis (Eds.), *El estudio de la prosodia en España en el siglo XXI: perspectivas y ámbitos* [The study of Spanish prosody in the XXI century] (pp. 125–140). Valencia (Spain): Universitat de València.

Miller, J., & Schwanenflugel, P. J. (2006). Prosody of syntactically complex sentences in the oral reading of young children. *Journal of Educational Psychology, 98*(4), 839–843. doi:10.1037/0022-0663.98.4.839.

Miller, J., & Schwanenflugel, P. J. (2008). A longitudinal study of the development of reading prosody as a dimension of oral reading fluency in early elementary school children. *Reading Research Quarterly, 43*(4), 336–354. doi:10.1598/rrq.43.4.2.

Myers, F. L., & Myers, R. W. (1983). Perception of stress contrasts in semantic and nonsemantic contexts by children. *Journal of Psycholinguistic Research, 12*(3), 327–338.

National Reading Panel (2000). *Report of the National Reading Panel. Teaching children to read: An evidence-based assessment of the scientific research literature on reading and its implications for reading instruction. Reports of the subgroups*. Washington, DC: U.S. Government Printing Office.

Navarro Tomás, T. (1944). *Manual de entonación española* [Manual of Spanish intonation]. New York: Hispanic Institute in the United States.

Pinnell, G., Pikulski, J., Wixson, K., Campbell, J., Gough, P., & Beatty, A. (1995). Listening to children read aloud: Data from NAEP’s integrated reading performance record (IRPR) at grade 4 (NCES Publication No. NCES 1995-726). Washington, DC: US Government Printing Office.

R Core Team (2016). R: A language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing (version 3.3.2) [Computer program]. Retrieved from https://www.R-project.org/.

Rasinski, T. V. (2004). *Assessing reading fluency*. Honolulu, HI: Pacific Resources for Education and Learning.

Rasinski, T., Rikli, A., & Johnston, S. (2009). Reading fluency: More than automaticity? More than a concern for the primary Grades? *Literacy Research and Instruction, 48*, 350–361. doi:10.1080/19388070802468715.

Schwanenflugel, P. J., & Benjamin, R. G. (2012). Reading expressiveness. In T. Rasinski, C. Blachowicz, & K. Lems (Eds.), *Fluency instruction: Research-based best practices* (pp. 35–54). Ney York (USA): Guilford Publications.

Schwanenflugel, P. J., Hamilton, A. M., Wisenbaker, J. M., Kuhn, M. R., & Stahl, S. A. (2004). Becoming a fluent reader: Reading skill and prosodic features in the oral reading of young readers. *Journal of Educational Psychology, 96*(1), 119–129. doi:10.1037/0022-0663.96.1.119.

Schwanenflugel, P. J., Westmoreland, M. R., & Benjamin, R. G. (2015). Reading fluency skill and the prosodic marking of linguistics focus. *Reading and Writing. An Interdisciplinary Journal, 28*, 9–30. doi:10.1007/s11145-013-9456-1.

Seymour, P. H., Aro, M., & Erskine, J. M. (2003). Foundation literacy acquisition in European orthographies. *British Journal of Psychology, 94*(2), 143–174. doi:10.1348/000712603321661859.

Shelton, M., Gerfen, C., & Gutiérrez Palma, N. (2012). The interaction of subsyllabic encoding and stress assignment: A new examination of an old problem in Spanish. *Language and Cognitive Processes, 27*(10), 1459–1478. doi:10.1080/01690965.2011.610595.

Smith, C. L. (2004). Topic transitions and durational prosody in reading aloud: production and modeling. *Speech Communication, 42*(3), 247–270. doi:10.1016/j.specom.2003.09.004.

Suárez-Coalla, P., Álvarez-Cañizo, M., Martínez, C., García, N., & Cueto, F. (2016). Reading prosody in Spanish dyslexics. *Annals of Dyslexia, 66*(3), 275–300. doi:10.1007/s11881-016-0123-5.

Szigriszt-Pazos, F. (1993). Sistemas predictivos de legibilidad del mensaje escrito: Fórmula de perspicuidad. [Readability predictive systems of the written message: Formula perspicuity] (Doctoral dissertation). Universidad Complutense de Madrid. Retrieved from http://biblioteca.ucm.es/bitstream/19911996/S3/S3019601.pdf.

Veenendaal, N. J., Groen, M. A., & Verhoeven, L. (2014). The role of speech prosody and text reading prosody in children’s reading comprehension. *British Journal of Educational Psychology, 84*(4), 521–536. doi:10.1111/bjep.12036.

Wells, B., Peppé, S., & Goulandris, N. (2004). Intonation development from five to thirteen. *Journal of Child Language, 31*(4), 749–778. doi:10.1017/S030500090400652X.
Wightman, C. W., Shattuck-Hufnagel, S., Ostendorf, M., & Price, P. J. (1992). Segmental durations in the vicinity of prosodic phrase boundaries. *The Journal of the Acoustical Society of America, 91*(3), 1707–1717.

Zutell, J., & Rasinski, T. V. (1991). Training teachers to attend to their students’ oral reading fluency. *Theory Into Practice, 30*(3), 211–217.