



# A review of reading prosody acquisition and development

Erika Godde<sup>1,2,3</sup> · Marie-Line Bosse<sup>1</sup> · Gérard Bailly<sup>2</sup>

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## Abstract

The present work reviews the current knowledge of the development of reading prosody, or reading aloud with expression, in young children. Prosody comprises the variables of timing, phrasing, emphasis and intonation that speakers use to convey meaning. We detail the subjective rating scales proposed as a means of assessing performance in young readers and the objective features of each as markers of progress. Finally, we review studies that have explored the intricate relations between automaticity, prosody and comprehension.

**Keywords** Reading prosody · Reading development · Reading comprehension · Reading fluency · Expressivity

There is a growing interest in the deepening our understanding of reading fluency and developing strategies for improving reading development in young readers. Fluency has long been defined as the ability to read rapidly and accurately, notably through automatic word recognition. Over the past few decades, a second key component of fluency has emerged: reading prosody. We now know that fluency is more than just a question of accuracy and speed but considers the communicative purpose of reading aloud and the role of the listener. Indeed, prosody has been described as “the music of speech” (Wennerstrom, 2001). The length and frequency of pauses, as well as the organization of phonemes duration give rhythm to speech. Variations of the fundamental frequency (F0), phoneme duration and intensity together with other verbal and coverbal cues shape speech rhythm and intonation. The way these cues

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✉ Erika Godde  
erika.godde@univ-grenoble-alpes.fr

<sup>1</sup> CNRS, LPNC, Université Grenoble Alpes, 38000 Grenoble, France

<sup>2</sup> CNRS, Grenoble-INP, GIPSA-Lab, Université Grenoble Alpes, 38000 Grenoble, France

<sup>3</sup> LPNC, Université Grenoble Alpes, Batiment BSHM, CS40700, 38058 Grenoble, Cedex 9, France

encode different phonological units and structures varies among languages (Hirst & Di Cristo, 1998), but also among people (Bolinger & Bolinger, 1989). Despite these inter-individual variations, decoding these precious prosodic indications provided by our interlocutors reveals not only the discourse structure but informs the person's emotional, mental and socio-psychological state. The functions of prosody in speech are essential from a communicative point of view (Bolinger & Bolinger, 1989; Wennerstrom, 2001). Firstly, prosody has an essential linguistic function: intonation and rhythmical structure (e.g., pauses) supplement content-based lexical and morpho-syntactic information with redundant and complementary cues that help the listener to parse, disambiguate, understand and remember what is said (Frazier, Carlson, & Clifton, 2006). It also has a paralinguistic function—such as emphasizing a word to focus the listener attention to various linguistic units (words, phrases ...), or adding sarcasm to convey the opposite of what is actually said. Finally, prosody also provides us with information about the speaker—for example, by revealing his or her emotional and physiological state—and how this may be affected by the content. These two last functions of prosody are clearly summarized by Bolinger and Bolinger (1989, p. 1):

Even when it interacts with such highly conventionalized areas such as morphology and syntax, intonation manages to do what it does by continuing what it is, primarily a symptom of how we feel about what we say, or how you feel when you say it.

As prosody is essential for communication, sensitivity to prosody is crucial in speech development (e.g., Schreiber, 1987). Babies rely on prosody to understand speech and learn to speak (de Boysson-Bardies, 1996; Morgan & Demuth, 2014). Developing sensitivity to their native language and in particular to the mother's prosody begins very early in life. The motherese used with infants eases the acquisition process (Harris, 2013; Nelson, Hirsh-Pasek, Jusczyk, & Cassidy, 1989). In turn, infants' babbling is also colored by their native language prosody, even before they utter their first sentences (de Boysson-Bardies et al., 1984; Prieto & Esteve-Gibert, 2018). The development of prosody continues until early adolescence (e.g., see Filipe, Peppé, Frota, & Vicente, 2017, in Portuguese or Wells, Peppé, & Goulandris, 2004, in English).

Prosody, especially speech rhythm, also plays a role in early reading development. Initially, it thought to be a consequence of the process of developing vocabulary and phonological awareness (Wood, Wade-Woolley, & Holliman, 2009). More recently, however, it was shown that prosody on its own can be predictive of variance in word reading at the first grade level in both English (Holliman, 2014; Holliman et al., 2017) and Spanish (Calet, Gutiérrez-Palma, Simpson, González-Trujillo, & Defior 2015a). Furthermore, it was shown that dyslexic readers show, among other impairments, lower prosodic sensitivity than typical readers, both in English (Goswami et al., 2002; Goswami, Fosker, Huss, Mead, & Szucs, 2011) and Spanish (Cuetos, Martínez-García, & Suárez-Coalla, 2018).

Just as prosody in speech is essential for understanding, it is natural that prosody when reading aloud, similarly, enhances comprehension of what is being read

for both the reader and the listener. Young readers often have the tendency of reading too fast. They believe that the goal of reading is to reach the end of the text as fast as possible, which is not in fact what it means to be a “good reader”. In the early 1990’s, this observation by Dowhower (1991) would lead prosody to be added to the definition of fluency in reading. An expert reader should in actuality read in the same manner he or she speaks, by using appropriate rhythm and intonation that allow the listener to easily process the speech and understand the content. Adding expression to what is being read is critical for emphasizing, focusing attention and conveying emotions, which effectively are what more recent models of fluency assessment have come to include (e.g., Kuhn, Schwanenflugel, & Meisinger, 2010; Rasinski, 2004), placing particular emphasis on phrasing and expressivity. The readers likely develop these skills along with other reading skills as they progressively improve their reading fluency. Given the importance of prosody in speech, reading acquisition and overall comprehension, it would seem obvious to understand precisely what the development of reading prosody involves. Unfortunately, the number of studies on prosody as a marker of fluent reading is limited. Prosody does, however, emerge in other studies on reading fluency but is described by different terms. To our knowledge, no previous paper has proposed a comprehensive review of prosodic reading development. Our objective in the present work is to fill that gap by providing an overview of previous investigations on prosodic reading development and its role in young readers’ acquisition of reading, and further, to examine how prosodic reading skills and comprehension develop in parallel and are complementary to one another throughout the reading experience.

## Prosody and reading

### Spontaneous speech prosody versus reading prosody

The need to specifically define reading prosody stems from the observation that prosody differs from spontaneous speaking and reading aloud performance. Indeed, while the goal of a fluent reader is to sound like someone talking spontaneously, a closer look at reading prosody reveals a number of differences between these two conditions of speech production (Guaitella, 1999).

First of all, the distribution of pauses and their durations differ between spontaneous speech and reading. In read speech, pauses are more likely to occur at major boundaries and are shorter and less frequent than in spontaneous expression (Goldman, Auchlin, & Simon, 2009; Grosjean & Collins, 1979; Hirschberg, 2000; Lalain, Legou, Fauth, Hirsch, & Didirkova, 2016). Pauses mark a lawful prosodic structure, as strongly related to punctuation (Guaitella, 1999) as to paragraph structure (Bailly & Gouvernayre, 2012), that do not exist in the planning of spontaneous speech. While articulation rate has also been reported to be higher in reading, results from studies in different languages have differed: Goldman et al. (2009) in a study in French and a study by Hirschberg (2000) in English reported higher reading rates, while Beinum (1991) found the opposite to be true in Dutch. Finally, Goldman et al.

(2009) reported a narrower melodic pattern in spontaneous speech when compared to reading speech in French, and Howell and Kadi-Hanifi (1991) found that stress patterns differed. In English, Cowie, Douglas-Cowie, and Wichmann (2002) posited that this contrast depends on context, as emotional expression is more likely to raise mean pitch height and intensity when spontaneously performed.

There is also significant variability in reading style among readers and reading situations (Cowie et al., 2002; Dellwo, Leemann, & Kolly, 2015; Howell & Kadi-Hanifi, 1991). For example, pause placement is particularly reader-dependent. Dellwo et al. (2015) looked at listeners' ability to distinguish between read and spontaneous spoken sentences in German. In spite of the relatively few acoustic differences, their 26 listeners were able to accurately distinguish between read and spontaneous spoken sentences. This led the authors to believe that the cues facilitating this are more subtle or nuanced than just pauses, speaking rates and melodic differences. In Japanese, an acoustic comparison between spontaneous speech and read speech shows that spontaneous speech can be characterized by a reduced spectral space (Nakamura, Iwano, & Furui, 2008).

To conclude, reading prosody differs enough from spontaneous speech prosody to enable listeners to easily distinguish one from the other. This difference would appear acoustic as well as linguistic. The acoustic markers of that difference are, however, not obvious, largely due to of the broad range of different speaking styles between readers.

## Reading fluency and prosody

It is important to begin by placing prosody in the context of the reading fluency curriculum. Even if the definitions, terms and features used in the literature to refer to reading prosody are diverse, all authors agree that reading prosody plays a critical role in reading fluency. For Kuhn et al. (2010, p. 233), “a second critical component of reading fluency is the ability to read with prosody; that is, with appropriate expression or intonation coupled with phrasing that allows for the maintenance of meaning.”

One of the earliest mentions of reading prosody in the context of defining reading fluency comes from Dowhower (1991). Reading fluency had previously been equated to reading rate—that is, the number of words correctly read in 1 min—without considering the contribution of prosody, considered harder to assess, even though speed and fluency do not always correlate (Grosjean & Collins, 1979; Valencia et al., 2010). According to Dowhower (1991, p. 166), “prosodic reading is the ability to read in expressive rhythmic and melodic patterns”. In that respect, she proposed six relevant acoustic features of mature reading prosody: appropriate pausal intrusion, phrase segmentation and length, phrase-final lengthening, terminal intonation contours and stress. Since then, several authors have stressed the importance of incorporating prosody in reading fluency curriculums (Kuhn et al., 2010; Rasinski, 2004; Rasinski, Rikli, & Johnston, 2009; Schwanenflugel, Hamilton, Kuhn, Wisenbaker, & Stahl, 2004; Schwanenflugel & Benjamin, 2012). Currently, reading prosody is generally considered to be a reading skill,

however its definition lacks precision, notably how it relates to reading fluency. Some definitions, such as that proposed by Kuhn et al. (2010, p. 240), consider prosody as one essential component of fluency: “Fluency combines accuracy, automaticity, and reading prosody [...]. It is demonstrated during oral reading through the ease of word recognition, appropriate pacing, phrasing and intonation.” By contrast, Cowie et al. (2002, p. 49) consider fluency and expressivity as two separate skills: “[...] fluency displays structured-oriented skills, expressiveness displays sense-oriented skills.” They suggested integrating phrasing into fluency and putting aside intonation and expressivity, which is to say, separating syntactic from semantic maturing. Importantly, all authors investigating the question have consistently drawn a distinction between three contributions of prosody to reading fluency: phrasing, intonation and expressivity.

**Phrasing** An essential function of prosody is to chunk the discourse into meaningful units as a means of facilitating the listener’s comprehension. The rhythm of speech, specifically the length of syllables combined with the position and duration of pauses, strongly contributes to this chunking process. In fact, boundary accents, pauses and pre-pausal lengthening cue syntactic grouping and structure. This chunking is occasionally referred to as phrasing (Kuhn et al., 2010; Rasinski et al., 2009), rhythmic organization (Cowie et al., 2002) or syntactic prosody (Erekson, 2010).

Three types of pauses exist that have different uses: breath, syntactic and hesitation pauses (Lalain et al., 2016). Breath pauses are necessary for air intake, can be accompanied by audible breathing noises and are used fairly frequently as discourse markers (Bailly & Gouvernayre, 2012). Hesitation pauses are symptomatic of a cognitive activity and are largely associated with decoding or planning problems during reading. These frequently translate to ungrammatical pauses. Syntactic pauses aim at highlighting syntactic units to ease sentence parsing and boost comprehension.

Pause position and duration, as well as pause distribution, vary throughout reading acquisition (Lalain et al., 2014). Pause misplacement is often symptomatic of young readers. Hesitation and respiratory pauses are relatively frequent in early reading. Hesitations are mainly due to decoding problems if the reader has not yet acquired reading accuracy and automaticity. Respiratory pauses are also frequently produced by early readers because of their slow speech rate and lower lung volume. Once children have acquired automaticity, they learn to coordinate their breathing and the syntactic parsing of the text. In expert readers, respiratory pauses are often placed at punctuation marks while syntactic pauses further highlight the grammatical structure. Respiratory pauses of skilled readers are generally longer than syntactic pauses and are located at major syntactic boundaries. As reading speed increases, the placement of respiratory pauses may become more anarchic: the need to breathe takes priority over respecting correct grammar. Training children to read fast may then contradict the acquisition of expert reading skills (Grosjean & Collins, 1979; Rasinski, 2006).

In fact, apart from punctuation, there is no prosodic cue in a written text. So punctuation gives only a part of the phrasing (Schreiber, 1980). Most of the phrasing has to be inferred from the syntactic structure of the text, the reader has to manage the syntactic chunking to be able to acquire the correct phrasing, enabling the comprehension of the text.

To summarize, the explicit nature of phrasing that is closely linked to the structure of the text may, therefore, make it the easiest components of reading prosody for young readers to acquire or develop, as long as the reader is able to extract the syntactic structure of the text and perform an online shallow parsing.

**Intonation and expressivity** Intonation and expressivity are two frequent terms found in the literature when referring to the subjective impact of the melodic variation of the voice. The problem is that these two terms lack precise definition and can be mistakenly interchanged. In the context of speech prosody studies, intonation refers to the suprasegmental prosody: the variation of pitch linked to linguistic and paralinguistic functions and is invariably specific to the language used (Hirst & Di Cristo, 1998). For example, syllables within a word may be accented in various positions in languages with lexical stress such as English or Spanish. French is considered as a language with no stress (Rossi, 1980), since accents occur at the end of the words. In tonal languages, lexical tones coexist with intonation like waves superimposed on larger swells.

These language particularities are likely to strongly impact reading acquisition and performance. Intonation is mostly linked to punctuation (e.g., it is used to cue declarative versus interrogative sentences). It can also mark asides—cued in the text by commas or brackets—as well as focus (Wennerstrom, 2001). Exclamation marks are also used by authors to induce a variation in the melodic pattern of the sentence. In prosodic phonology, intonation and phrasing are closely linked. In the prosodic structure, the intonation phrase constitutes an intermediate level between the syllable, the word and the intonation unit. The intonation phrase is a stretch (or chunk) of spoken material that has its own intonation pattern. In a nutshell, intonation and phrasing are parts of the linguistic prosody both in speech and reading.

In contrast, expressivity is more subtle. A reader can read with appropriate phrasing and intonation but with no expressivity. His or her reading will be understandable but will lack interest for the listener. Expressivity is in fact linked to paralinguistic prosody (Wennerstrom, 2001). Like intonation, it is encoded through multiparametric variations, pitch, rhythm, intensity as well as timbre, and ultimately it offers implicit information about the text. Authors using the term expressivity generally refer to F0 and intensity amplitude or slope (e.g., Álvarez-Cañizo, Suárez-Coalla, & Cuetos, 2017; Cowie et al., 2002). It can also be cued by punctuation, for example exclamation marks. Indeed, they often trigger expressive reading: the choice of attitude—incredulity, contempt, irony, evidence... (see Golan, Baron-Cohen, & Hill, 2006, for an extensive taxonomy of complex emotional displays by face and voice)—depends on the context and the reader's understanding of the situation. Punctuation alone is not sufficient to translate to expressivity in written language so the reader is prompted to infer it from the textual content (Erekson, 2010; Martin, 2011). Erekson (2010) notably insists on the fact that expressive reading implies that the reader has a deep understanding of the text but also infers the emotional state of the character given the context of the story or dialog. This can be explicitly written (e.g., “the boy is mad and he shouts”) or not written at all and instead should be inferred from context.

Intonation and expressivity are not always easy to infer from the text alone, and are also highly speaker specific, across language, culture and individuals. This

aspect of prosody is the most difficult to teach and acquire by beginners and is also the most challenging to measure in reading assessment.

### Assessing reading prosody

Reading prosody assessment is an important issue for both teachers and researchers. The evaluation protocol and rated dimensions must be clearly defined to produce reliable results. Rating scales have been used and improved since the 1990's. Generally, this assessment is subjective and relies on expert listeners' perceptual judgments. More recently, acoustic parameters have been used to perform automatic scoring, that predict perceptual judgements quite accurately.

**Subjective scales** The first rating scales used for measuring prosody were fluency scales that attempted to look further than the reading rate. Such an example is given in Table 1. They were unidimensional scales rating both decoding, phrasing intonation and expressivity (e.g., Pinnell et al., 1995; Zutell & Rasinski, 1991). These scales were mostly developed for the purpose of pupil assessment by teachers. The first three levels focus on the grouping skills. Expressivity appears in the 4th level, assuming that grouping precedes expressivity in the acquisition of reading prosody. Moreover, the term "expressivity" lacks a clear definition, which leaves it up to the assessor's personal interpretation. These unidimensional scales assess several skills in the same level, neglecting the potential variability of development among these skills in children. Consequently, placing a child in a unidimensional scale can be quite difficult.

To improve and facilitate fluency assessment, Zutell and Rasinski (1991) proposed a multidimensional scale, again, conceived to be used by teachers. Rasinski (2004) and Rasinski et al. (2009) further updated this multidimensional scale (see Table 1) to allow for the separate assessment of four key features: pace, smoothness, phrasing and expression. Each feature is rated on a 4-point scale ranging from poor

**Table 1** Examples of subjective scales used to evaluate reading fluency

Unidimensional fluency scale adapted from Pinnell et al. (1995)				
Score	Habilities			
4	Read with appropriate rate, phrasing and expression			
3	Read in small group phrasing, no expression			
2	Read in small groups, inappropriate phrasing			
1	Read word by word			
Multidimensional fluency scale adapted from Rasinski (2004)				
Dimension	1	2	3	4
Expression	Non existent	Poor	Mostly correct	Adapted interpretation
Phrasing	Monotonic	Small inappropriate	Run-on and pauses	Appropriate
Smoothness	Frequent pauses	Several rough spots	Occasional breaks	Smooth
Pace	Laborious	Slow	Fast and slow	Conversational

to correct performance. The problem lays in the fact that pace and smoothness are quite straightforward and easy to evaluate, whereas assessing phrasing and expression can prove more challenging. Indeed, these features tend to differ considerably throughout a given text and both are by nature listener-dependent. A further complication is that assessors may project or be influenced by their own reading strategies. Moreover, without a clear definition of expression, expectations that the assessor may have of a good reader employing appropriate expressivity might also affect the ratings. Actually, when several assessors evaluate the same students, the inter-rater agreement can be satisfactory (i.e.,  $> .70$ ) as long as the raters receive appropriate group training (e.g., Moser, Sudweeks, Morrison, & Wilcox, 2014; Paige, Rasinski, Magpuri-Lavell, & Smith, 2014; Schwanenflugel & Benjamin, 2016). Without this training, the inter-rater agreement tends to be weaker (e.g. Godde, Bailly, Escudero, Bosse, & Gillet-Perret, 2017).

After having investigated the inter-rater consistency of fluency assessment in the literature using the two scales previously presented, Haskins and Aleccia (2014) pointed out a lack of transparency in their use and reliability. They tested their own multidimensional scale to rate fluency. Here again, a 4-point scale was used to assess 6 key prosodic features grouped into two categories: phrasing and expression. Phrasing combines smoothness and punctuation, while expression combines vocal emphasis, inflection, intonation and voice. These features are rated from 1 (no use) to 4 (correct use throughout the entire reading). They asked 83 teachers to rate the prosody of video-recorded children reading the same text. The raters had received no training on the scale. Correlation coefficients between random pairs of raters revealed a range from low (.30) to moderate (.53). Benjamin et al. (2013) proposed an acoustically-grounded multidimensional scale detailed in the following paragraph. Using assessments made by 3 raters, all experts in children reading assessment, they still found a moderate inter-rater reliability on exact agreement (even if the reliability on adjacent agreement was better). As a whole, these results attest to a lack of reliability of subjective scales; they should be used with caution. Moser et al. (2014) underline this in their strong recommendation of using at least 2 passages to reach a reliable rating of the pupils being assessed.

To conclude, subjective multidimensional scales primarily dedicated to in-class assessment can be useful for teachers. They may, however, lack the precision or reliability to be used for screening and research purposes.

**Objective acoustic markers** For researchers, a particular area of interest considers the acoustic markers of child reading prosody. Cowie et al. (2002) measured 40 different acoustic markers in the recordings of 8 to 10-year-old readers. They related these acoustic markers to subjective ratings of these recordings. It appears that the acoustic correlates of fluency and expressiveness are those that one would expect by the very definition of the terms. That is to say, fluency is mainly correlated to basic temporal organization: pause duration, pause frequency, syllabic rate and pitch movement frequency. Expressiveness is mainly linked to pitch variation, i.e., pitch movement magnitude and duration and their variation from one sentence to another. However, if fluency markers are primarily linked with temporal organization, they are also linked—to a lesser extent—with expressiveness and vice versa. So even if some acoustic markers seem to reliably



characterize fluency and expressiveness, the one-to-one correspondence between objective features and subjective judgment is not that simple. In fact, expressiveness, often linked to pitch variation, also depends on fluency skills. Young readers need minimal fluency skills—such as automaticity—to develop expressiveness skills. These observations on acoustic markers have been confirmed by several other studies (see below in Development section).

Benjamin et al. (2013) evaluated the correlation between a new subjective multi-dimensional scale and acoustic markers of prosody in 2nd and 3rd graders reading assessments. They extracted distributions of several characteristics of the children's prosody: inter-sentential pause lengths, intra-sentential pause ratio, sentence final pitch declination for declarative sentences and pitch contours. A principal component analysis of the objective cues leads to 2 potential distinct prosodic features interpreted as expressive intonation, that is pitch variation variables, and natural pausing, or pause variables. It should be noted that pause variables also showed secondary relations with expressive reading (as in Cowie et al., 2002) for the same reasons previously stated. Features associated with skilled readers (i.e., level 4 on the subjective scale) are larger pitch drops at the end of declarative sentences and larger pitch variation inside the sentences at appropriate places. Features associated with poor readers (i.e., level 1 on the subjective scale) are flat or consist of inappropriate intonation contours and end of sentence pitch variations that are inappropriate with regards to punctuation. Characteristics of intermediate levels (levels 2 and 3 of the subjective scale) are less clear because medium-level readers showed a mix of upper and lower level skills (e.g., they are expressive but not throughout the whole text).

In conclusion, these two studies highlight the difficulty involved in objectively assessing the expressiveness of a reader, especially a medium-level reader, because of the intra- and inter- reader variability. The use of subjective scales, even acoustically grounded, should be used in conjunction with specific training of the raters and should be interpreted with a degree of caution. For research purposes, the use of acoustic parameters to describe reading prosody shows great potential for providing insights into the development of reading prosody. Of additional interest would be to further correlate this objective characterization with subjective ratings with a view to predicting performance from signals without the need of costly listening tests.

## Reading prosody development in young readers

Unlike acquisition of decoding and automaticity, reading prosody development has been understudied (see Table 2 for an overview). Indeed, we counted only a handful of global studies on reading prosody development including and comparing children of different ages (Álvarez-Cañizo et al., 2017; Miller & Schwanenflugel, 2008; Lopes, Silva, Moniz, Spear-Swerling, & Zibulsky, 2015). Other more specific works (Schwanenflugel et al., 2004, 2015; Benjamin & Schwanenflugel, 2010; Schwanenflugel & Benjamin, 2017; Cowie et al., 2002; Paige et al., 2017) studied the acquisition of given prosodic features (e.g., focus, text complexity, link between fluency and prosody).

**Table 2** Synthesis of the main features of the different studies conducted on reading prosody development presented in alphabetic order; *AA* acoustic analysis, *SR* subjective ratings

Paper	Language	Grade	Measures			Impact of reading fluency
			SR	AA		
				Pause	Pitch	
Álvarez-Cañizo et al. (2017)	Spanish	3, 5, adults	X	X	X	
Benjamin and Schwanenflugel (2010)	English (US)	2, adults	X	X		X
Cowie et al. (2002)	English (UK)	4, 5	X	X	X	X
Lopes et al. (2015)	Portuguese	2, 3	X			X
Miller and Schwanenflugel (2008)	English (US)	1 to 2	X	X		
Miller and Schwanenflugel (2006)	English (US)	3, adults	X	X	X	
Paige et al. (2017)	English (US)	1, 2, 3	X			X
Paige et al. (2014)	English (US)	9	X			
Ravid and Mashraki (2007)	Hebrew	4		X	X	
Schwanenflugel et al. (2004)	English (US)	2, 3, adults		X	X	X
Schwanenflugel et al. (2015)	English (US)	3			X	X
Schwanenflugel and Benjamin (2017)	English (US)	3			X	
Young and Bowers (1995)	English (Can)	5	X			X

### Main characteristics of the studies

We found 13 studies published in English on reading prosody development by conducting an extensive search in Google scholar with the keywords “reading+prosody+development” and by investigating the quotation of Kuhn et al. (2010), who introduced a definition of reading prosody.

The main features of these 13 studies are summarized in Table 2. Most of the studies are interested in the earlier development of reading prosody during the first years of primary school: 9 out of these 13 studies involve pupils between grades 1 and 3. A common observation of these studies is that pupils first need to acquire decoding and automaticity before progressing further to add prosody to their reading. Only one study (Paige et al., 2014) focused on middle school pupils and the late development of prosody. The studies concerning a single grade often describe the difference of performance between fluent and less fluent readers in each of the acoustic parameters assessed.

Concerning the diversity of acoustic parameters, most of the studies are interested in pause frequency and duration, both intra- and inter-sentential (see Table 2). Grammatical pausing was also investigated (Benjamin & Schwanenflugel, 2010; Miller & Schwanenflugel, 2008; Schwanenflugel et al., 2004), most notably in young children. Pitch variation was studied with particular interest in the context of sentence type—in particular, sentence-initial and final pitch movements

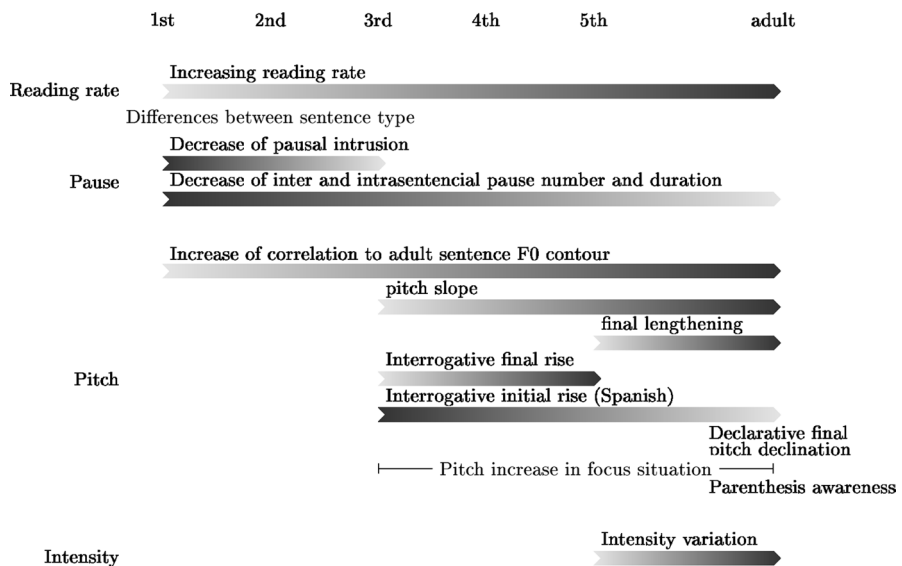
(Álvarez-Cañizo et al., 2017; Benjamin & Schwanenflugel, 2010; Cowie et al., 2002; Miller & Schwanenflugel, 2008; Schwanenflugel et al., 2004). The alignment of the F0 contour with reference to an adult contour has also been frequently used as a cue for estimating reading development (Benjamin & Schwanenflugel, 2010; Miller & Schwanenflugel, 2006; Ravid & Mashraki, 2007; Schwanenflugel et al., 2004). Intensity is rarely mentioned. With the exception of Cowie's exploration of reading prosody (Cowie et al., 2002), only one study on focus marking (Schwanenflugel, Westmorland, & Benjamin, 2015) considers intensity variation.

Since all studies focused on use of a single language—mostly English, but also Portuguese or Hebrew—, inter-language comparisons and hypotheses have not been widely developed. Only Álvarez-Cañizo et al. (2017) hypothesized about a possible difference between languages. Indeed, we would expect decoding acquisition to be language-dependent. As an example, transparent languages with straightforward grapheme-phoneme correspondences can be decoded rapidly, whereas opaque languages with irregular grapheme-phoneme mapping take longer to learn to decode (Seymour, Aro, & Erskine, 2003). As such, one hypothesis is that children may acquire prosodic reading earlier in a transparent language (Álvarez-Cañizo et al., 2017). Certain language specificities may also impact the development of reading prosody. For example, in Spanish, interrogative and exclamatory punctuation marks are presented both at the beginning and at the end of sentences, e.g., "¿Cuándo es la fiesta?" (When is the party?). Álvarez-Cañizo et al. (2017) hypothesized that, consequently, the pitch contour specific to interrogatives should appear sooner in Spanish than in other more opaque languages.

## Major findings of previous studies

Taken as a whole, these 13 studies provide us with an overview of the general development of reading prosody studied across elementary grade levels. The evolution of acoustic markers of prosody is summarized in Fig. 1. Several of the studies also describe prosodic specificities that can differentiate between poor readers and good readers at the same grade level, as shown in Table 3. Our review highlights four important benchmark variables that pave the way for the development of reading prosody: these are acquiring fluency, planning appropriate pauses, choosing the appropriate 'tune' or intonational contour, and finally developing expressive language skills. Finally, we cite those works that addressed the large variability of inter- and intra-reader performance and offer insights into the few existing models of reading prosody development.

**Fluency** The first main conclusion of these studies is the importance of reading fluency (i.e., decoding and automaticity) as a prerequisite for the acquisition of reading prosody. Children become expressive only once they have acquired reading automaticity (e.g., Lopes et al., 2015; Miller & Schwanenflugel, 2008; Paige et al., 2017). Indeed, automaticity reduces the overall cognitive load which effectively frees up attention and cognitive resources—inter alia—that can then be devoted to expressiveness. Consequently, the acoustic markers of appropriate prosody are systematically lower for less fluent readers than more fluent readers (Fig. 1).



**Fig. 1** Proposed time chart showing progressive stages of reading prosody skills development supported by results of the studies reviewed

**Table 3** Synthesis of the differences observed between fluent (high reading rate) and less fluent (low reading rate) readers of the same age

	Low fluency	High fluency
<b>Pauses</b>		
Intra and inter sentential pauses	Long	Short
Complex text	More pauses, more ungrammatical	More pauses, more grammatical
Long text	Increased discontinuities	
<b>Expressivity</b>		
Sentence F0 contour	Flat	Adult-like
F0 rise in interrogative and exclamative sentence	Low	High
Fit to context	Weak	Strong
Complex text		More expressivity F0 contour more adult-like
Long text	Weakening	

**Pauses** Another trend that several studies addressed is the reduction of all kinds of pauses when reading skills increase (Álvarez-Cañizo et al., 2017; Benjamin & Schwanenflugel, 2010; Cowie et al., 2002; Miller & Schwanenflugel, 2008; Ravid & Mashraki, 2007; Schwanenflugel et al., 2004). This trend appears both when comparing children who read at different levels and same-level children with various reading skills. Young children who are poor readers tend to use ungrammatical

pauses more frequently and over longer periods. Additionally, the durations of punctuation pauses used by fluent readers frequently decrease. Miller and Schwanenflugel (2008) conjecture that children are less motivated to respect punctuation cues as their reading skills improve. Effectively, adults tend to rely less on punctuation (Chafe, 1988). Ravid and Mashraki (2007) showed that adult-like pausing patterns in Hebrew—that uses a large set of punctuation marks (e.g., *sof pasuq*, *paseq*, *maqaf*...)—appear before intonation, often as early as the 4th grade.

**Intonation** Intonation as a linguistic function is markedly more difficult to measure than pausing. That said, it has been shown that some features of intonation are acquired quite early in reading acquisition, seen in the fact that initial or final rise in interrogative sentences can be present in 3rd graders (Álvarez-Cañizo et al., 2017; Miller & Schwanenflugel, 2006). Nonetheless, intonation at this early stage is not yet adult-like and continues to evolve. On the other hand, other features, such as final lengthening or pitch declination in declaratives, can either appear much later, or can be absent altogether at the 5th grade level (Álvarez-Cañizo et al., 2017). This implies that intonation continues to develop after the fifth grade. Concerning language differences, it was shown that intonation for interrogative and exclamative sentences does not appear earlier in Spanish (Álvarez-Cañizo et al., 2017) than in English (Schwanenflugel et al., 2004), despite the fact that Spanish punctuation marks give strong cues concerning the sentence type.

Finally, the correlation between the F0 contour of children and adults consistently increases from the 1st to 5th grade levels (Álvarez-Cañizo et al., 2017; Benjamin & Schwanenflugel, 2010; Miller & Schwanenflugel, 2006; Ravid & Mashraki, 2007; Schwanenflugel et al., 2004) but is still not very high in 5th grade, which confirms that the acquisition of some aspects of reading prosody continues after the 5th grade.

**Expressivity** Few expressivity features have been studied in children, which as we have just pointed out, is most likely because it is the most difficult aspect of reading prosody to acquire and to assess. Nevertheless, Schwanenflugel et al. (2015) noticed that 3rd graders are able to emphasize words that are meant to be emphasized in various ways: direct quotes, exclamation points or contrastive context. Children do, however, have trouble knowing how to handle parentheses.

**Variability** The largest body of the studies that focused on studying pupils at a single grade level showed that there is a significant variability in their use of prosody. The expressiveness strategies are different from one child to another. For example, different pitch contours can lead to equally expressive readings, which have led several authors to posit that acoustic markers can only roughly evaluate expressiveness skills (Cowie et al., 2002). This degree of variability is particularly visible between children with different reading skills (see Table 3) (e.g., Cowie et al., 2002; Lopes et al., 2015; Schwanenflugel et al., 2004). The differences observed between skilled and less skilled readers are the same as those that differentiate children and adults (Binder, Tighe, Jiang, Kaftanski, & Ardoin, 2013). Moreover, the degree of variability between fluent and less fluent readers also depends on text complexity and length (e.g., Benjamin & Schwanenflugel, 2010). When a given text is either more complex or longer, variability between fluent and less fluent readers will tend to be higher, notably in terms of expressivity and ungrammatical pausing (Benjamin & Schwanenflugel, 2010).

Less skilled readers make more pauses, appropriate or not. They rely more on punctuation. Regarding pitch, their F0 contour tends to be flatter or more monotone. They also provide poor cues of modalities, for example, by omitting declination lines or falling/rising boundary tones for declarative/interrogative sentences. Cowie et al. (2002) pointed out that pitch variations progressively become more important as the readers develop their fluency. Less fluent readers typically exhibit poor pitch variation between sentences.

As slow and poor readers, children with dyslexia or language impairment also present numerous long and ungrammatical pauses compared to control children, their reading rate is slower and their melodic contour is flatter than those of control children (Suàrez-Coalla, Alvarez-Cañizo, Martinez, Garcia, & Cuetos, 2016; Jordan, Cuetos, & Suarez-Coalla, 2019; Lalain et al., 2012). These studies support the impact of decoding and automaticity issues on fluency. The different authors point out the use of cognitive resources on decoding at the expense of anticipation, comprehension and prosodic planning.

**Developmental model** Two studies explored the links between different markers of prosody in order to describe potential dependencies. In a longitudinal study, Miller and Schwanenflugel (2008) examined the relationship between pauses (pausal intrusion rate) and pitch (F0 contour match to an adult reference), by monitoring both in 1st and 2nd graders. Unsurprisingly, they found that pauses and pitch recorded in 1st grade pupils are respectively correlated to pauses and pitch measured one year later. More importantly, the pausal intrusion rate in first grade is also related to the F0 match in second grade. Indeed, the children having fewer pausal intrusions in first grade present a more adult-like F0 contour in the second grade. This result suggests that a decrease of pausal intrusion is a precursor of improved intonation.

In the same study, Miller and Schwanenflugel (2008) also tested the contribution of pausal intrusion, F0 match and word reading skills recorded in 1st and 2nd grade pupils, as predictors of 3rd grade level reading fluency. As expected, word reading skills observed in at the 1st and 2nd grade levels are related to reading fluency skills seen in the 3rd grade. However, both F0 match in 1st and in 2nd grade pupils also proved to be important predictors of reading fluency in the 3rd grade once early reading skills were taken into account. Thus, it would appear that the early development of intonation contour plays a crucial role in the development of later stage fluent reading. Schwanenflugel et al. (2015) also examined the relationship between reading rate, accuracy and different prosodic features in 3rd grade readers. This study confirmed that throughout the development stage, reading rate and accuracy are correlated to reading prosody markers such as intra-sentential pausing or pitch change.

## Discussion

The present review of studies that have focused on reading prosody in children provides an overview of the main rules governing reading prosody acquisition, such as (1) that fluency—mostly automaticity—is necessary to begin to enhance prosody,

(2) that an early decrease of pausal intrusions allows for later enhancement of intonation, and (3) that the early ability to read with appropriate intonation and expressivity can fairly accurately predict later stage reading skills.

There are, however limitations to the developmental synthesis proposed here. Importantly, there is a lack of data from various sources because several of the 13 studies reviewed here were conducted by the same teams and were part of the same project. There is also a noticeable gap in the literature of investigations focused exclusively on reading prosody as an isolated skill; it has more commonly been addressed as a part of others skills such as reading fluency or comprehension, and has largely been evaluated using only subjective scales.

The lack of available data also stems from the fact that all studies except one focus on primary school pupils, whereas there is data that would suggest that prosody development further continues as young readers enter secondary school. For example, sentence-final boundary tones have been shown to appear after the end of the primary school. In secondary school, fluency in general—prosody in particular—is only very rarely addressed. A series of studies conducted by Paige, Rasinski, and Magpuri-Lavell (2012) and Rasinski et al. (2005) showed that reading skills have a positive impact on pupils' literacy achievement, particularly in the case of struggling readers. This alone suggests that it would be worth exploring the acoustic markers of prosody produced by secondary school pupils. Moreover the differences in prosodic reading observed in young readers with different fluency skills can also be observed in high-school and young adults (Binder et al., 2013; Paige et al., 2014), and prosody is also related to comprehension in adults (see section Prosody and Comprehension). However, after primary school, reading is barely taught, it becomes only a tool to acquire new skills in many fields, leaving struggling reader with general difficulties. Exploring prosody acquisition after primary school could lead not only to a better knowledge of its late development, but could also help designing intervention to help older struggling readers.

A comparison between English and Spanish studies suggests that language transparency and punctuation style have little impact on prosody acquisition. It would be interesting to test this assumption further by exploring prosody acquisition across a wider range of languages. Another potentially important line of exploration might be to look specifically at the impact or role of curriculum on reading prosody development. Prosody has been used in the US for much longer than in Europe as an integral part of fluency assessment protocols (e.g., National Reading Panel (U.S.) & National Institute of Child Health and Human Development (U.S.), 2000), and specific training is made available for that purpose. Conversely, fluency in France is still measured largely by gauging reading rate, which effectively confines assessment to accuracy and automaticity. The result is that very little training is offered in prosody itself. It could potentially be interesting to develop reading prosody training programs in different languages and to compare reading prosody development in the same language, notably in children with different curriculums.

This review reveals several important missing points concerning reading prosody development, which certainly reserve further investigation. One of them is the role of syntactic awareness, which could also be an important prerequisite of prosody development. Fluency, word reading, accuracy are often used as predictors of

prosody development. However, to produce appropriate phrasing, pupils also need to be able to parse the text into meaningful units (Young & Bowers, 1995). Another interesting point that deserves more attention is the coordination of breathing and reading (Bailly & Gouvernayre, 2012; Bailly, Rochet-Capellan, & Vilain, 2013; Grosjean & Collins, 1979; Lalain et al., 2014). As mentioned above, breathing is one indispensable motivation for pausing. When poor readers increase their reading speed, breathing tends to become haphazard and induces ungrammatical pausing, disturbing reading prosody. It could also be interesting to investigate when children manage to produce relevant or appropriate breath pauses, that is, when they learn to coordinate breathing and reading.

Both syntactic awareness and breathing coordination necessitate an online analysis of the text and its syntax, as well as anticipation and planning. According to several authors, the reader needs to first acquire decoding and automaticity in order to free cognitive resources which could be allocated to analysis and anticipation. The problems encountered by children with language impairment and dyslexia could come from this (e.g. Suárez-Coalla et al., 2016; Jordan et al., 2019). The anticipation issue has been raised, *inter alia*, by Schreiber (1980). We didn't find any studies focusing on the anticipation issues and their link with decoding and automaticity skills, with the reading rate or with the age of the reader. Is anticipation and online analysis only a matter of decoding skills or also a matter of cognitive maturity? This question leads back to the lack of studies in secondary grades. As cognitive maturity has an impact on prosody development, and as the brain is not completely mature at the end of primary grades, studies with elder pupils could bring a lot of additional information on prosody development.

Finally, these studies have well characterized the relation between fluency and prosody with different levels of text complexity. The fact that text complexity enhances prosody in good readers circles back naturally to the role of prosody in reading comprehension. We further explore this issue in the next section.

## Reading prosody and comprehension

According to Schreiber (1991) and Morgan and Demuth (2014), children rely on the regular prosodic patterns of speech to perform a shallow syntactic parsing of utterances. When it comes to reading, they have to reverse this process and rely on syntactic parsing and online comprehension to produce adequate prosody and fluent reading. Meisinger, Bradley, Schwanenflugel, Kuhn, and Morris (2009) warn about the downsides of intensive training to increase reading rate. It often improves at the detriment of other reading skills, like prosody and comprehension. It creates what they term "word callers" who can read fluently but with little or no understanding of the text being read. In reality, we expect to see a strong relation between syntax, prosody and reading comprehension given that syntactic grouping is essential to understanding utterances, and *a fortiori*, the text itself. This relation has been studied in several languages, in both adults and children. The correlation between reading prosody and reading comprehension has been shown to be significant in most studies. However, in the context of development, this relation raises the question of the



causal link between prosody and comprehension. Does prosody enable children to understand the text? Or does understanding the text enable them to adapt appropriate prosodic parameters while reading aloud?

### **Prosody and comprehension in adult readers**

As mentioned earlier in section “Development”, prosody is a central part of speech comprehension. Frazier et al. (2006) underline the importance of prosodic phrasing in speech comprehension. Two studies, conducted respectively with French and German adults, extend that observation to both oral and silent reading. Dodane and Brunellière (2006) and Kentner and Vasishth (2016) showed that adults covertly recreate prosody when reading silently when confronted with complex or ambiguous sentences. The word reading time in silent reading is correlated to the word lengthening in aloud reading (Dodane & Brunellière, 2006). Kentner and Vasishth (2016) results reveal a strong interaction between text disambiguation and prosodic cues—that is, local sentence rhythm and global context comprehension—in both silent and aloud reading. Both teams hypothesized then that readers covertly recreate in silent reading the prosodic accentuation of aloud reading needed to process complex sentences.

Another important cue of prosody for comprehension is the relationship between syntactic structure, pausing and comprehension. Koriat, Kreiner, and Greenberg (2002) proposed that prosody acts as a tool for early syntactic extraction. Their study, conducted with Hebrew-speaking students, reveals that the extraction of prosodic structure precedes the analysis of meaning. In this study, reading prosody is linked to the syntactic structure but remains independent from semantic coherence. Along these same lines, Binder et al. (2013) showed that skilled readers do not use pauses as frequently as less-skilled readers. Low-skilled adult readers tend to make more pauses, especially at commas where they always produce long pauses, whereas skilled readers will not pause when commas are used, for example, to separate a list of adjectives, but will pause when a comma separates two clauses. This study showed that comprehension and pausing pattern, number, placement and duration are linked.

Taken together, these results indicate that prosody, particularly pause placement and phrasing, is essential to expert reading comprehension.

### **Link between prosody and comprehension in young readers**

During reading acquisition, several literacy skills develop simultaneously: accuracy, automaticity, reading rate, prosodic skills and comprehension. As presented in section “Development”, these skills are interdependent, but what is the exact role of comprehension in the acquisition of literacy skills? Comprehension is often presented as the ultimate goal of reading acquisition. That said, establishing a link between comprehension and the development of other literacy skills is not that straightforward. While a number of previous studies have questioned the relation

between fluency and comprehension, it is only more recently that increased attention has been given to the relation between prosody and comprehension.

The first hints in favor of a link between prosody and comprehension in child reading come from the comparison between aloud and silent reading. Several studies report that, in young and poor readers, reading comprehension is better in oral reading than in silent reading (e.g., Dickens & Meisinger, 2016; Price Meisinger, Louwse, & D’Mello, 2016; Prior et al., 2011), while comprehension scores in both conditions are the same for middle-school and skilled readers. Paige et al. (2014) reported an impact of prosody on silent reading comprehension in 9th graders. They suggest that prosody serves as a mediator between automaticity and comprehension. They hypothesize that oral reading benefits young readers because prosody helps them to understand the content. Nevertheless, the results may be biased by the fact that the reading rate is significantly faster in silent reading compared to oral reading (e.g., Prior et al., 2011), suggesting that comparing oral and silent reading may be irrelevant for studying how prosody and comprehension relate to each other.

Another hint in favor of a link between prosody and comprehension is the effect of text complexity on reading prosody. Benjamin and Schwanenflugel (2010) studied the impact of text complexity on reading prosody in 3rd graders. It appears that children tend to accentuate prosody while reading complex texts by using both pausing and pitch variation. This effect is particularly salient with good readers. Miller and Schwanenflugel (2006) observed the same trend in 3rd graders who accentuated prosody in the case of complex sentences. Young and Bowers (1995) also showed that phrasal knowledge—measured by the ability to parse a text with meaningful boundaries between phrases or clauses—significantly explains reading fluency and prosody, in particular with difficult text and long sentences. These three studies with children stressed the hypothesis that prosody supports or boosts comprehension.

To conduct this review, we looked specifically for studies conducted to explore reading prosody and comprehension in elementary children in several languages. A search with “reading + prosody + comprehension” in Google Scholar and the investigation of the quotations of Rasinski (2004),—credited with developing the Multidimensional Fluency Scale that is today widely used to study prosody-comprehension links—enabled us to find the studies linking reading fluency and comprehension. We included in our review 11 studies that specifically investigated the reading prosody-reading comprehension link (see Table 4), and 5 longitudinal studies (see Table 5).

In the studies involving early readers (Lopes et al., 2015; Schwanenflugel et al., 2004), the correlation between reading prosody and reading comprehension happened to be weak. This suggests that for pupils at the 1st and 2nd grade levels, comprehension is mainly related to decoding speed and accuracy. At these grade levels, a low reading rate has a strong impact on comprehension. However, Paige et al. (2017) identified a mediating role of prosody in the relationship between automaticity and reading comprehension in early reading acquisition. One hypothesis about reading comprehension of young readers is that they understand the text by listening to themselves (Kuhn et al., 2010; Schreiber, 1991). Based on this same hypothesis, several studies screened for pauses, in particular the proportion of inappropriate pauses and their relation with reading comprehension. For example, Arcand et al. (2014) highlight the impact of inappropriate

**Table 4** Synthesis of the main features of the different studies exploring a link between reading prosody and reading comprehension presented in alphabetic order; AA acoustic analysis, SR subjective ratings

Paper	Language	Grade	Measures		
			SR	AA	
				Pause	Pitch
Álvarez-Cañizo et al. (2015)	Spanish	3, 6		X	X
Arcand et al. (2014)	French	3	X		
Calet et al. (2015b)	Spanish	2, 4	X		
Lopes et al. (2015)	Portuguese	2 to 3	X		
Miller and Schwanenflugel (2006)	English (US)	3, adults		X	X
Paige et al. (2014)	English (US)	9	X		
Paige et al. (2017)	English(US)	1, 2, 3	X		
Ravid and Mashraki (2007)	Hebrew	4		X	X
Schwanenflugel et al. (2004)	English (US)	2, 3		X	X
Veenendaal et al. (2014)	Dutch	4	X		
Yildirim et al. (2018)	Turkish	4, 5, 6, 7, 8	X		
Yildiz et al. (2014)	Turkish	5	X		

The subjective ratings used the multidimensional fluency scale (Rasinski, 2004)

pauses in reading comprehension in 3rd graders independently from reading rate and accuracy. They confirm the importance of appropriate pausing for reading comprehension. It should be noted that, even if less investigated with young readers, pitch variation also appear to be linked to comprehension (Álvarez-Cañizo, Suarez-Coalla, & Cuetos, 2015; Schwanenflugel et al., 2004).

After the 3rd grade, the direct correlation between reading prosody and reading comprehension seems to strengthen. This trend was found in various languages: Dutch (Veenendaal, Groen, & Verhoeven, 2014), Spanish (Álvarez-Cañizo et al., 2015; Calet, Gutiérrez-Palma, & Defior, 2015b), and Turkish (Yildirim, Rasinski, & Kaya, 2018). A strong correlation between inappropriate pausing and comprehension was also confirmed with older students and in several languages: with Spanish 3rd and 6th graders (Álvarez-Cañizo et al., 2015), with 4th graders in Dutch (Veenendaal et al., 2014), as well as in Hebrew (Ravid & Mashraki, 2007). The correlation between pitch and comprehension is also present in older students (Álvarez-Cañizo et al., 2015; Calet et al., 2015b). Studies monitoring middle school pupils—ranging from the 4th to 8th grade—observed that prosody predicts a larger part of reading comprehension as the grade level advances (Yildiz et al., 2014; Yildirim et al., 2018).

To summarize, the relation between prosody and reading comprehension seems weak for young readers, probably because of the importance of reading rate and decoding skills in comprehension at this age. As children acquire better reading skills, however, this relation appears to strengthen.

**Table 5** Synthesis of the different longitudinal studies exploring a causal relationship between reading prosody and reading comprehension, presented in alphabetic order; prosody was measured with subjective ratings using MDFS for multidimensional fluency scale (Rasinski, 2004) and NAEP scale (National Reading Panel (U.S.) and National Institute of Child Health and Human Development (U.S.), 2000)

Author	Language	Grade	Assessment	Measures	Causal links		
					No	Uni directionnal	Bi directionnal
Fernandes et al. (2018)	Portuguese	2 to 3 4 to 5	3 times	MDFS with 6 levels	4 to 5		2 to 3
Klauda and Guthrie (2008)	English (US)	5	2 in 3 months	Subjective scale 5 dimensions			X
Lai et al. (2014)	English (US)	2	3 times	NAEP scale	X		
Lopes et al. (2015)	Portuguese	2 to 3	4 times	Subjective assessment	X		
Veenendaal et al. (2016a, 2016b)	Dutch	4 to 6	3 times	MFDS		Changing with grades	

## Prosody and comprehension: causal links?

As we outlined in the previous section, the link between reading prosody and comprehension is observed in many languages and is strengthened by increased reading performance. However, the causal relationship between reading prosody and comprehension in development, if there is one, is not clear in the studies previously mentioned. One question is the direction of this causal relationship. Some data suggest that children rely on prosody to boost their comprehension, particularly when confronted with complex texts. The use of emphasis when reading complicated texts or ambiguous sentences has been observed in both adults (e.g., Binder et al., 2013; Kentner & Vasishth, 2016; Koriat et al., 2002) and children (e.g., Benjamin & Schwanenflugel, 2010; Frazier et al., 2006; Miller & Schwanenflugel, 2006; Schimmel & Ness, 2017). As observed by Schreiber (1991), children still rely on prosodic patterns of speech to infer syntactic organization of sentences when they are beginning to learn to read. Their understanding tends to improve when they read aloud (Frazier et al., 2006). One interpretation of these studies is that good readers rely on prosody to understand the text and, as such, will have a tendency to over-emphasize reading difficult passages that are more complex. These observations seem to favor a causal link from prosody to comprehension. The fact that this effect is particularly noticeable with highly skilled readers may suggest, however, that this tendency depends on level of reading skills involved and, consequently, is reflective of the stage of reading development (Calet et al., 2015b).

Longitudinal studies are known to be one of the most reliable methods for examining causal relationships during reading development. According to our research, only five longitudinal studies have aimed specifically at exploring the bidirectional links between reading prosody and reading comprehension (see Table 5).

The results of these studies are nearly inconclusive: 2 studies out of 5 did not observe any link between prosody and comprehension. Lopes et al. (2015) screened prosody and comprehension in 98 children four times at the 2nd and 3rd grade levels. The correlation between the ratings of these two dimensions was very low. One shortcoming of that study, mentioned by the authors, was the short term follow-up and the repetitive use of the same text at relatively short intervals of time. Lai, Benjamin, Schwanenflugel, and Kuhn (2014) conducted a longitudinal one-year study with 2nd graders and didn't find any relation between reading prosody and comprehension. Considering that comprehension is mostly linked to fluency in early readers, a possible explanation is that the second graders were not fluent enough to observe an impact of prosody on comprehension at this age.

Nevertheless, a bidirectional link was observed in the other 3 remaining studies. Klauda and Guthrie (2008) were the first to explore the possibility that bidirectional relations exist between fluency—prosody in particular—and comprehension. They indeed found an influence of prosody on comprehension and vice versa in their study observing 5th graders at 3 month intervals. This study has paved the way for longer term studies. Veenendaal, Groen, and Verhoeven (2016a, 2016b) studied pupils from the 4th to 6th grade in Dutch and proposed a bidirectional model that fits well with their data. In this model, comprehension at the 4th grade level is positively correlated to prosody in the 5th grade. Then the link is reversed and the prosody at the 5th

grade is positively and significantly correlated to comprehension at the 6th grade. They also noticed that the different components of fluency—reading rate, phrasing, intonation and expressivity—have changing correlations to comprehension over time and as reading skills progress. This bidirectional link was also observed in Portuguese between the 2nd and 3rd grades (Fernandes, Querido, Verhaeghe, & Araujo, 2018). They also found a predictive effect of prosody related to effortless comprehension (text vs. word reading) but found that evidence of a bidirectional relation between the 4th and 5th grades no longer existed. According to these authors, the relation depends on grade level and may be strongly influenced by the orthographic transparency of the language. Indeed, Portuguese is characterized by an intermediate level of orthographic depth, compared to Dutch which is transparent, which subsequently explains a bidirectional link for Dutch (Veenendaal et al., 2016a) but not for their Portuguese data.

## Discussion

Several studies have conclusively established that a relationship exists between prosody and comprehension. Once automaticity is in place, this link strengthens. The causal relation, however, is less clear. The link may be bidirectional and may change over time with the development of more advanced reading skills. Unfortunately, that fact that so few studies have focused on the possible causal relations between prosody and comprehension prevents us from gaining a clear picture, notably because the few that have focused on this specific dynamic were unable to produce converging results, for a number of reasons. Age difference between cohorts, differences in language transparency, and methodological variations are among the many possible causes explaining this divergence. We could add other possible reasons like difference of grammatical complexity between languages or difference of reading curricula between countries. More longitudinal studies on prosody and comprehension development would potentially shed important light on this question. Gaining deeper knowledge of the direction of this link could translate into developing new interventions to support readers with poor comprehension.

Syntactic awareness was measured only by Veenendaal et al. (2016a) and Klauda and Guthrie (2008), as one of the significant predictors of comprehension. Any link between syntactic awareness and oral reading prosody has not yet been directly studied. Given the use of syntactic awareness to correctly parse discourse, while also essential for appropriate phrasing, it could be worth investigating the link between syntactic awareness, phrasing and comprehension.

## Conclusions

Oral reading prosody is a recent area of interest in the reading curriculum. It can be assessed either with subjective scales or by screening acoustic parameters. Subjective scales provide researchers and teachers with a rapid and easy way to assess reading prosody, but these are mostly designed for classroom use and their reliability

depends on the availability of multiple trained assessors. To study prosodic parameters in greater detail, as well as the development of the language-specific spatio-temporal patterns, an analysis framework will need to be established that takes into account current prosodic models and theories of intonation.

The development of reading prosody begins with the development of the other reading skills. The studies reported here in different languages offer a timeline that roughly outlines prosody development. Phrasing is the first skill to develop with the reduction of number and lengths of pauses. Once decoding and automaticity are acquired, young readers can focus on the appropriate placement of the pauses, using appropriate intonation and adding expressiveness to their readings. The development begins in early years of reading acquisition and continues until adulthood. Some prosodic features are in fact not yet managed at the end of primary school. More studies with older pupils and in various languages could be useful to provide a wider and more complete view of reading prosody development.

Prosody is linked to comprehension, both in speech and reading. The direction of the link between reading prosody and reading comprehension has not been sufficiently studied to provide a clear picture of prerequisites, if any. Nevertheless, this bidirectional link seems to evolve with fluency skills and grade level. A plausible explanation is that the pupils need to understand the text to adjust their prosody to its content in the early stages of reading acquisition. As the reading skills increase, pupils turn back to relying on prosody to enhance their comprehension of the text. As for development, more studies would be useful to understand the precise nature of the relation between prosody and comprehension. They should also examine if particularities of the language—orthographic, linguistic as well as phonological—have an impact on the prosody-comprehension link.

Future research on reading prosody development and the possible comprehension-prosody link would be useful towards designing new methods of intervention (e.g., see Rasinski & Cheesman Smith, 2018). Indeed, if the bidirectional link is confirmed, improving reading prosody could lead to an implicit improvement of comprehension. Training reading prosody could be a way to help both fluent readers and poor comprehenders. Prosody teaching raises two questions: when and how. In many curriculums, reading instruction focuses firstly on decoding and automaticity and then possibly prosody is taught. Rasinski (2006, 2010) pointed out the issues of teaching decoding and automaticity apart from prosody. This separation tends to create fast readers at the expense of comprehension of both listener and reader. As reading is the combination of decoding, automaticity, prosody and comprehension, Rasinski suggests that every action should be taught together. Actually, this question closely depends on the main factors that influence prosody development. Is it more linked to cognitive maturity, automaticity, comprehension or a combination of several factors? A more precise development scheme of reading prosody would potentially help determine the best time to work with young readers on reading prosody in order to have a maximal impact on comprehension.

The second issue about prosody training is the intervention design. The first important point is the choice of the texts used. Indeed to improve prosody the text read should lead to prosody, like poetry or theater. According to Young and Rasinski (2018), repeated reading for performance, like Readers Theaters, give motivation

to children to improve their prosody. In fact repeated reading focused on prosody, and not on rate, helps children to extract the syntax and meaning of the text and so improve prosody. Another promising intervention is modeling. Listening to an expert expressive reader gives the child guidance to what expressive reading sounds like. The modeling could also be important in pre-reading years, especially when teaching prosody and decoding simultaneously. It is easier for a child to produce prosodic reading, when he/she has a picture of what is prosodic reading.

To conclude, prosody in reading has been shown to be an important part of reading skills, just as decoding, automaticity and comprehension. Despite this, its inclusion in the curriculum is not optimized. Future research on its development, its place in the curriculum and the different way to enhance prosodic skills of pupils, young readers and more skilled ones, needs to be conducted.

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